Frontier Technology of Identified Thrust Crops of High Value

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Classification of fruits according to their optimum storage temperatures and potential storage life

Potential storage life (weeks)	Optimum storage temperatures		
	0-2°C	3-5°C	12-14°C
<2	strawberry	-	Guava, pineapple
2-4	Cherry, peach, plum	Tangerine, mandarin, carambola	Banana, mango
4-6	-	orange	Grapefruit, lime, pummelo
>6	Apple (non chilling sensitive cultivars), pear, kiwi fruit	Apple (non chilling sensitive cultivars)	lemon

Frontier technology is so different from the existing technology that the processing plant in use will not be suitable to use the new technology

Commercialisation of frontier technology would very likely involve new investment

Thermal processing

- Conventional methods
  - low temperature for long time, eg. canning
- Advanced methods
  - -HTST
  - -UHT
  - -thin profile processing
  - -agitation retort processing
  - -aseptic processing

Microwave Heating

- Uses industrial, scientific and medical frequencies
- 2450 or 915 MHz
- 12 or 34 cm in wavelength
- Dielectric heating mechanism
- Volumetric heating
- Penetration ability ~ 1-2 cm at 2450 MHz
- Used for defrosting, dehydrating, blanching and pasteurisation
- Drying in combination with conventional hot-air or vacuum drying

Radio-Frequency Heating

- Applies a high-voltage AC signal to a medium placed between parallel electrodes set up as a capacitor
- Heating due to dipole heating and electric resistance heating
- The longer wavelengths permit deeper penetration
- Reduced energy consumption
- Used for thawing, dehydrating, blanching, pasteurisation and sterilisation of processed foods

Ohmic Heating

- Also called electric heating
- Uses food itself as a conductor of electricity that is taken from mains
- Rapid and uniform heating
- Unlimited heat penetration
- Useful for pasteurisation and sterilisation

Definition

Minimally processed or fresh-cut fruit is defined as any fresh fruit or vegetable or any combination thereof that has been physically altered from its original form, but remains in a fresh state. These fruits and vegetables have been trimmed, peeled, washed, and cut into 100% usable product that is largely bagged or prepackaged to offer consumers high nutrition, convenience and value while still maintaining freshness.

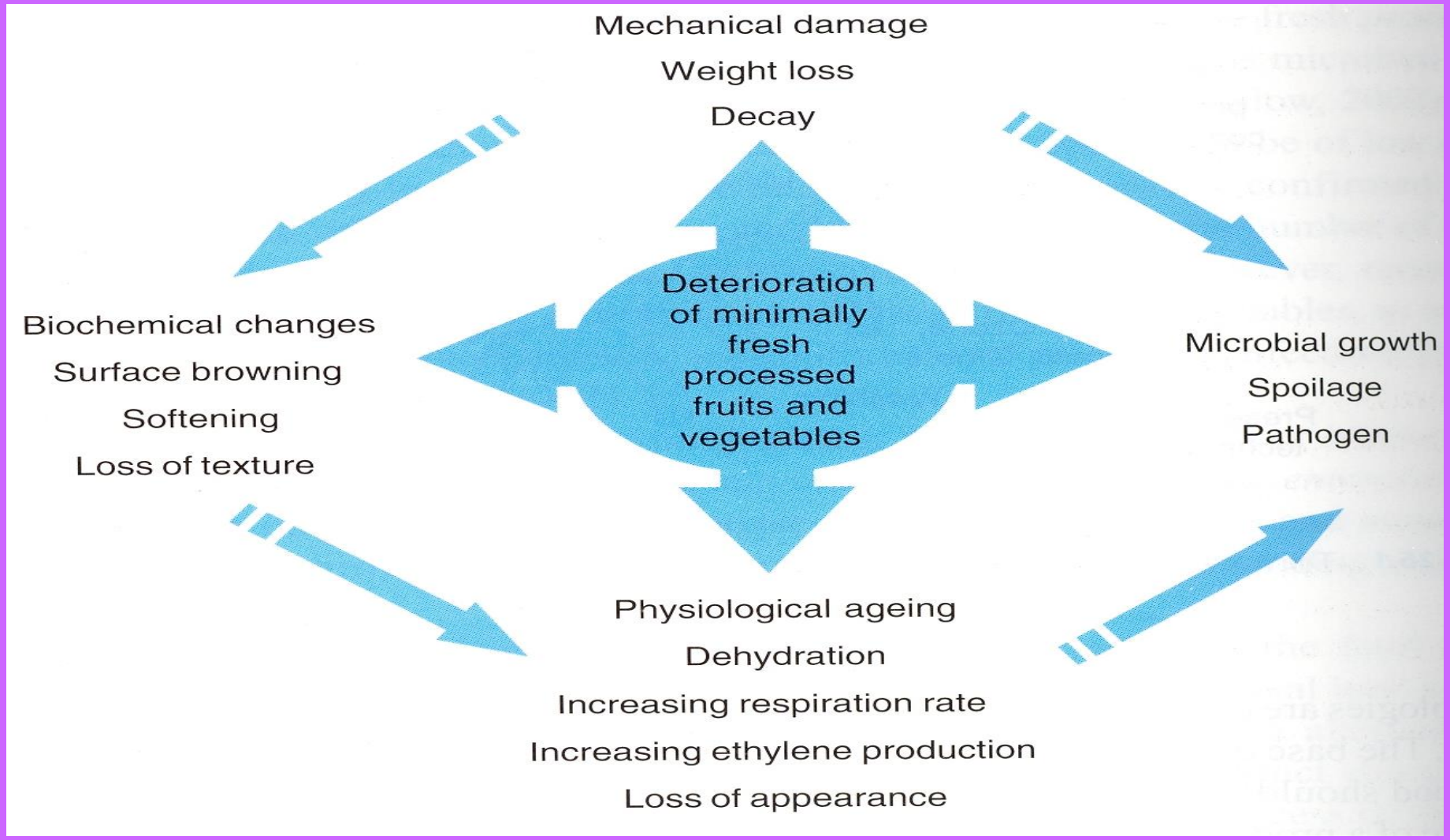
(International Fresh-Cut Produce Association, 2002)

Characteristics of minimally processed produce

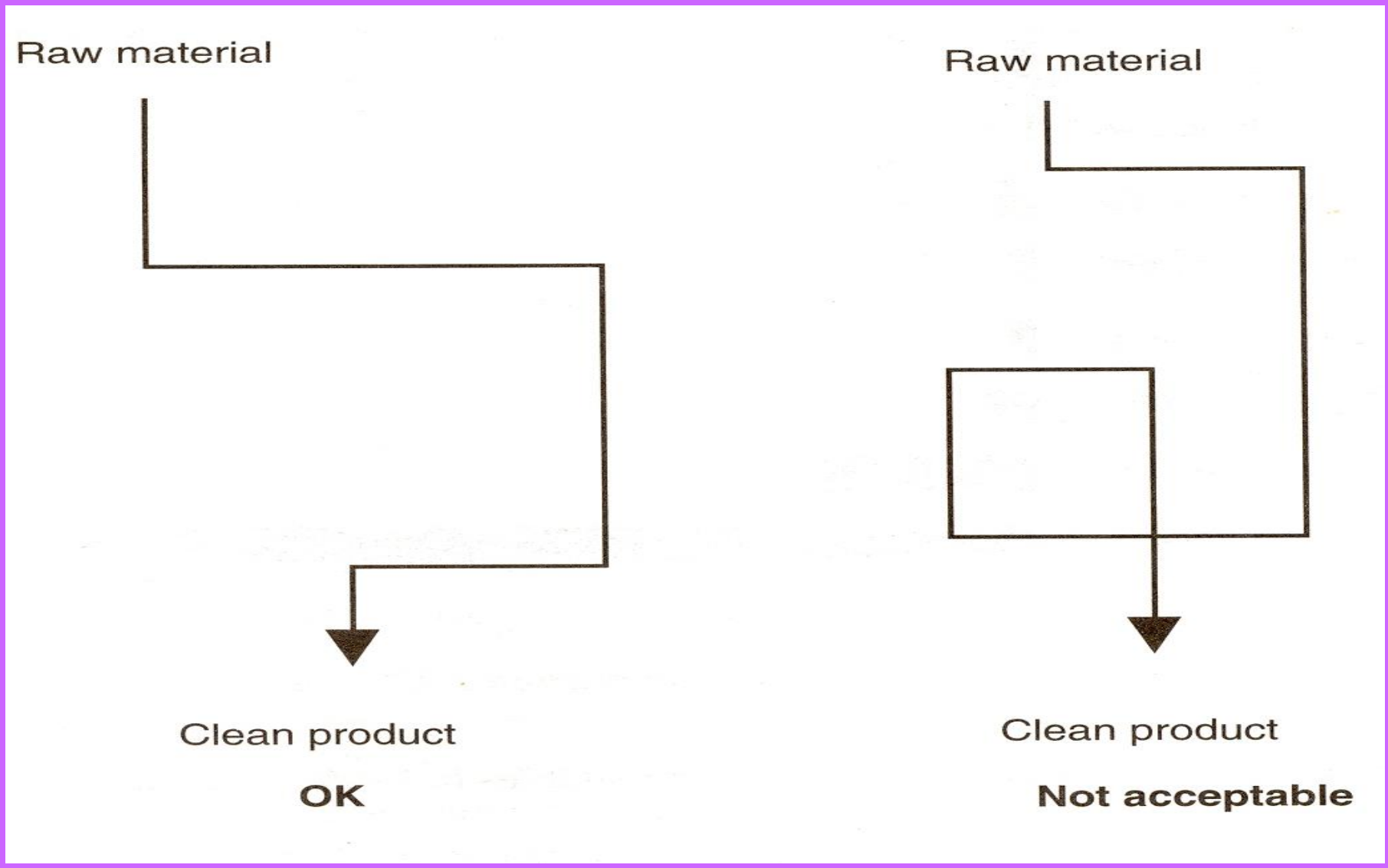
- Fresh
- Provides convenience
- Perishable: shelf life of fruits is 7-8 days, vegetables 10 -14 days
- No waste material

Unit operations in minimal processing

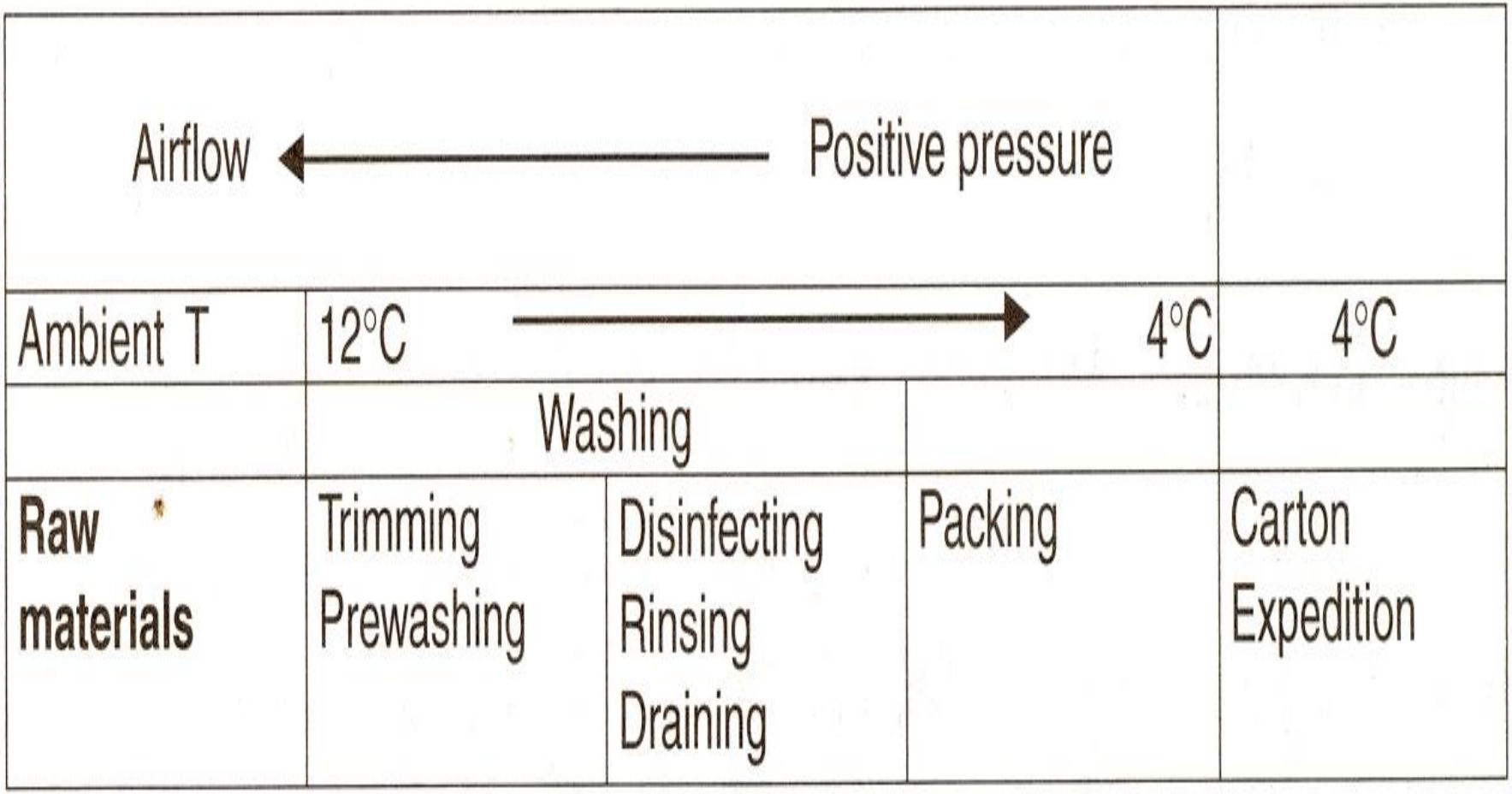
- **Receiving, inspection and storage of raw materials**: processing and storage at 1-5^{o}C
- **Cleaning and disinfection**: clean water, chlorinated water, H_2O_2, ozone, peroxyacetic acid, trisodium phosphate
- **Peeling, deseeding, trimming, coring and cutting**: vegetables, mechanically, fruits, manually with sharp knives
- **Washing and cooling**: 0^{o}C, 50-100 ppm chlorinated water
- **Dewatering**
- **Packaging and distribution**: 1-5^{o}C, compartments in packages to prevent vibrations



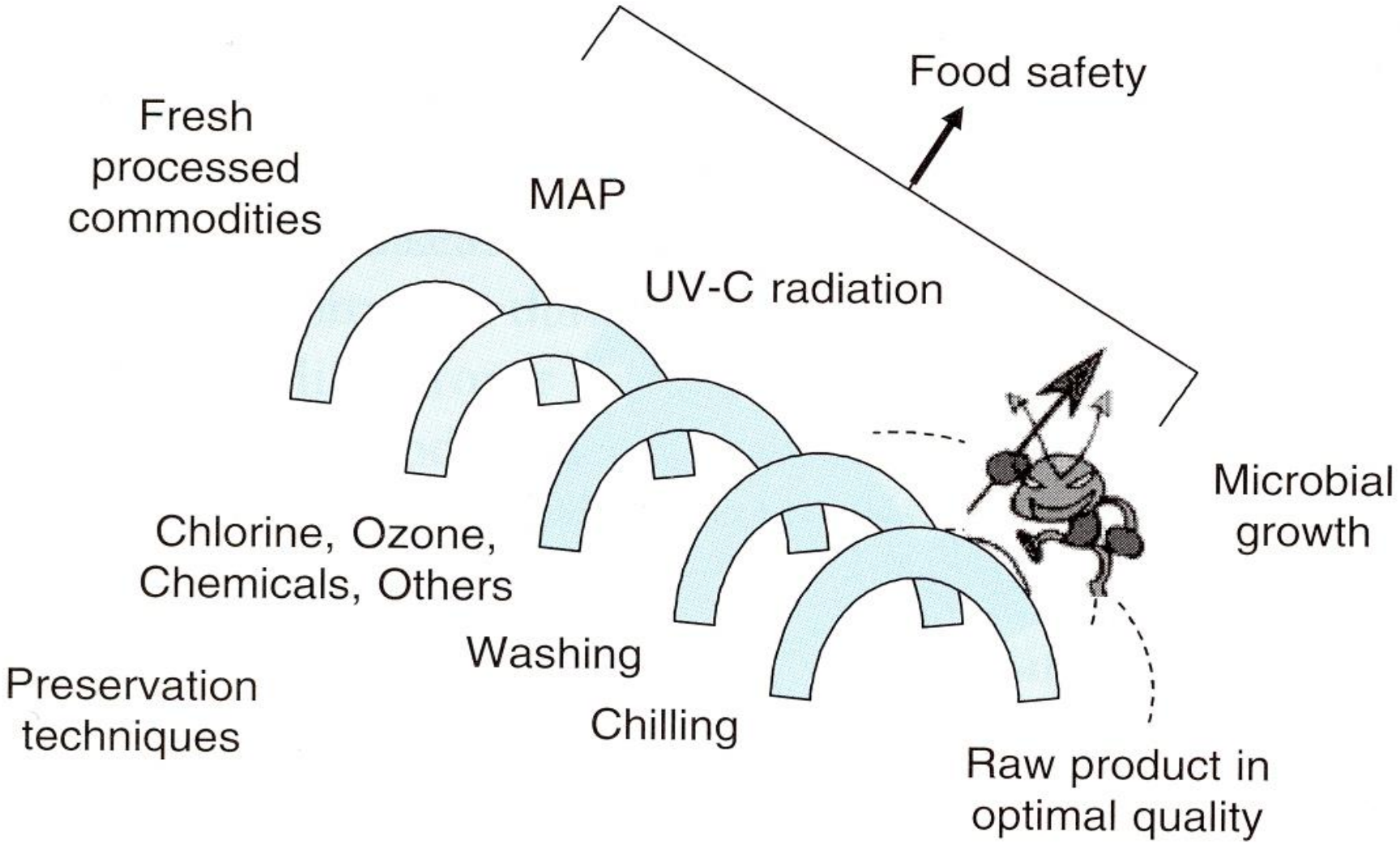
Factors that affect minimally fresh processed fruit and vegetables decay and shelf life



Principle of the forward-only movement



Temperature gradient and air flow in the processing unit



The hurdles concept

Quality aspects for minimally processed produce

- **Cultivar selection:**

  for compatibility with minimal processing, packaging and distribution

- **Optimum degree of ripeness for processing:**

  produce having the best sensory attributes may not be suitable for handling and processing

- **Microbial spoilage:**

  both pathogenic and spoilage microorganisms, fruits with high pH under packaging conditions can promote pathogens like *L.monocytogenes, C.botulinum*

- **Enzymatic browning:**

  physical methods like lowering of temperature and oxygen, use of MAP and edible coatings

Quality aspects for minimally processed produce

- **Enzymatic activity:**

  chemical methods like inhibiting polyphenloxidase activity, removal of oxygen and phenolic compounds, use antibrowning agents as dip solutions-

  - **-ascorbic acid**
  - **-erythorbic acid**
  - **-citric acid**
  - **-malic acid**
  - **-EDTA**
  - **-cysteine and derivatives**

- **Textural losses:**
  - **-low storage temperature**
  - **-removal of ethylene**
  - **-calcium solution dip**

Quality aspects for minimally processed produce

- **Appearance and sensory quality**
  - **-freshness**
  - **-taste**
  - **-aroma**
  - **-colour**
  - **-texture (for repeated acceptance)**

- **Nutritional aspects**
  - **-calories↓**
  - **-vitamins ↑**
  - **-minerals ↑**
  - **-phytonutrients ↑**
  - **-fiber↑**

Shelf life extension of fresh cut fruits

- Temperature management: requires control of
  - -respiration rate
  - -metabolic processes
  - -enzyme activity
  - -microbial growth
  - -storage temperature

- MAP: extends shelf life by minimising
  - -water loss
  - -ethylene production rate
  - -chlorophyll degradation
  - -cell wall degradation
  - -phenolic oxidation
  - Use proper packaging material

Shelf life extension of fresh cut fruits

- **Humidity**
  - **-to restrict water loss from cut surface**
  - **-reduce surrounding temperature**
  - **-increase RH**
  - **-create a barrier**

- **Edible coatings**
  - **-reduce respiration**
  - **-retard water loss**
  - **-prevents colour change**
  - **-improves texture**
  - **-improves mechanical integrity**
  - **-improves handling characteristics**
  - **-retains volatile flavour compounds**
  - **-reduces microbial growth**

Non thermal processing technologies

1. High-Pressure Processing

-uses hydrostatic pressure

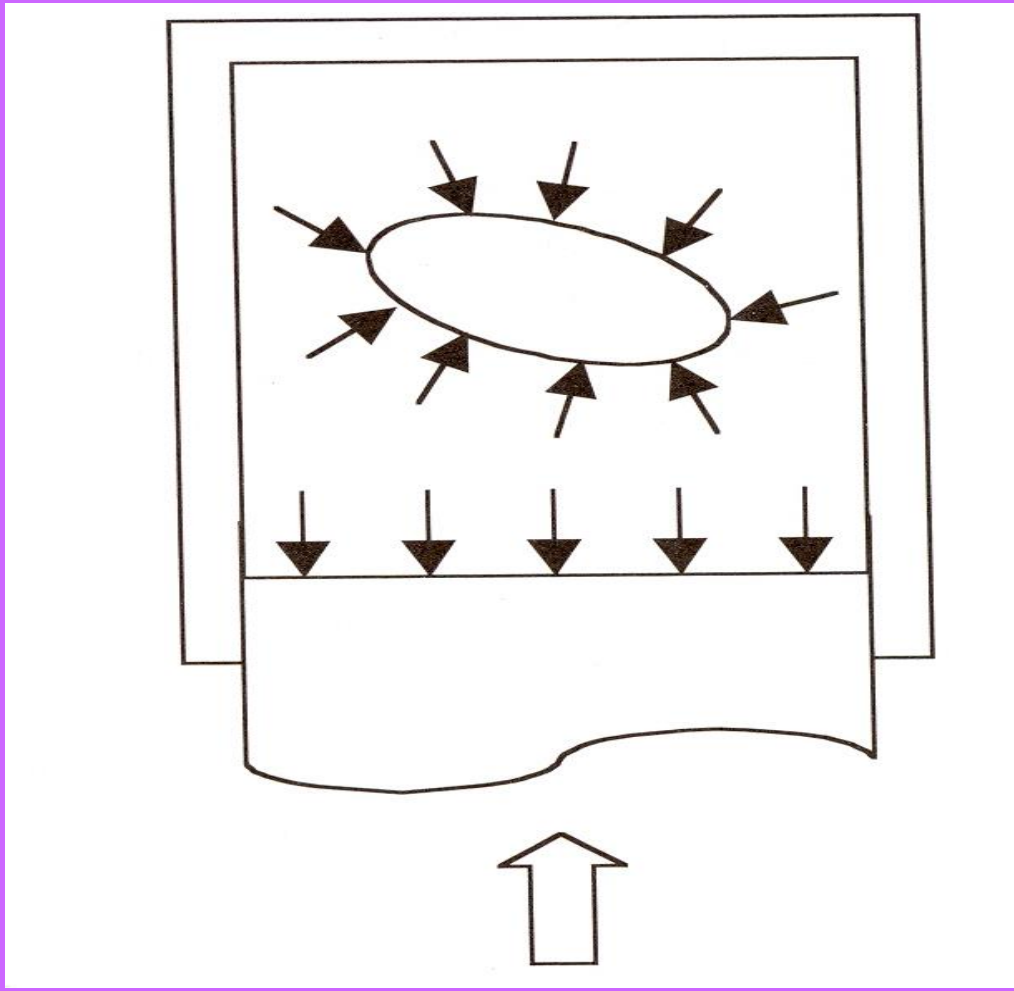
-requires pressure vessel

-requires pressure transmitting medium: liquid

-batch process for solid foods

-semi-continuous process for liquids

-pressure range is normally 50-1000 MPa



The isostatic principle in high pressure processing

Pressures required to achieve a 5-log cycle inactivation ratio for certain microorganisms, for a 15 min treatment

Microorganism	Pressure (MPa)
Yersinia enterocolitica	275
Salmonelle typhimurium	350
Listeria monocytogenes	375
Salmonella enteritidis	450
Escherichia coli O157:H7	680
Staphylococcus aureus	700

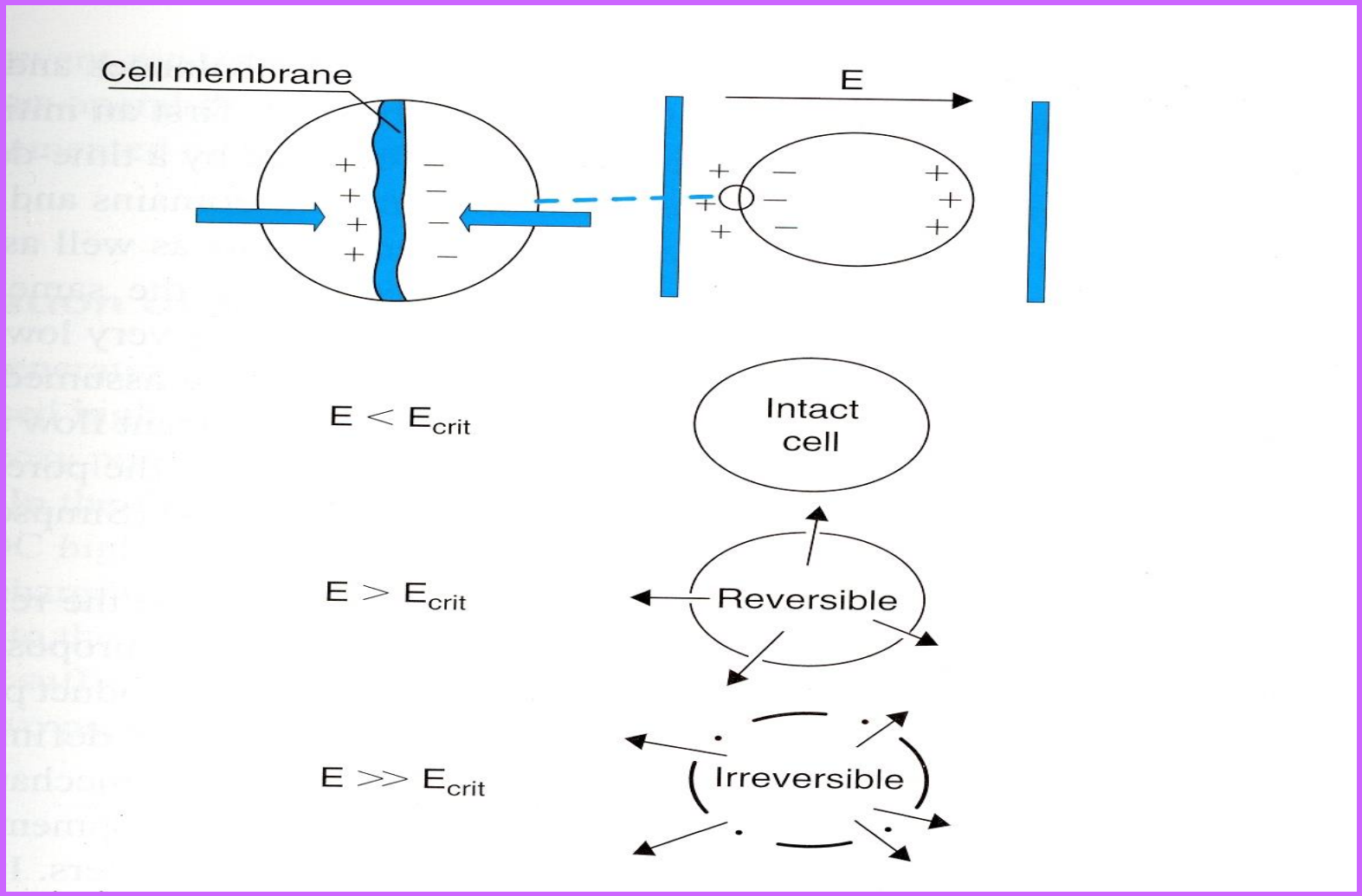
Shelf life comparison of orange juice based on sensory evaluation

Storage temp.(^{0}C)	Shelf life studies	
	High pressure treated (500 MPa/5min/35 ^{0}C)	Thermally pasteurised (80 ^{0}C for 30 s)
0	>90	60
5	>90	47
10	47	25
15	32	16

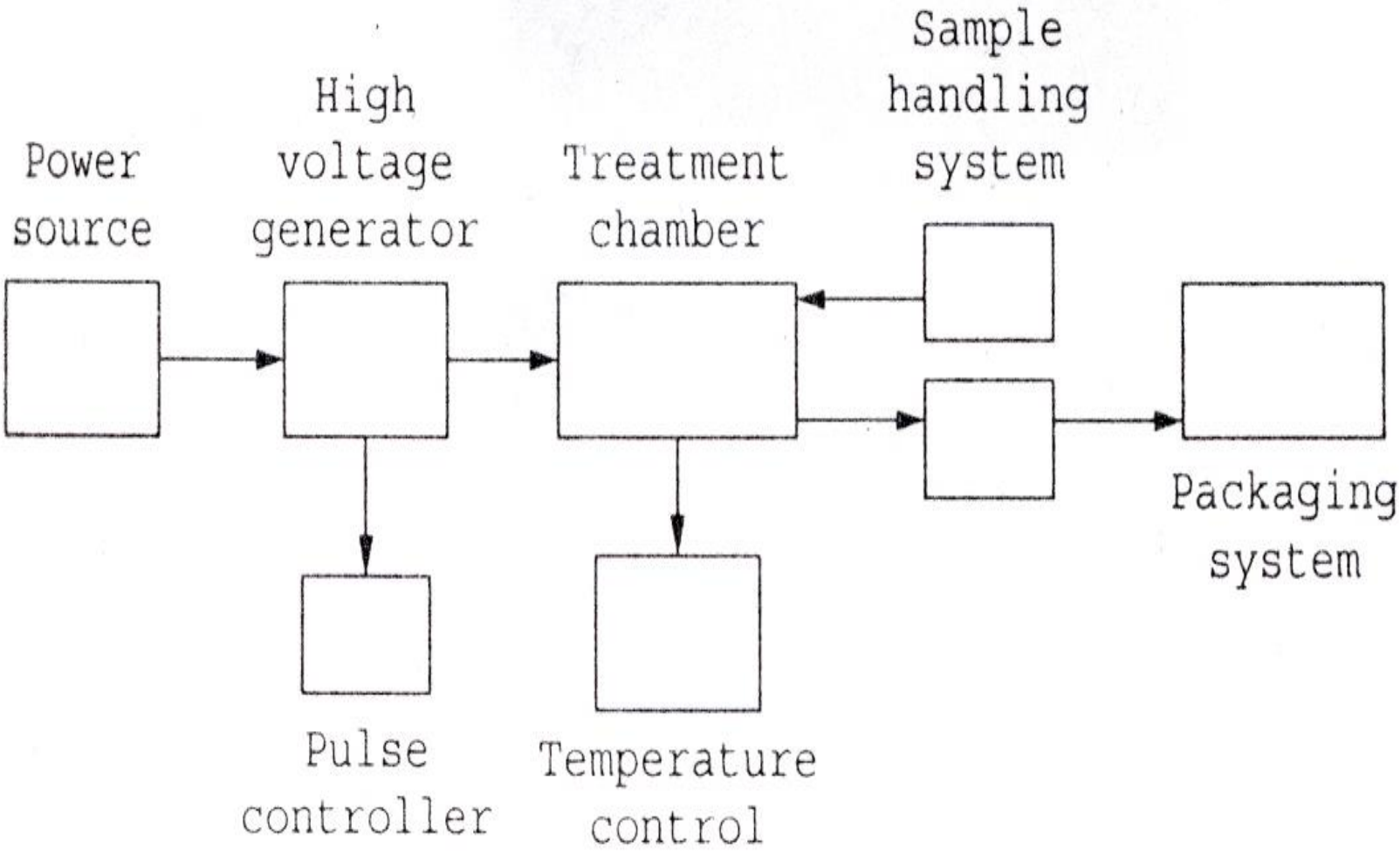
2. Pulsed Electric Fields

-application of pulses of high voltage (typically 20-80 kV/cm) to foods placed between two electrodes for less than 1 sec

-extends shelf life of foods



Schematic depiction of mechanism of membrane permeabilization by electrocompressive forces induced by an external electrical field. Increasing treatment intensity will lead to formation of large, irreversible membrane pores


Power source
High voltage generator
Treatment chamber
Sample handling system
Packaging system
Pulse controller
Temperature control

PEF System

Effect of PEF on microorganisms

- Inactivates cell membrane

  modifications in permeability and ion exchange

- Changes cell morphology and biochemical reactions
- Causes protein denaturation
- Inhibits genetic mechanism
- Denatures enzymes
- Disrupts ribosome functions

THANK YOU