IMG 222

FOOD PRESERVATION

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Content

Principle of food preservation

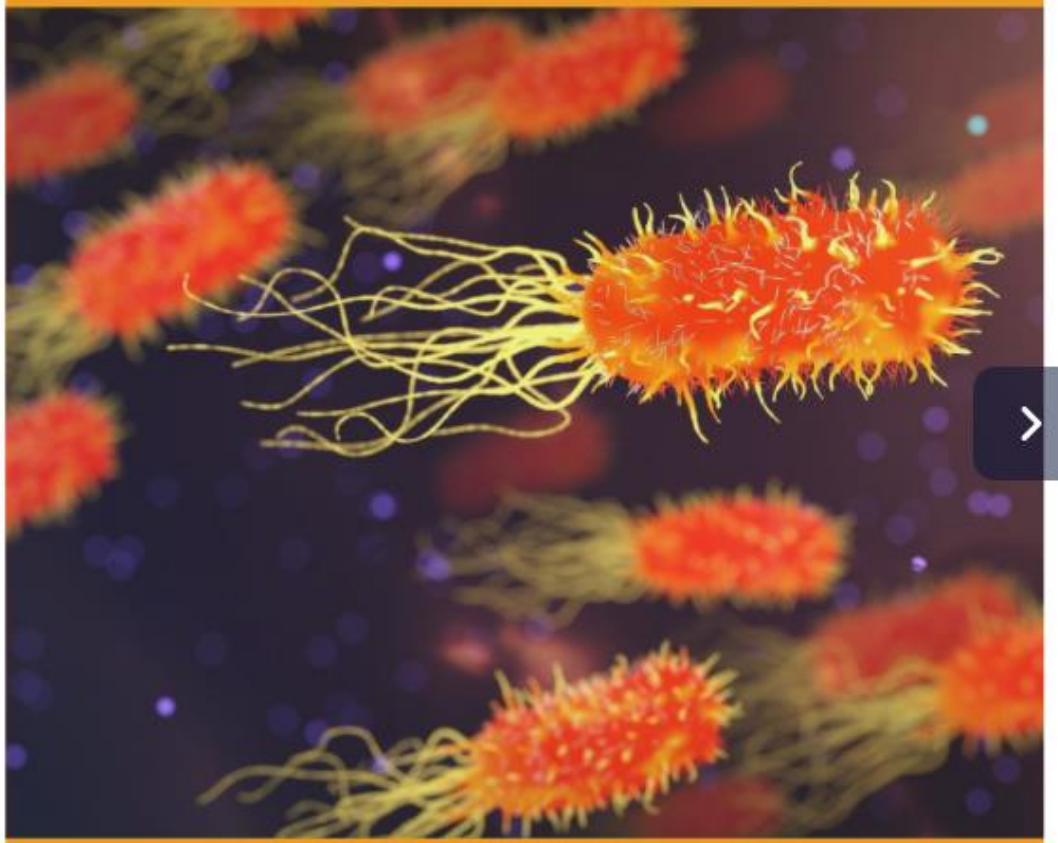
Methods of food preservation

Principle of food preservation

- Prevention or delay of microbial decomposition
- Prevention or delay of self-decomposition of the food
- Prevention of damage

Prevention or delay of microbial decomposition

- By **keeping out** microorganism (asepsis)
- By **removal** of microorganism (filtration)
- By **inhibiting the growth and activity** of microorganism (drying, anaerobic condition, lowering the temperature, etc.)
- By **killing** the microorganism (heat or radiation)



Prevention or delay of self-decomposition of the food

- By destruction or inactivation of enzymes
- By prevention or delay of purely chemical reactions
  - e.g. prevention of oxidation

Prevention of damage

- Prevent damage cause by insects, animals, mechanical, etc..

Microbial decomposition of foods will be prevented if all spoilage organisms are killed and recontamination is prevented.

Methods of preservation

- Asepsis- keeping out microorganisms.
- Removal of microorganisms.
- Maintenance of anaerobic condition.
- Use of high and low temperatures.
- Drying and smoking.
- Use of chemical preservatives.
- Irradiation.
- Combinations of two or more of the above methods.

Asepsis

Natural protection

- Outer layer of animal and plant tissue protects the inner layer from microorganisms.
- This protective covering will delay / prevent microbial decomposition
  - e.g. shells of nuts, skins of fruits and vegetables etc.

Packaging of food

- Wrapping, hermetically sealed containers (airtight).
- This methods will prevents primary contamination during handling.

Sanitary methods

- handling and processing foods
- e.g. in the dairy industry, contamination with microorganisms is avoided as much as possible in the production and handling of milk.

Physical method to remove microorganisms

Filtration

- Complete removal by using a pre-sterilized filters e.g. in fruit juices, soft drinks and water.
- Coarse filters are initially used to remove the large compounds and this is followed by ultrafiltration

Physical method to remove microorganisms

Centrifugation

- Particle separation through centrifugation force,
- Through differences in size, shape and density
- Three groups, namely
    1. separation of immiscible liquids,
    2. clarification of liquids by removal of small amounts of solids, and
    3. removal of solids

Physical method to remove microorganisms

Washing

- Helpful in removing soil microorganisms from fresh fruits and vegetables that may be resistant to heat process during canning.

Physical method to remove microorganisms

Trimming

- Trim away spoiled portions of a food.

Maintenance of anaerobic conditions

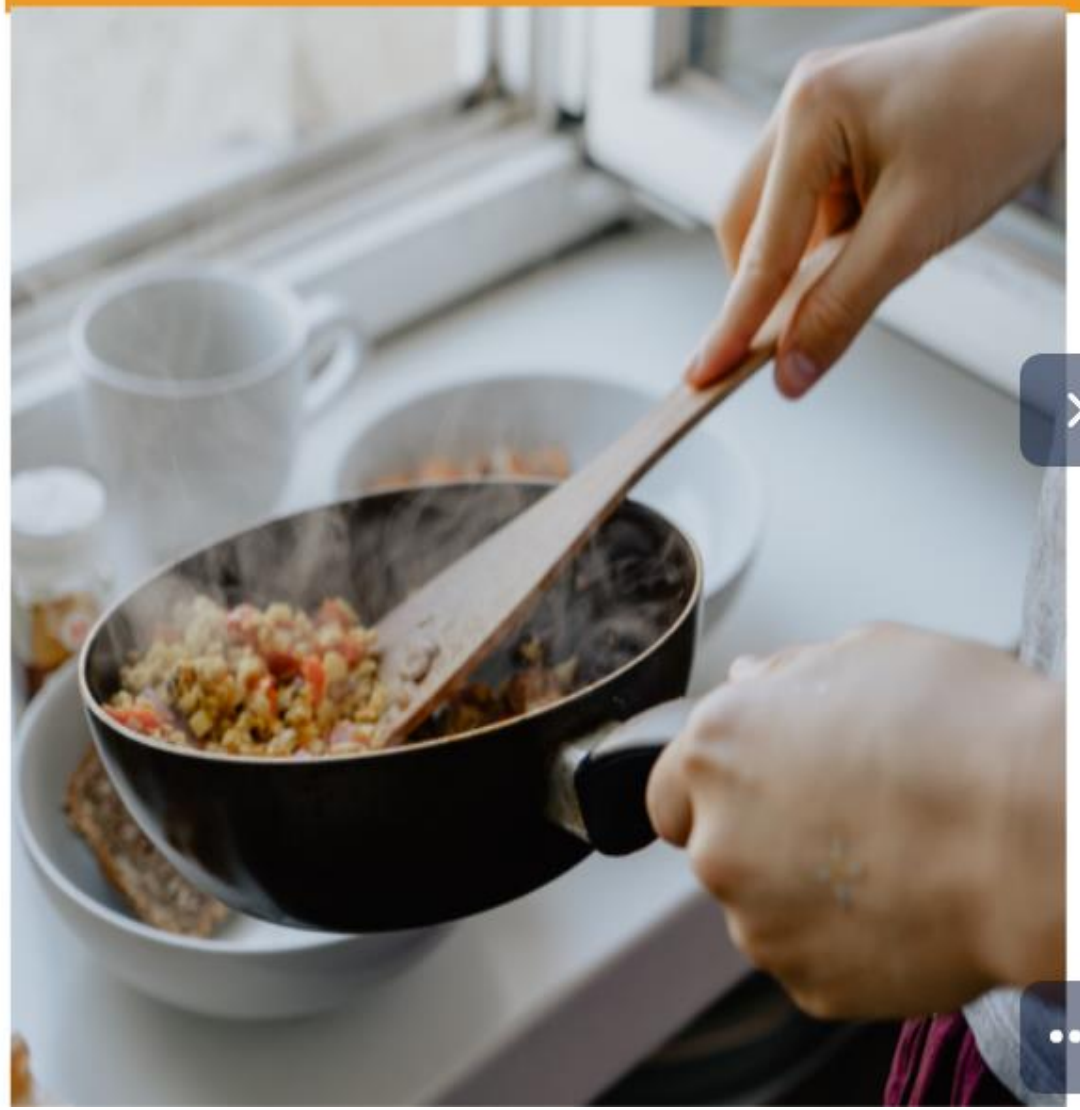
- Anaerobic conditions can be achieved by a complete fill, evacuation of the unfilled space, replacement of air by C02 or N2 and others.
- Spores are resistant to heat and may survive in canned food but they unable to germinate in the absence of oxygen, except the anaerobic bacteria, e.g *Clostridium botulinum*

Use of HIGH temperature

Temperature and time used in heat processing will depend on:

(a) The effect of heat on the food
- pasteurization
- heating at about 100°C
- heating above 100°C

(b) Other preservative methods employed



Heat treatments that kills most but not all microorganisms.

Example: Milk 63°C, 30 mins; 72°C, 15 secs

Juice 77°C, 30 mins; 88°C, 30 secs

The pasteurized products are cooled promptly after the heat treatment.

LTLT: Low Temperature Long Time (63°C, 30 min)

HTST: High Temperature Short Time (72°C, 15 sec)

UHT: Ultra High Temperature (135-140°C, 2 - 4 sec)

a) Pasteurization is important when:

- Heat treatment will not harm the quality of product
- Main spoilage microbes are not very heat resistant e.g. yeast in fruit juices
- Kill pathogens
- Any surviving organisms will be treated with other preservative methods
- Competing organisms are to be killed, allowing a desired fermentation

Preservation methods used to supplement pasteurization

- Refrigeration.
- Keeping out microorganisms by packaging.
- Maintenance of anaerobic conditions.
- Addition of high concentration of sugar.
- Presence of chemical preservatives (e.g. sodium benzoate)

b) Heating at about 100°C

- Sufficient to kill all microbes but not spores,
- Many acid foods are successfully preserved at 100°C.
- Methods:
  - Boiled, Immersion, Baking, Simmering, Roasting, Frying, Blanching, Exposure to flowing steam

b) Heating above 100°C (sterilization)

- Sufficient to kill all microbe and spores
- All commercially sterile foods should be stored in cool and dry place to prevent any survival thermophilic spores from germinating and cause, spoilage to the foods.
- In general, microbial spoilage can occur due to under processing and/or leakage after processing.

Canning process

- Preservation of foods in sealed containers followed by application of heat treatment.
- Canning (also known as hermetically sealed containers) is done in tin cans, glass containers, aluminum and plastic pouches.
- Hot water canning - high acid food
- Pressure canning - low acid food

Objective of heating food

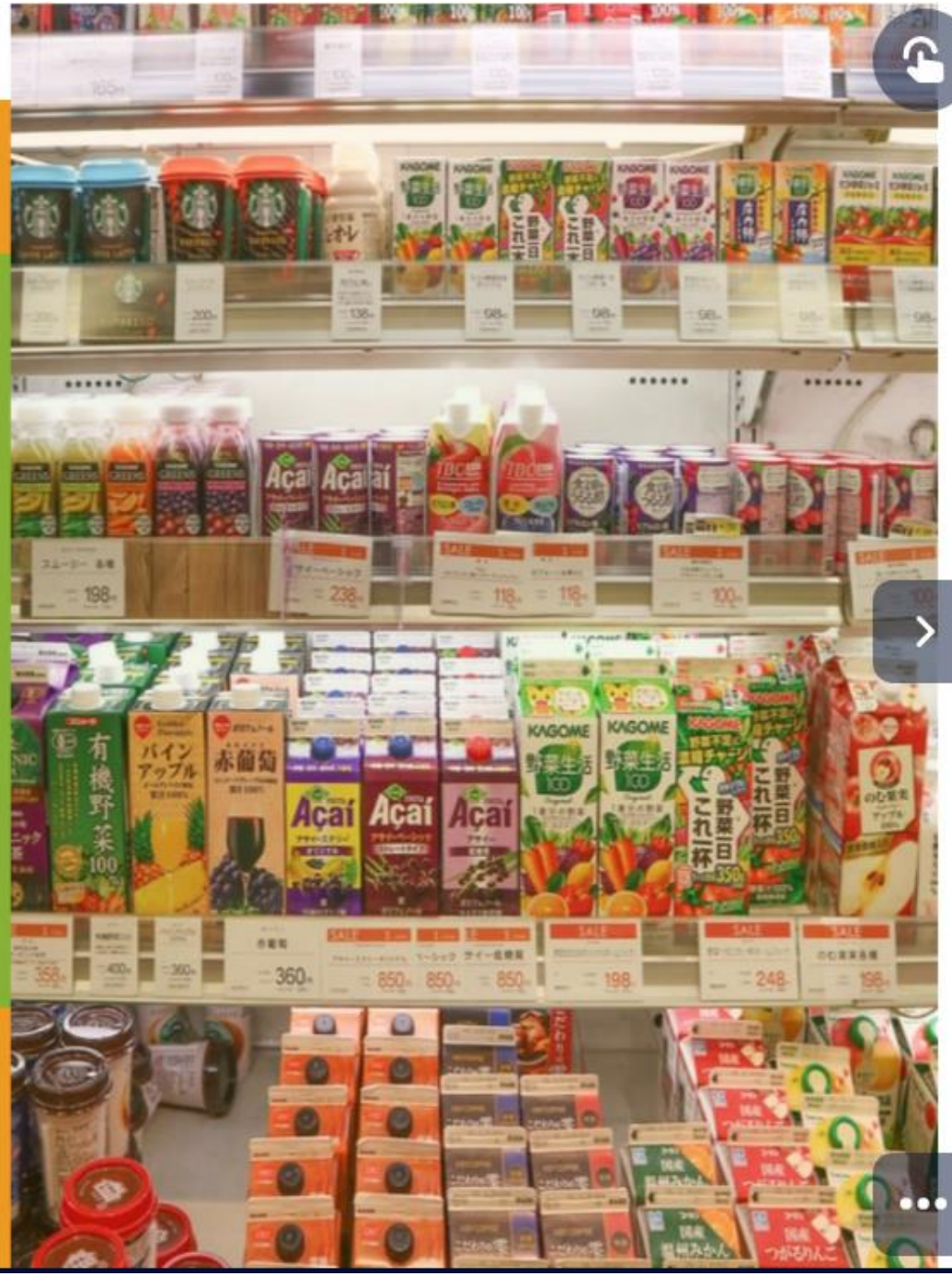
- To destroy pathogens and spoilage microorganisms
- To destroy the vegetative cells and spores of yeast, bacteria and moulds
- To destroy undesirable enzymes this can affect the quality of foods.
- To control the growth of surviving microorganisms
- To retain the acceptance and nutritional quality of foods
- To reduce competition

Use of LOW temperature

- Low temperature reduces the activity of microorganisms by reducing the chemical reaction and action of enzymes.
- Hence, less microbial growth and spoilage' is delayed / prevented.

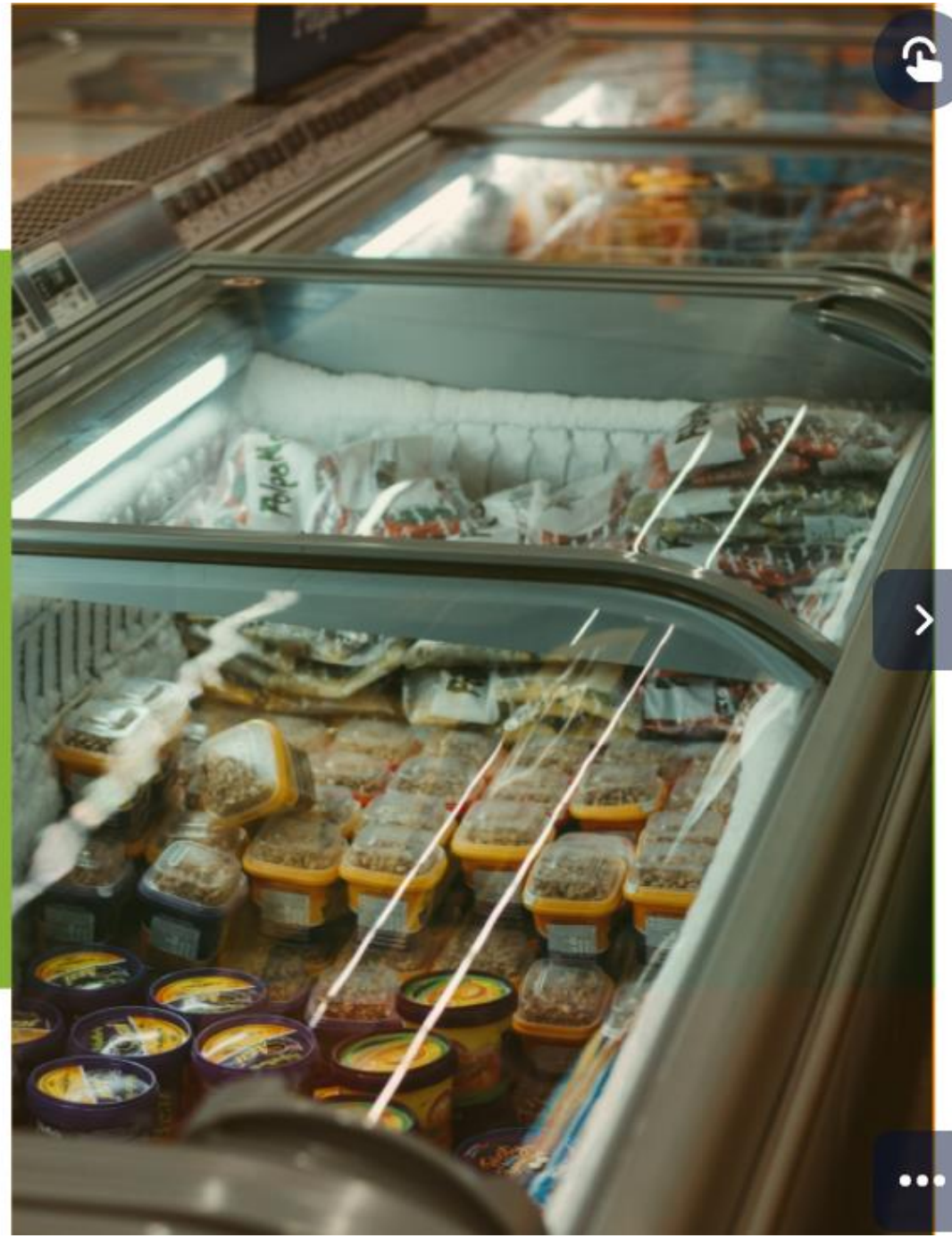
a) Chilling temperature

- Temperature of 6°C can prevent the growth of pathogens except *Clostridium botulinum* type E and retard the growth of spoilage microorganisms.
- Main method for temporary preservation of food.
- Psychrotroph can grow at low temp. e.g. F*lavobacterium* spp. & *P. alcaligenes* but they have a low growth rate.



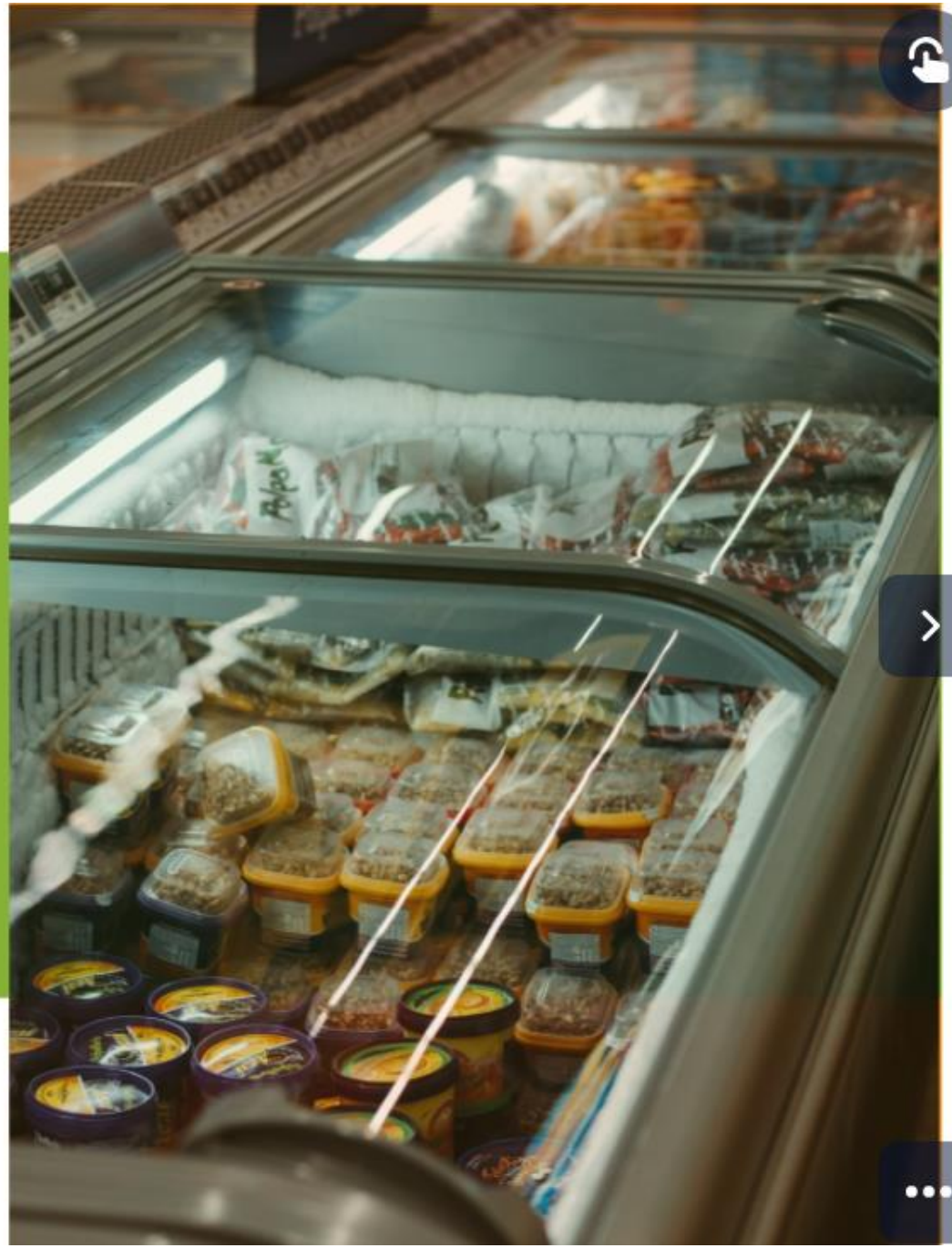
a) Freezing temperature

- Cause reduction in number of viable microorganism but does not sterilize the food.
- The percentage of microorganisms killed during freezing and storage varies depending on:
  (a) Substrate (kind of food)
  (b) Type of freezing



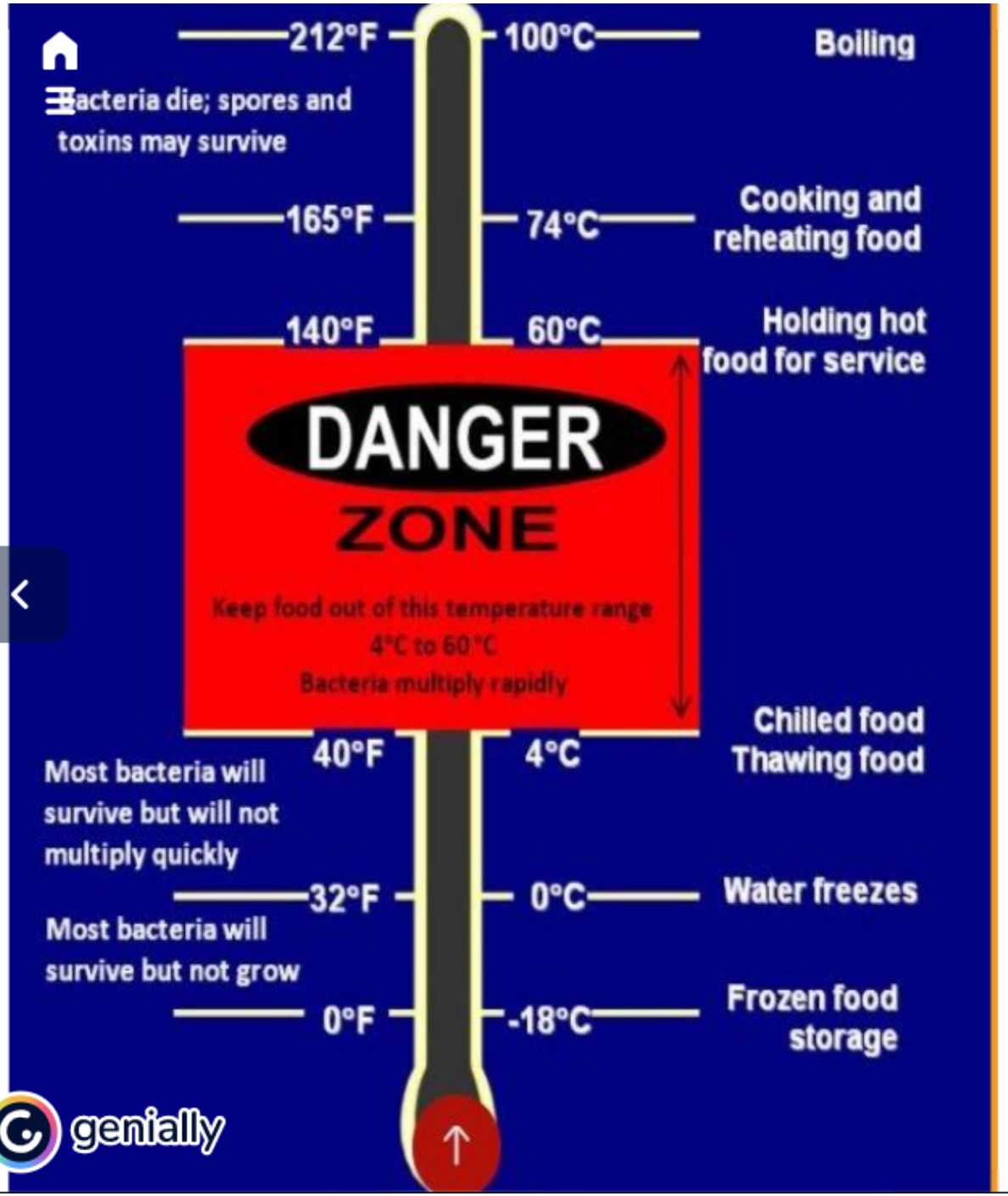
Freezing

- (a) Substrate: protein, fat and other substance can have protective effect; therefore killing rate is reduced. High moisture and low pH can increase killing rate.
- Type of freezing:
  - slow freezing (temp. lowered to -20°C within 3 - 72 hrs)
  - fast freezing (temp. lowered to -20°C within 30 mins



Advantages of fast freezing

- Smaller ice crystal form - less mechanical destruction to food
- Short period of solidification - sudden death to microorganisms and quick inactivation of the enzymes.
- Food quality after thawing is better



Important temperature to remember!!

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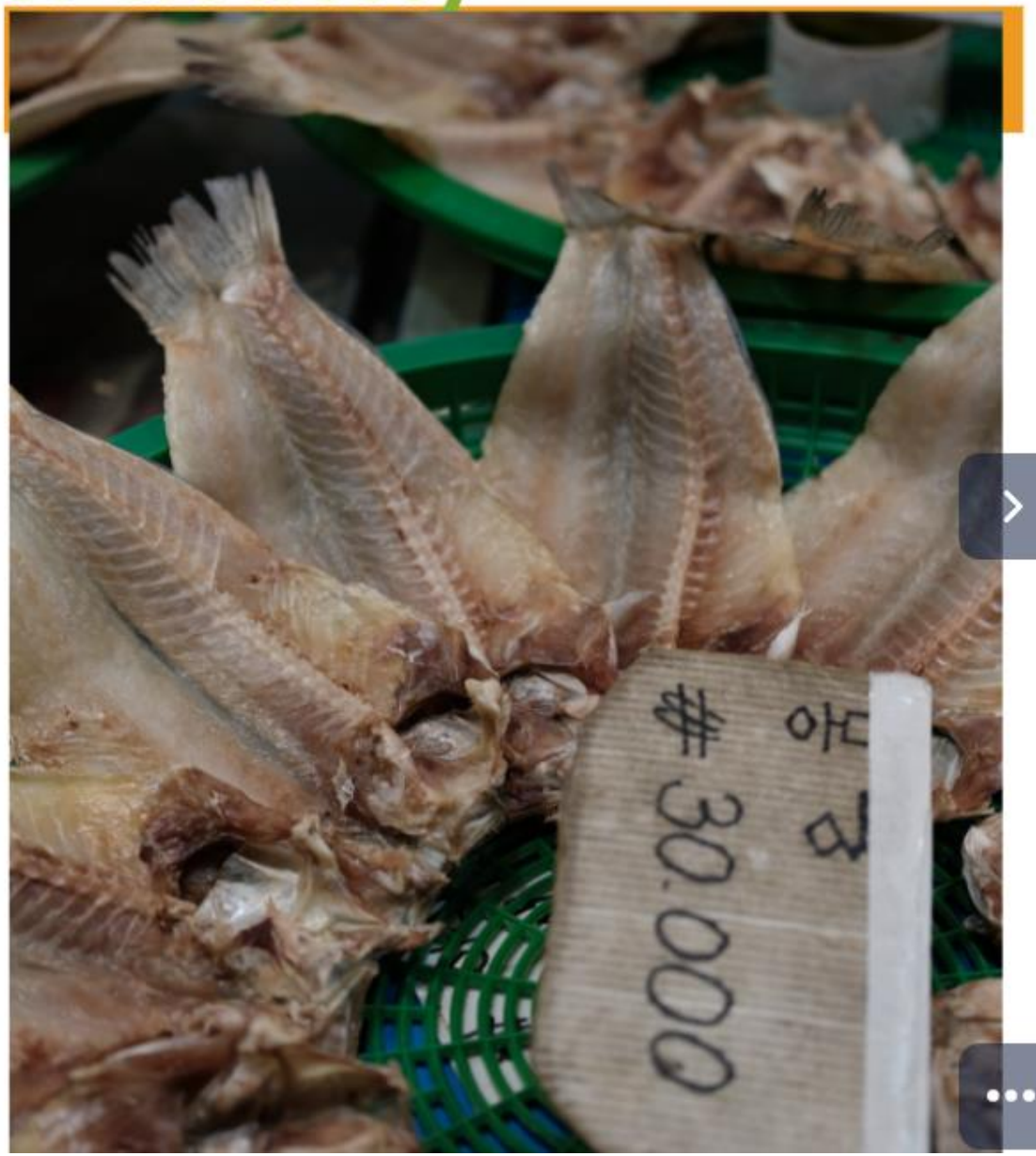
Drying / Reduced water activity

- Methods which lower the water content of food to a point where the activities of enzymes and food spoilage and food poisoning microorganisms are destroyed / inhibited.
- The lower the water activity (aw) of food, the greater is the inhibition.
- Microorganisms need water for transport of nutrients, nutrient metabolism, and removal of cellular wastes.



Drying / Reduced water activity

- If aw is 0.75 - 0.70, the spoilage is delayed.
- If aw is 0.65, the spoilage is most unlikely to occur up to 2 years.
- Molds and yeasts are more important in spoilage dried foods as bacteria require higher water content for growth.
  - *Streptomyces rouxii* (aw 0.65)
  - *Aspergillus* spp. (aw < 0.70)

In a food, the total water (moisture) is present as free water and bound water

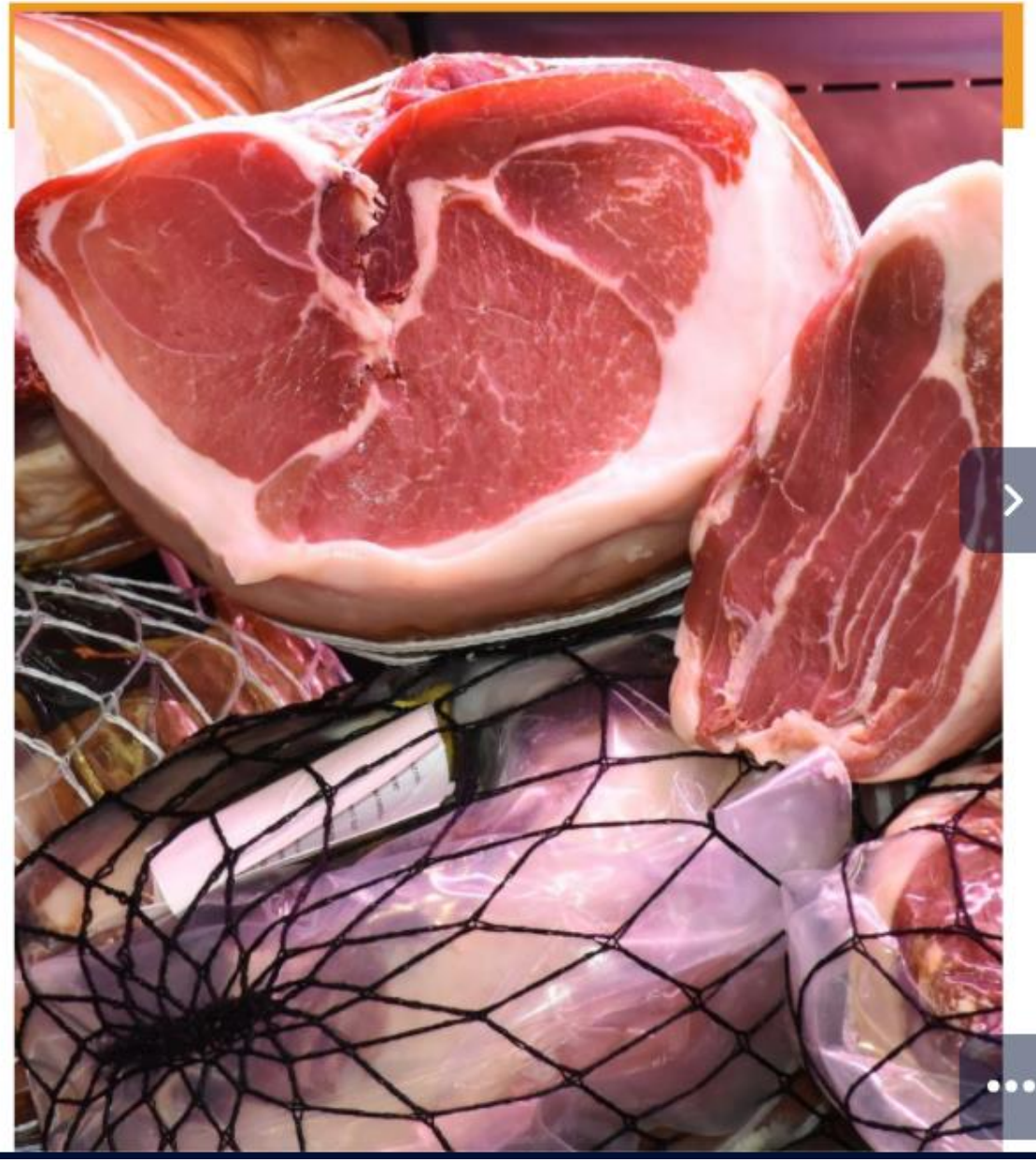
BOUND WATER bound to hydrophilic colloids and solutes and is not available for biological functions

Only the FREE WATER (which is related to A W) is important for microbial growth

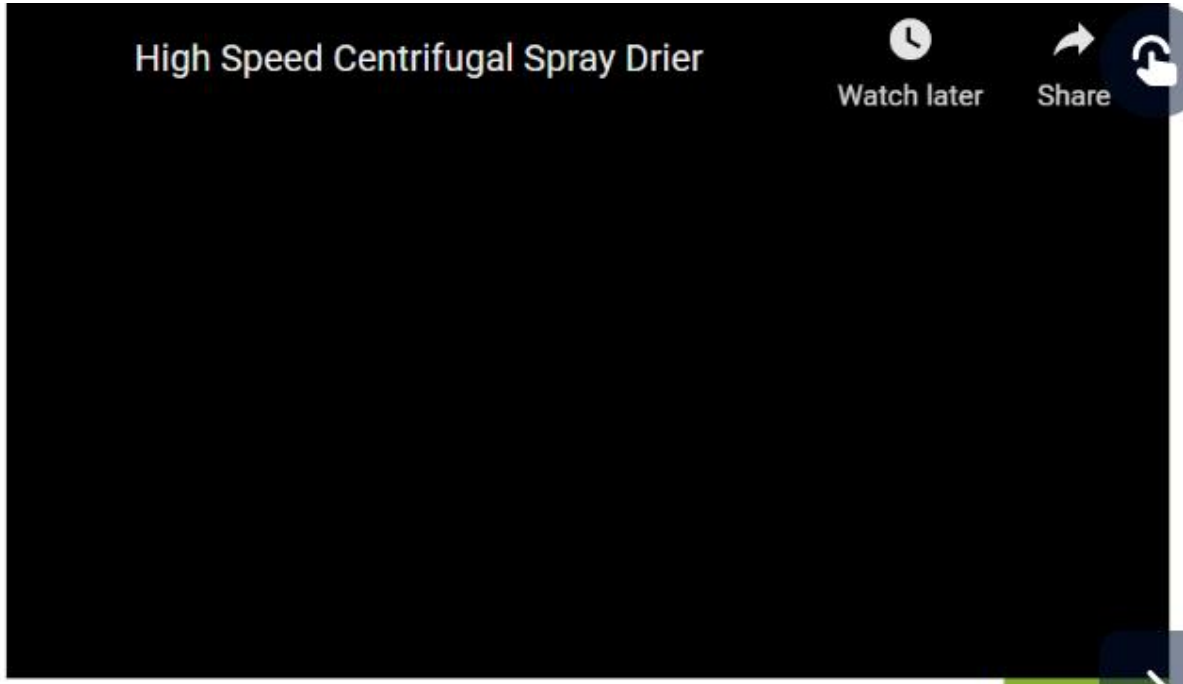
The loss of water causes an osmotic shock and plasmolysis

Drying method

- Sun drying
- Smoking
- Freeze drying
- Spray drying



Spray drying vs freeze drying



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Smoking

- Heating foods using smoke from various types of wood to preserve foods.
- The smoke produces heat which kills some microorganisms on the surface
- Heat also reduces the aw.

Reduced water activity by the addition of solutes

- Addition of solutes such as salt, sucrose, glucose wil reduce the aw
  - salted fish
  - fruit jam
- Low aw cause injury and kill the microbes
- Depend on the nature of microorganisms

Clostridium botulinum Type E	0.97
Clostridium perfringens	0.95
Escherichia coli	0.95
Salmonella enterica	0.95
Vibrio parahaemolyticus	0.94
Staphylococcus aureus	0.86
Pseudomonas fluorescens	0.97
Lactobacillus viridescens	0.94
Yeast	
Saccharomyces cerevisiae	0.90
Saccharomyces rouxii	0.62
Debaryomyces hansenii	0.83
Molds	
Rhizopus nigricans	0.93
Penicillium chrysogenum	0.79
Penicillium patulum	0.81
Aspergillus flavus	0.78

Chemical preservatives

- Food additives / preservatives:
- A substance or a mixture of substance which are specifically added to prevent deterioration or decomposition of a food"
- Deterioration may be caused by:
  - (a) Microorganisms
  - (b) Food enzymes
  - (c) Chemical reactions

Chemical preservatives

- Chemical preservatives are used mainly to inhibit the growth and activity of microorganisms by:
  - (a) Interfering with their cell membranes
  - (b) Their enzyme activity
  - (c) Their genetic mechanisms

Control by low pH using organic acid

- Low pH can kill / inhibit microbial growth - depend on the nature of the microorganism
- Organic acid can present in 3 form
  - naturally present in food (citric acid in citrus fruits, benzoic acid in cranberries, and sorbic acid in rowan berries)
  - by product of fermentation (lactic acid, acetic acid, propionic acid)

Microorganism	*Minimum Growth pH*
Gram-Negative Bacteria	
Escherichia coli	4.4
Pseudomonas spp.	5.6
Salmonella serovars	4.5
Vibrio spp.	4.8
Serratia spp.	4.4
Gram-Positive Bacteria	
Bacillus cereus	4.9
Bacillus stearothermophilus	5.2
Clostridium botulinum	4.6
Clostridium perfringens	5.0
Enterococcus faecalis	4.4
Lactobacillus spp.	3.8
Staphylococcus aureus	4.0
Listeria monocytogenes	4.6
Yeasts	
Candida spp.	1.5–2.3
Saccharomyces spp.	2.1–2.4
Hansenula spp.	2.1
Rhodotorula spp.	1.5

Many organic acids are used as food additives to reduce the pH of food and restrict microbial growth

Among the organic acids used in food as preservatives are acetic, propionic, lactic, citric, sorbic, and benzoic acids; their SALTS;

Chemical preservatives in food

PROPIONATES

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- Used in bakery, cheese food & spreads
- Sodium or calcium propionates prevent bacteria and mold growth

BENZOATES

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Used in jam, jellies, margarine, carbonated drinks, fruits etc.

SORBATES

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- Sorbic acids and sorbate salts are used as a direct antimicrobial additive in foods as a spray, dip or coating on packaging materials.
- Used in cheese, dried fruit, bakery etc

ACETATES

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Dehydroacetic acid has been used to impregnate wrappers for disease to inhibit mold growth.

- Acetic acid (vinegar) is used in mayonnaise, ketchup, sausages etc

NITRITES AND NITRATES

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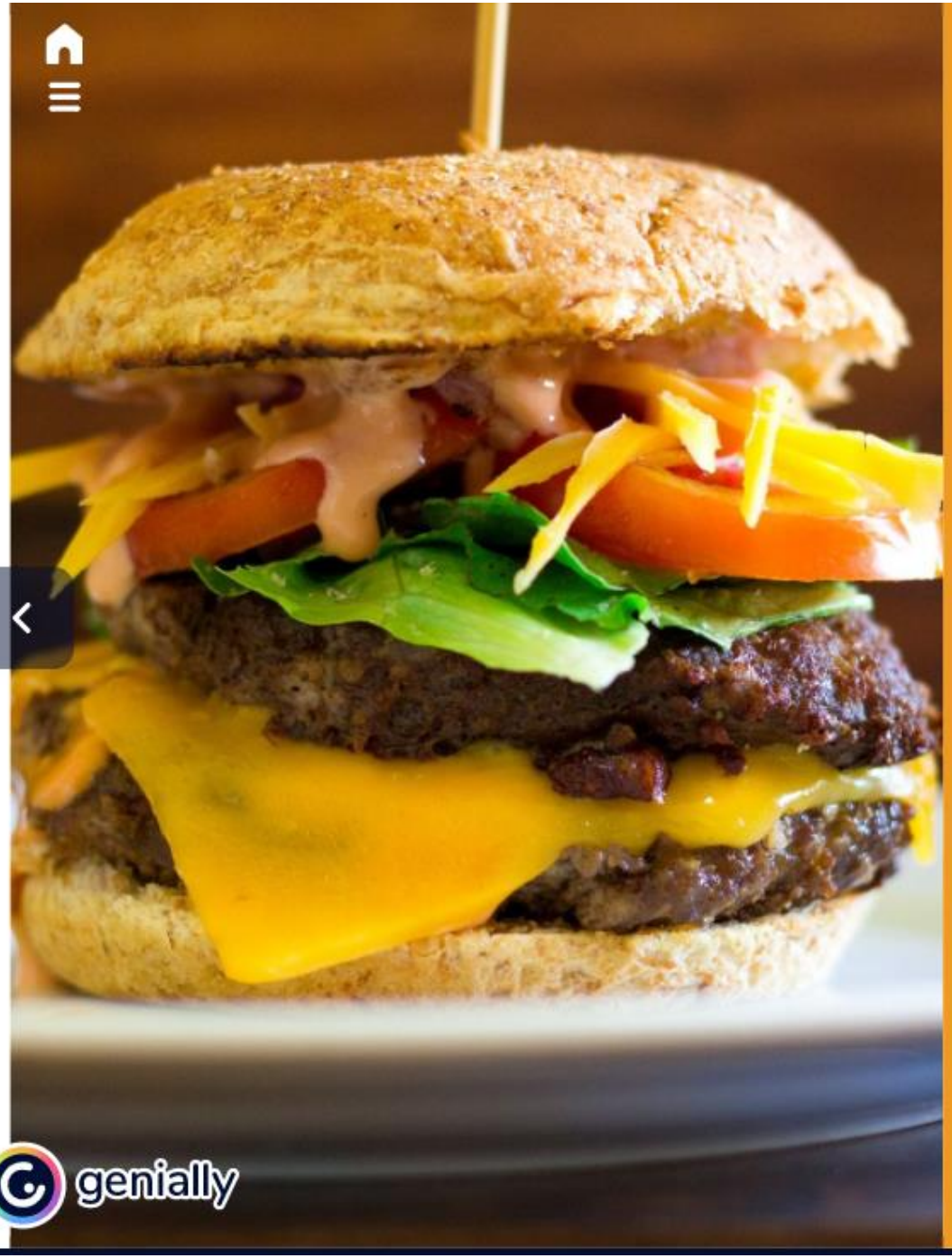
- nitrites give a stable red color. to meat
- Restricted because it can react to other substance e.g. amines and form nitrosomines which is carcinogenic.
- Nitrites are shown to have an inhibitory effect toward *C. botulinum*.



An ideal chemical preservative should have:

- A wide range of antimicrobial activity
- Non toxic to human beings and animals
- Economical
- No effect on the flavour, taste or aroma of the original food
- Should not be inactivated by the food
- Should not encourage the development of resistant strains
- Should rather kill than inhibit microorganisms

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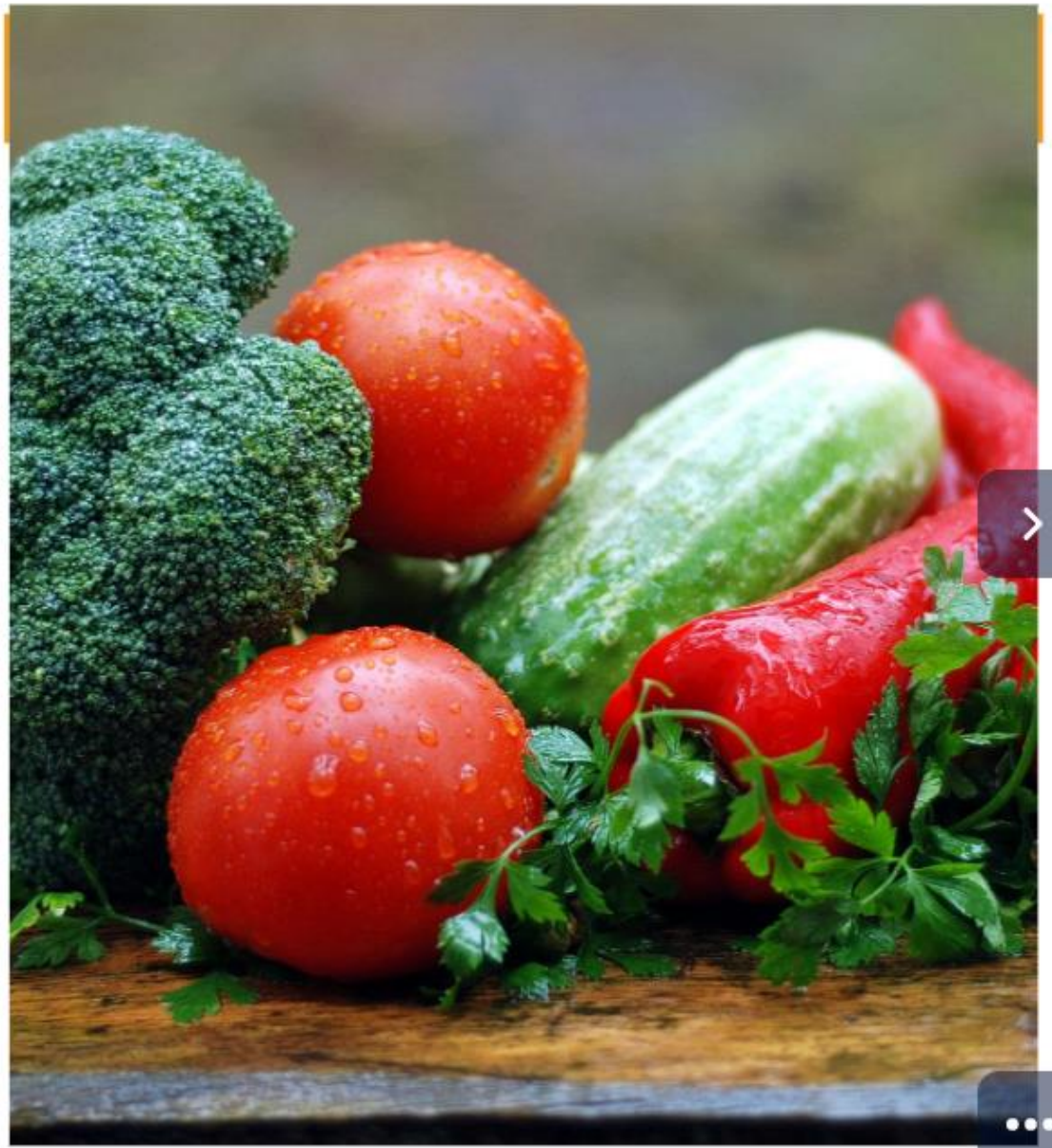
Modified atmosphere

- Controlled atmosphere packaging (CAP)
- Modified atmosphere packaging (MAP)
- Active packaging (AP)
- Vacuum packaging (VP)

Inhibit the growth of aerobes, but anaerobes & facultative anaerobes may grow



Other preservation methods

- Membrane filtration technology

Other preservation methods

Radiation

- Gamma ray
- X ray
- UV
  - Inactivate microbes on the food surface (meat, fish, bread, fruit and vegetables, water)

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Thank you!