IIT KHARAGPUR

NPTEL ONLINE
CERTIFICATION COURSES

Dairy and Food Process and Products Technology

PROF. TRIDIB KUMAR GOSWAMI
AGRICULTURAL AND FOOD ENGINEERING DEPARTMENT
IIT KHARAGPUR
Lecture 6

Appertization: processes where the organisms that survive are non pathogenic, not capable of developing within the products under normal storage condition.

Appertized food is not necessarily sterile, but completely free from viable organisms.
Commercially sterile – relative concept – objected by law.

COLD PRESERVATION:

$Q_{10} = K_{10+T} / K_T$

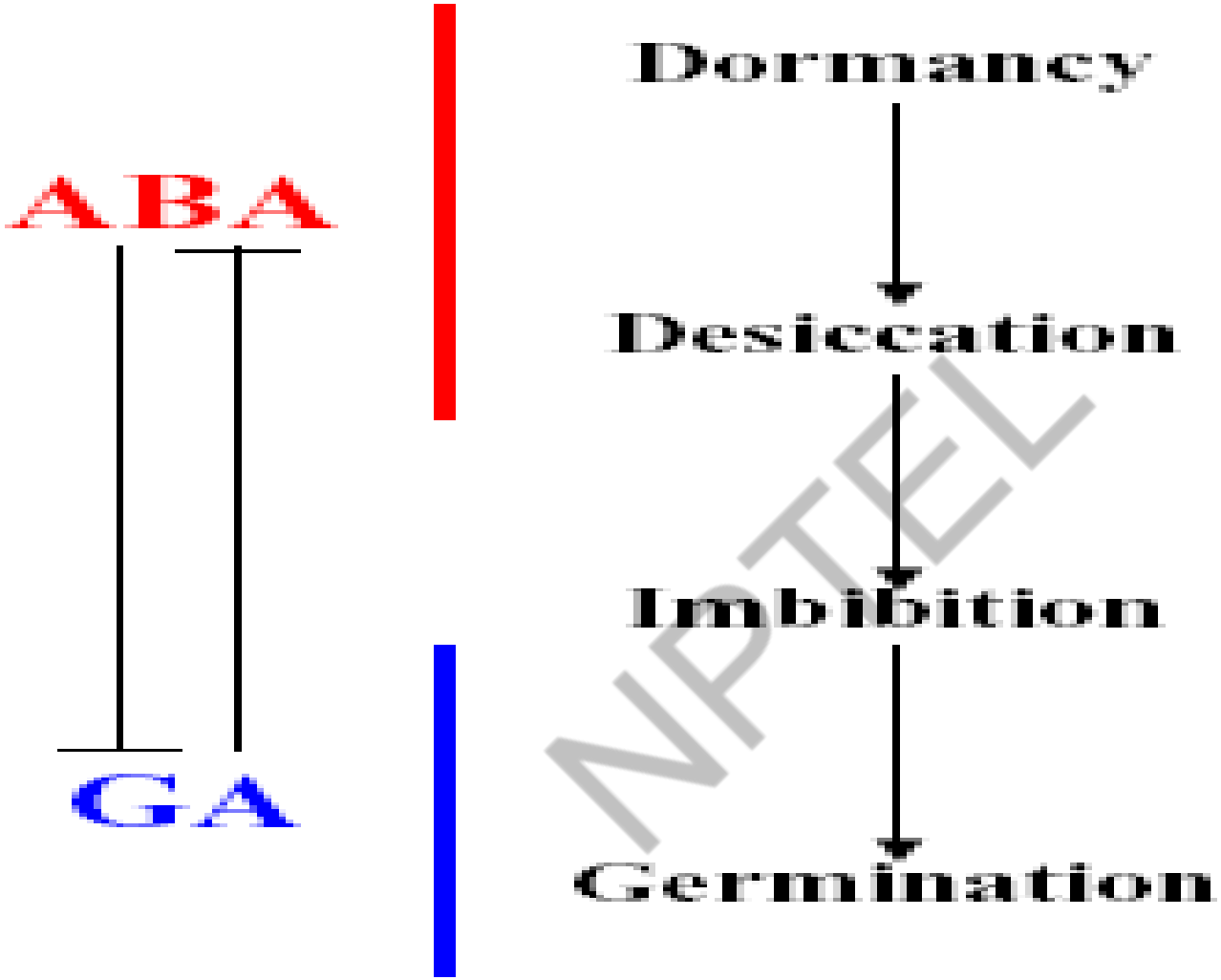
10 ^oC lowering of temperature makes shelf life almost double.

Without a doubt, the most important factor affecting post harvest life is **temperature**. This is because **temperature** has a profound affect on the rates of biological reactions, e.g., metabolism and respiration.

Over the physiological range of most crops, ie., 0 to 30 °C, increased temperatures cause an exponential rise in respiration. The Van't Hoff Rule states that the velocity of a biological reaction increases 2 to 3-fold for every 10 °C rise in **temperature.**

Typically,

- Q_{10} for growth = 1.5
- Q_{10} for imbibitions = 1.5 to 1.8
- Q_{10} for photosynthesis = 2.1 to 2.5
- Q_{10} for respiration = 2 to 3



Photosynthesis

H_2O + CO_2

Energy

Which splits water

ATP and $NADPH_2$

Light is Adsorbed By Chlorophyll

Calvin Cycle

ADP
NADP

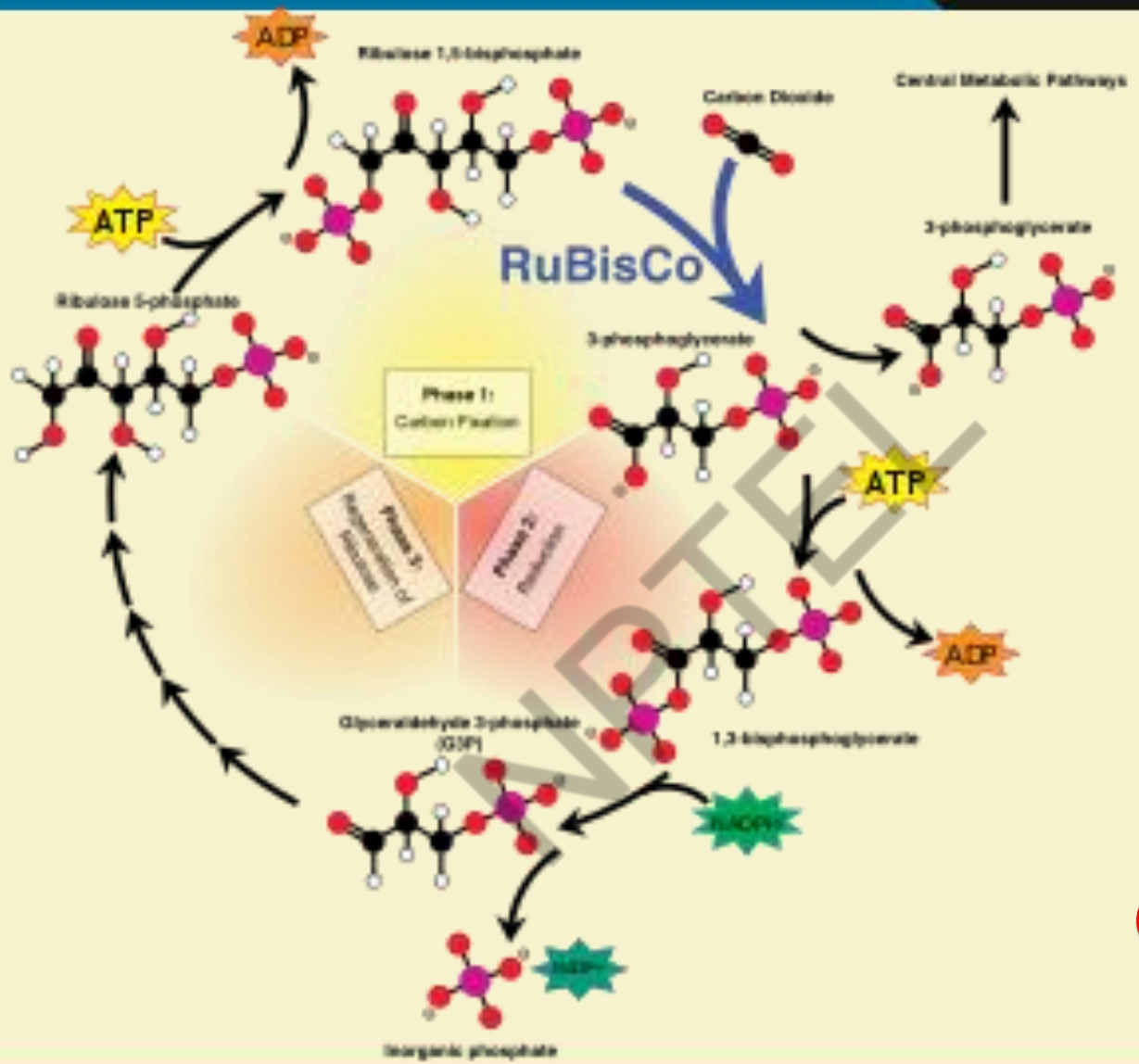
Chloroplast

Used Energy and is recycled.

O_2

$C_6H_{12}O_6$

Light Reaction + Dark Reaction



Calvin Cycle

RESPIRATION

CYTOPLASM

GLYCOLOSIS HAPPENS HERE!

PROTEINS

AMINO ACIDS

CARBO'S (SUGARS)

GLUCOSE $C_6H_{12}O_6$

FATS (LIPIDS)

GLYCOLOSIS IN CYTOPLASM NO OXYGEN!

MAKES 2 ATPS

PYRUVIC ACID

ACETYL-CoA

ATP TOTALS

GLYCOLOSIS=2

RESPIRATION=34

BOTH=36!

O_2 ENTERS HERE

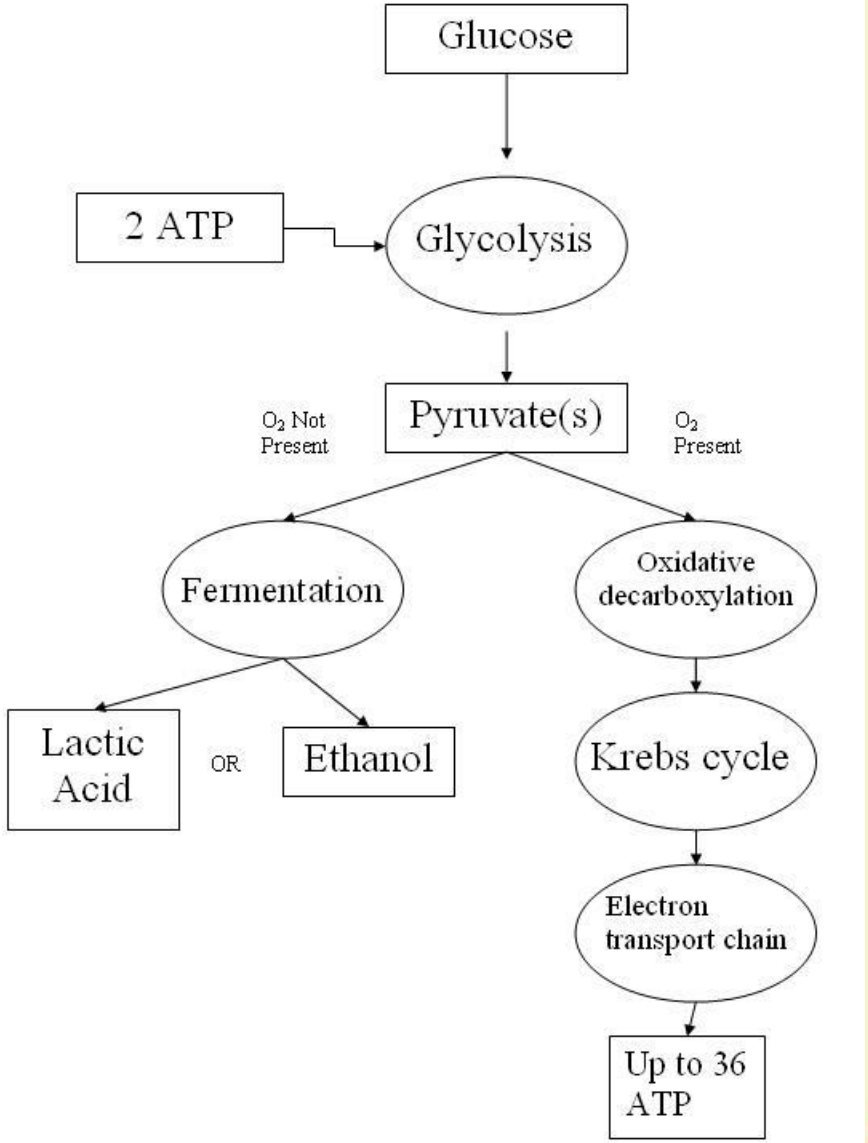
KREBS CYCLE AND ELECTRON TANSPORT

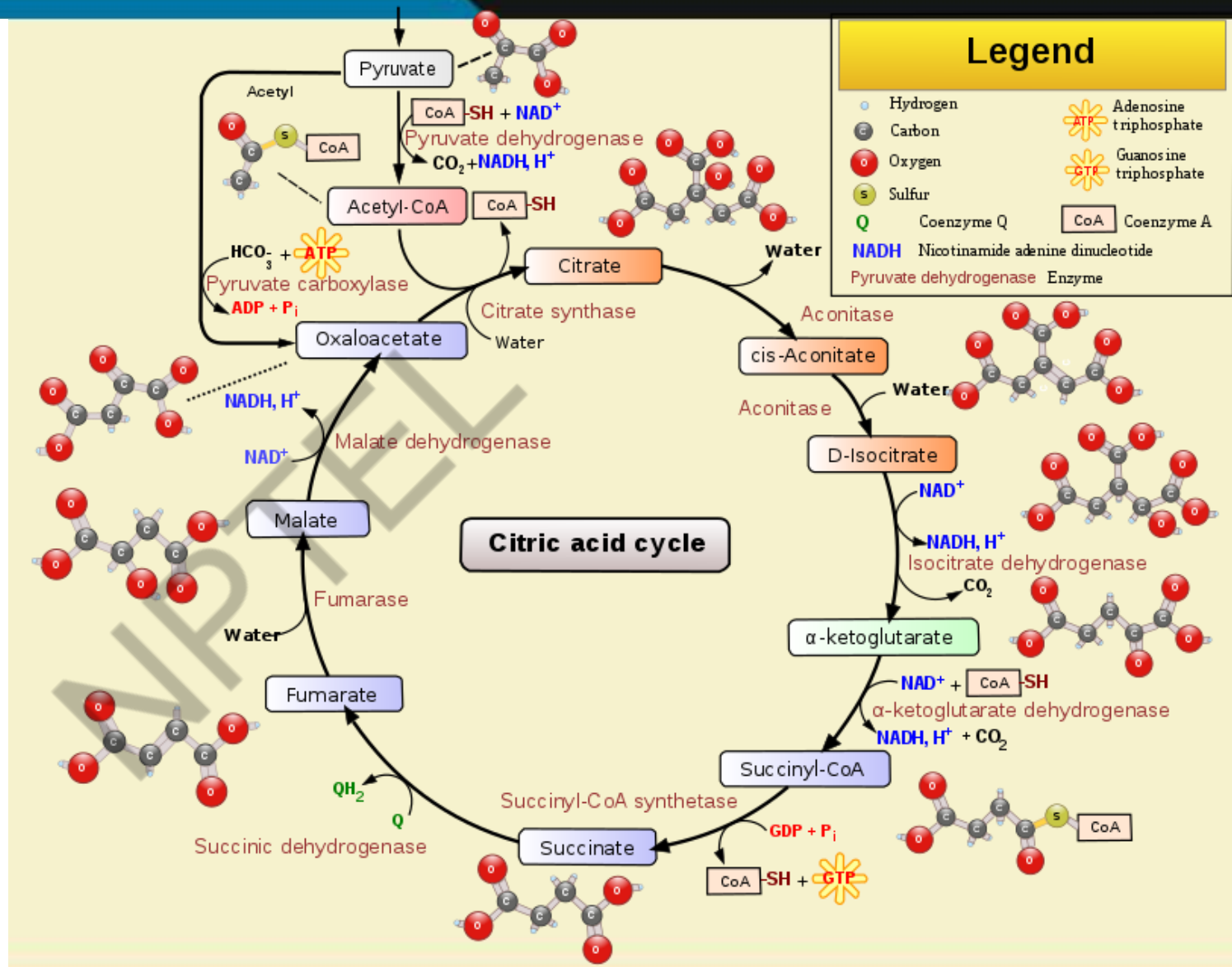
MAKES 34 ATPS

CO_2 IS RELEASED

MITOCHONDRIA

RESPIRATION HAPPENS IN THIS ORGANELLE!


Glucose
2 ATP
Glycolysis
Pyruvate(s)
O_2 Not Present
O_2 Present
Fermentation
Oxidative decarboxylation
Lactic Acid
OR
Ethanol
Krebs cycle
Electron transport chain
Up to 36 ATP


Legend
Hydrogen
Carbon
Oxygen
Sulfur
Coenzyme Q
Nicotinamide adenine dinucleotide
Pyruvate dehydrogenase Enzyme
Adenosine triphosphate
Guanosine triphosphate
Coenzyme A
Pyruvate
Acetyl
CoA
Pyruvate dehydrogenase
Acetyl-CoA
Citrate
Water
Citrate synthase
Oxaloacetate
Pyruvate carboxylase
ADP + P_i
Aconitase
cis-Aconitate
D-Isocitrate
Isocitrate dehydrogenase
α-ketoglutarate
α-ketoglutarate dehydrogenase
Succinyl-CoA
Succinyl-CoA synthetase
Succinate
Succinic dehydrogenase
Fumarase
Malate
Malate dehydrogenase
Citric acid cycle

Chill storage: 0 to 5 °C, only psychrotrophs can grow relatively slowly. e.g. generation time for pseudomonas available in fish is 6-8 hours at 5 °C compared to 26 hr at 0 °C.

- As the temperature is lowered the plasma membrane of the organism undergoes phase transition from liquid crystalline to the gel in which transportation of solutes is extremely difficult.
- Mesophiles can grow at chilling temperature but not necessarily killed. Certain psychrotropes such as pseudomonas do grow and cause food poisoning.

- Moisture loss – a major problem. Protected by several types of packaging.

Large pieces of meat are often packed in plastic bags or sprayed with various moisture resistant coatings. Eggs are coated with edible oil which seals the minute pores in egg shells. Beefs ageing at 90% R.H. for several weeks at 2 ^{o}C is treated with UV rays.

FREEZING: The most popular method and brought conveniences at homes. Food material begins to freeze as temp decreases. Perishable foods are stored at –18 ^{o}C or below.

- Microbial growth is not possible at this temperature . but enzymatic and non enzymatic reactions are not stopped but the rates are slowed down.

Temp.	-18 ^{o}C	-12^{o}C	-7^{o}C
Cauliflower	12 month	2.5 month	10 days
Chicken	27 month	15 month	8 month

Comparison betⁿ chilling and freezing storages

Product	4 °C Temp	-18 °C Temp
Fresh egg in shell	3 to 5 weeks	Don't freeze
Raw yolks, whites	2 to 4 days	1 year
Hotdogs,opened pckge	1 week	1 to 2 months
Fresh Beef, Lamb, Pork	3 to 5 days	6 to 12 months
Chicken or turkey, whole	1 to 2 days	1 year
Pizza	3 to 4 days	1 to 2 months
Juices, fruit drinks, punch	3 weeks unopened	8 to 12 months
Butter	1 to 3 months	6 to 9 months
Cottage Cheese	1 week	Doesn't freeze well
Lean fish (cod, haddock)	1 to 2 days	6 months
Fatty fish	1 to 2 days	2 to 3 months

Thank You!!

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Lecture 07

What are food additives?

Food additives are substances those are added to products to perform specific technological functions such as PRESERVATIVE, INHIBIT GROWTH of PATHOGENS, COLOURING or FLAVOURING MATERIAL.

Justification – Maintains nutritional quality of food; Enhances stability reducing wastage; Makes food attractive to consumers in a manner that precludes deception; Provides essential aids to food processing.

TYPES of ADDITIVES:-

- Natural – which are found naturally such as extracts of beetroot can be used as a colouring agent.
- Manmade additives:- Chemicals (synthetic) substances may be found naturally such as Benzoic acid (E210) – used as preservative.
- Artificial – Synthetically produces, naturally not available

Food Additives

- Food additives are any substitute that becomes
- part of a food product
- either directly or indirectly during processing, storing
- or packaging.

GRAS

- Generally Recognized As Safe
- First established 700 placed on the list without going through testing
- Now those substances are being reevaluated
- Foods have been removed

What is required to Become A Food Additive

1. Prove additive is effective
2. Prove additive can be detected and measured in final products
3. Study the effects of the substance on animals (in large doses)
4. Submit results to validate the findings
5. Schedule a public hearing
6. FDA approves or rejects

Functions of Food Additives

- **1. Preservatives – Keep food fresh and reduce spoilage. Control bacteria, mold, fungi, and yeast.**
- **Benzoates**
- **BHT, BHA (antioxidants)**
- **Calcium Propionate (inhibits molds)**
- **Sodium Bisulfate / meta bisulfite**
- **Sodium Nitrate**

Functions of Food Additives

- **2. Processing Aids – Improve consistency, add stability, aid oil and water mixtures, and retain moisture**
- **Gums (Algin, Carrageenan, Xanthan)**
- **Aluminum, Calcium Silicate**
- **Benzoyol Peroxide**

Functions of Food Additives

- **3. Nutrients – Maintain or improve the nutritional quality of food.**
- **Alpha- tocopherol**
- **Ascorbic Acid**
- **Biotin**
- **Beta Carotene**
- **Calcium Pantothenate**
- **Folic Acid**

Functions of Food Additives

- **4. Flavors – Complement, magnify or modify the taste of aroma of a food**
- **Aspartame**
- **Corn Syrup**
- **Ethyl Vanillin**
- **Mannitol**
- **Monosodium Glutamate**

Functions of Food Additives

- **5. Colors – Give foods a desired, appetizing or characteristic color.**
- **Carmel**
- **Beta-apo-8-Carotenal (Orange)**
- **Citrus Red**
- **FD & C Blue No 1**
- **FD & C Red No 3**
- **FD & C Yellow No 5**

Some common preservatives and their primary activity

Chemical Affected	Organism(s)	Action	Use in Foods
Sulfites	Insects & Microorganisms	Antioxidant	Dried Fruits, Wine, Juice
Sodium Nitrite	Clostridia	Antimicrobial	Cured Meats
Propionic Acid	Molds	Antimicrobial	Bread, Cakes, Cheeses
Sorbic Acid	Molds	Antimicrobial	Cheeses, Cakes, Salad Dressing
Benzoic Acid	Yeasts & Molds	Antimicrobial	Soft Drinks, Ketchup, Salad Dressings

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Lecture 8

FOOD QUALITY : WHAT IS IT?

- Food quality is the extent to which all the established requirements relating to the characteristics of a food are met. Examples:
  - Identity of a food in relation to a standard (e.g., standardized food)
  - Declared gross or net quantity (e.g., weight or volume) of a unit of the food or net fill of a food container
  - Declared or claimed amount of one or more stated components of a food

- **Appearance (e.g., size, shape, color)**
- **Flavor**
- Aroma
- **Texture**
- Viscosity
- **Shelf-life stability**
- Fitness for use as human food
- **Wholesomeness**
- Adulteration
- **Packaging**
- Labeling

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Lecture 9

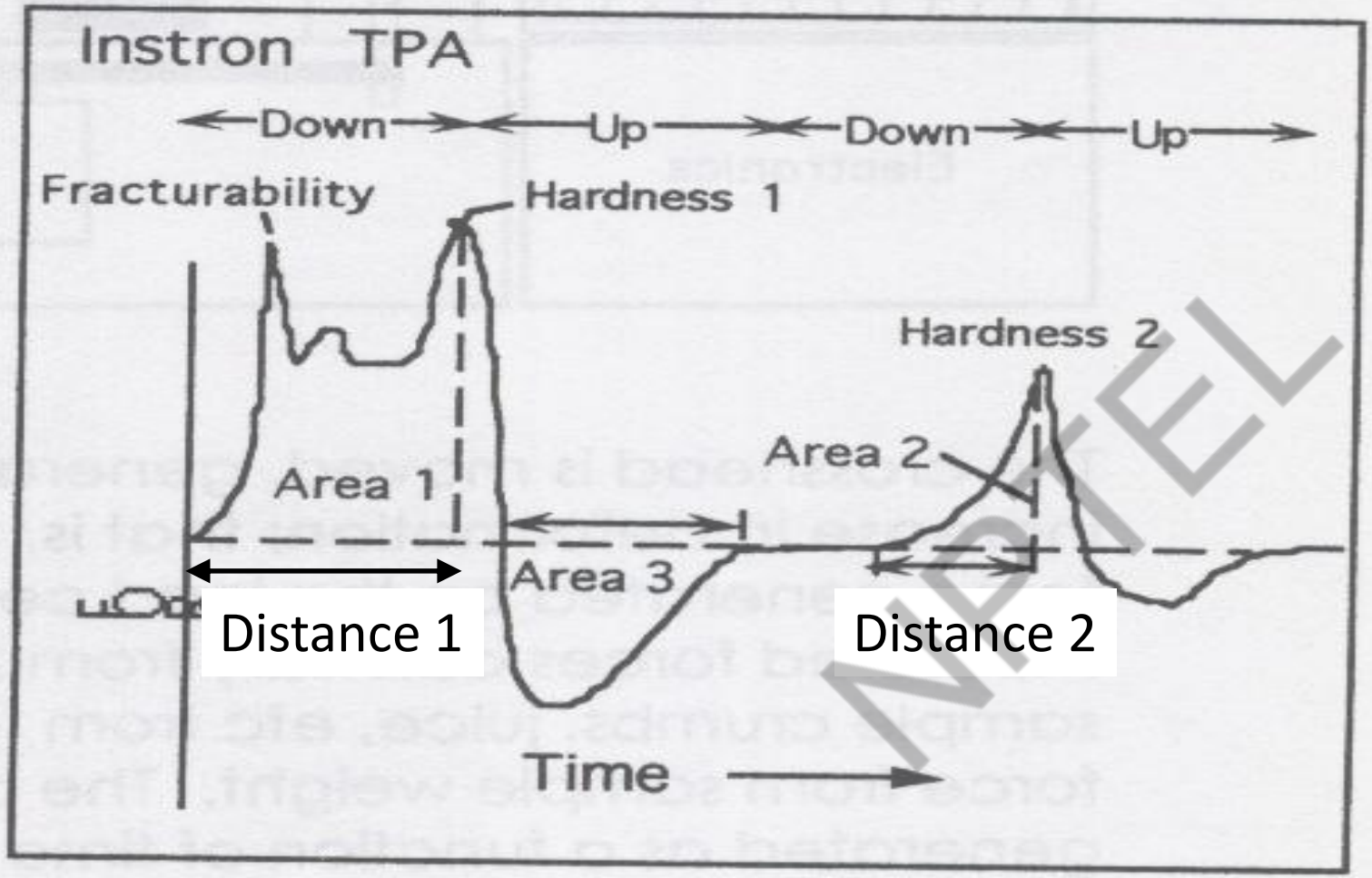
Texture profile analysis (TPA)

- Measurement of texture attributes by mimicking the act of chewing
- The probe will interact with the food 2 times
- Change of force and time will be recorded
- From the force-time curve, texture attributes of the sample can be determined / calculated

- **Aroma is an odour and is often referred to as a smell and is sensed by receptors in the nose.**

- **Taste, or gustation, is the sensation of saltiness, sweetness, sourness, bitterness and umami (savoriness).**

- Flavour is the sense of taste and smell combined.



TPA force profile

- **Among the attributes that can be determined are:**
- **i. Fracturability**
  - Force needed to produce the first significant fracture during the first bite
- **ii. Hardness**
  - **Largest force produced during the first bite**

iii. **Cohesiveness**

- Ratio of area under the positive curve between the first and second bite (Area 2 / Area 1)

iv. **Adhesiveness**

Work needed to pull out the probe from the sample after the first bite (Area 3)

v. **Springiness**

Ration of the biting distance of the second bite with the first bite (Distance 2 / Distance 1)

vi. **Gumminess**

Hardness x cohesiveness

vii. **Chewiness**

gumminess x springiness

Product Quality

Consumer :

Freshness, Taste, Variety, Convenience.

Retailer:

Availability, Accessibility, Presentation, Prolonged Shelf-life & Conformance.

Manufacturer:

Meet and/or exceed the expectations of the Consumer & the Retailer.

Product Safety

Consumer:

Preservation without compromising **quality**

Retailer:

Sustainable preservation over an expanded distribution network

Manufacturer:

Meet and/or exceed the expectations of the consumer and the retailer.

EMERGING TECHNOLOGY:-

Drivers & Opportunities

- Product Quality & Safety
- Consumer Convenience
- Total System Cost

Technological Advancements

- Packaging Processes
- Packaging Materials
- Value Added Features

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Lecture 10

EMERGING TECHNOLOGY:-

Drivers & Opportunities

- **Product Quality & Safety**
- **Consumer Convenience**
- **Total System Cost**

Technological Advancements

- Packaging Processes
- Packaging Materials
- Value Added Features

Emerging Technologies:-

Consumers' desire - minimally preserved and processed foods – **leading to** • more convenience in terms of **shelf life, storage, preparation for consumption** • higher quality in terms of **flavour, texture, and appearance** • fresher • more natural • nutritionally **healthier** • minimally packaged • **safer**

Response of food scientists and technologists – minimal

♦ milder processing w.r.t. minimal overheating, less intensive heating ♦ **fewer** additives w.r.t. less use of **chemical preservatives**

♦ Increased use of combination or **hurdle technologies** ♦ Evaluation and use of **naturally occurring** preservation system ♦ **Reduction** in levels of salt, fat, sugar ♦ Reduced, **environmentally friendly** packaging ♦ More attention to the elimination of **food poisoning** microorganisms from the most often contaminated foods.

Exhisting technologies:-

♣ **To inhibit the growth of microorganisms in foods -**

➢ Lowering of temperature – chill, frozen storage

➢ Lowering of water activity – drying, curing, addition of sugar

- Lowering of pH – acidification, fermentation
- Vacuum packaging – removal of oxygen
- Mod. atmosph. packaging (MAP)– add. of mix of CO_2, O_2, N_2
- Addition of preservatives – **inorganic** (SO_3^{-2}, NO_3^{-2}); **organic** substances - sorbate, benzoate, propionate; antibiotic - nisin
- Controlling food microstructure – water in oil emulsion

♣ **To inactivate microorganisms in foods –**

- Heating – pasteurization, sterilization

- Restricting access – packaging, aseptic processing

♣ **To use naturally occurring preservative systems -**

- Bacteriolytic & other enzymes – lysozyme, lactoperoxidase
- Nonenzymatic proteins and other polypeptides – nisin, pediocin, culture products, lactoferrin, lactoferricin
- Plant derived other antimicrobials – herb and spice extracts

– leads to development of new methods

➢ efficacy proved – requires to be commercially exploited.

Emerging physical procedures –

Θ **high hydrostatic pressure**; Θ combined ultrasonic, heat and pressure (manothermosonication); Θ **high voltage gradient pulses** (electroporation), Θ electron beam and gamma irradiation, Θ **laser and non-coherent light pulses**, Θ high magnetic field pulses.

High hydrostatic pressure:-

Inactivates vegetative microorganisms by pressure pasteurization – 400 to 600 MPa (4000 to 6000 atm)

– large species to species and strain to strain variations, and very large protective effects from the constituents of some foods (at low water activities). Example, Escherichia Coli 0157H7.

Manothermosonication (combined ultrasonic, heat & pres.):-

Ultrasonication at high enough intensities inactivate bacteria and reduces heat resistance of bacterial spores. The effect is synergistic with raised temperature, but as the temperature is raised, the overall synergism is reduced.

Because, as the vapour pressure of water rises, it has the effect of reducing the effectiveness of cavitation, which is the main **cause of microbial death**. Application of a slight overpressure (a few bars) maintains the synergism at the higher temperature. This combination procedure has the potential for reducing pasteurization and sterilization temperatures for **pumpable liquids and for semisolid foods**.

High voltage electric pulses:-

High voltage electric shocks (**electroporation**) are most effective for the inactivation of **vegetative** bacteria, yeasts, and molds, while bacterial **spores** are much more **tolerant**.