

# Current and Emerging Processing Technologies for Seabuckthorn (*Hippophae rhamnoides* L.) and Its Products

GROWING **Opportunities**

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A Member of Manitoba Agri-Health Network

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# Presentation Outline

## GROWING Opportunities

- Introduction – FDC and MAHRN
- Harvesting Technologies
- Seabuckthorn (SBT) – *A Plant with Many Uses*
- Processing Technologies
  - Juice Processing
  - Oil Processing
  - Leaf Processing
- Summary

# Food Development Centre

*Services and Capabilities*

## GROWING Opportunities

- A Special Operating Agency of Manitoba Agriculture, Food and Rural Initiatives (MAFRI)
- A member of Manitoba Agri-Health Research Network (MAHRN)
- Engine of economic development for Manitoba and the agri-food industry



# Service Lines

## GROWING Opportunities

- Product Development Services
- Process Engineering Services
- Pilot Plant Commercial Processing
- Analytical Support Services
- Library and Information Services
- Training

# Harvesting Technologies

## GROWING Opportunities

- SBT has bright yellow or orange fruits
- Manual
  - Hand-picking
  - Using metal hooks
- Manual harvesting is labour intensive and expensive but produces very clean fruits for processing



# Harvesting Technologies

## GROWING Opportunities

- Shrub Shaking
  - Limited success reported on *Indian Summer* variety
  - Damage to tree trunks reported
- Cut-and-Freeze/Cut-and-Harvest
  - Most effective and economical method for a wide range of SBT varieties
  - Limits production due to alternating harvest



# Seabuckthorn – a plant with many uses

## GROWING Opportunities

<u>Plant Part</u>	<u>Component</u>	<u>Uses</u>
Fruits	Pulp, seed, juice	Food, drinks, pharmaceuticals
Pulp	Oil	Pharmaceuticals, cosmetics, pigment
Seeds	Oil	Pharmaceuticals, cosmetics
Leaves	Sterols, Flavonoids, carotenoids	Pharmaceuticals, cosmetics, teas
Bark	Hippophan (5-hydroxytryptamine), proanthocyanidins	Pharmaceuticals
Roots		Soil conservation, land reclamation

# Chemical Components of Seabuckthorn

## GROWING Opportunities

- **Fruits contain**
  - Many bioactives including vitamin C, vitamin E, flavonoids and carotenoids
- **Seed and Pulp Oils**
  - Known for their fat-soluble vitamins, plant sterols, essential fatty acids



Ferme Nicole

# What Makes SBT Fruit Unique

## GROWING Opportunities

Constituent	Amount (per 100 g of fruit or oil)	Recommended Daily Intake (RDI)
Vitamin C	500-1,000 mg (700 mg)	60 mg (< 10 g of fruit)
Vitamin E	Up to 200 mg (300 IU)	8-10 mg (5 g of oil)
Folic acid	Up to 0.08 mg	0.18-0.2 mg (250 g of fruit)

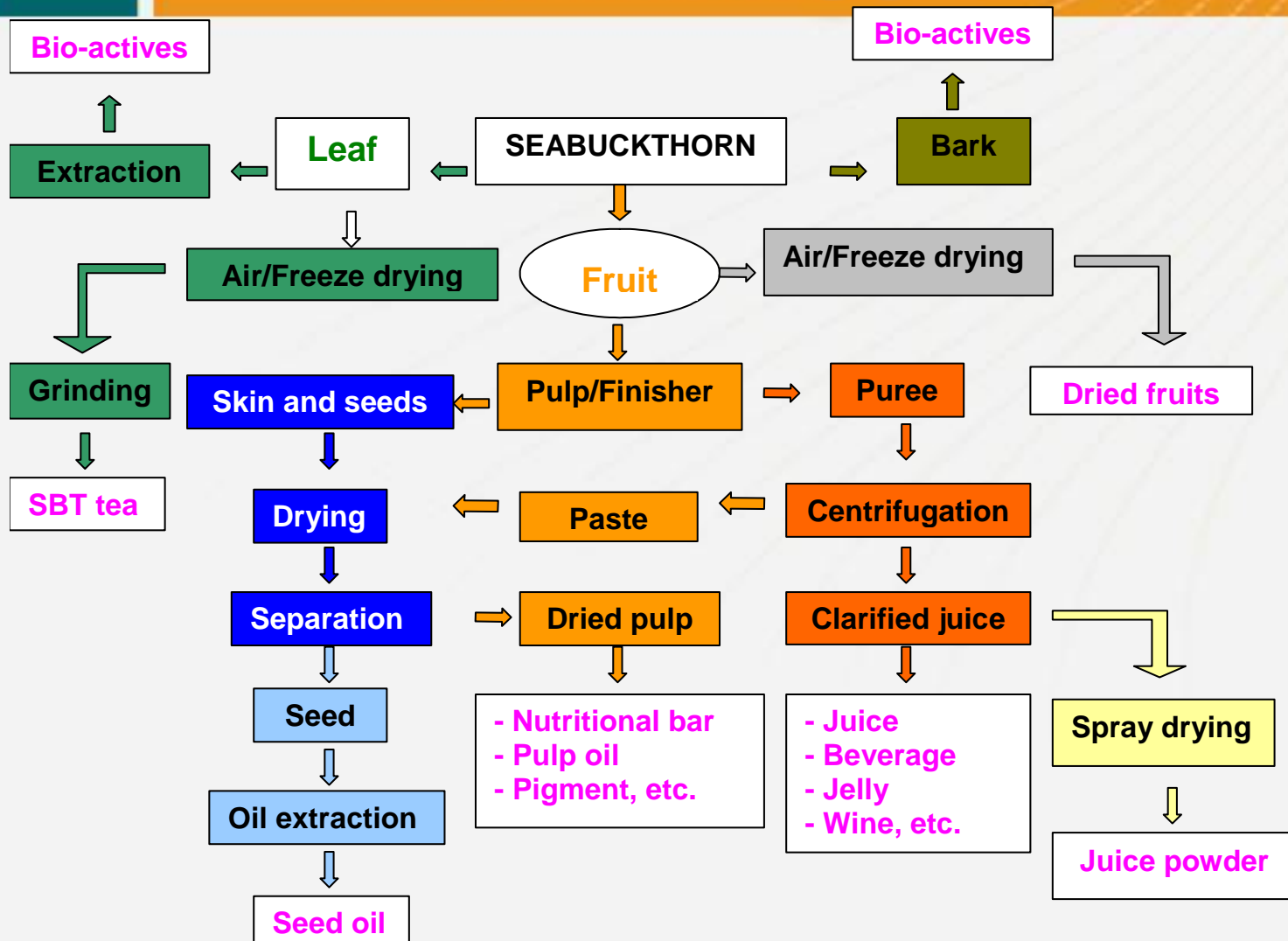
# What Makes SBT Fruit Unique

## GROWING Opportunities

Constituent	Amount
Unsaturated: oleic acid ( $\omega$ -9), palmitoleic acid ( $\omega$ -7), palmitic acid and linoleic acid ( $\omega$ -6), and linolenic acid ( $\omega$ -3) Saturated and sterols (mainly $\beta$ -sitosterol)	6-11%
Carotenoids, including $\beta$ -carotene, lycopene, zeaxanthin	30-40 mg/100g of fruits
Flavonoids (e.g., mainly isorhamnetin, quercetin glycosides, and kaempferol	100-1000 mg/100g of fruits
Organic acids (malic and quinic major ones)	3.5-4.4 (% malic)

# Seabuckthorn Processing

GROWING Opportunities



# SBT Juice Processing

## GROWING Opportunities

- **Fruit selection/cleaning**
  - Important to remove stems, leaves and other debris
  - Ideally should be done during harvest before storage
- **Pressing**
  - Making sure all the fruits break to release juice during pressing
  - Pulper/Finisher is recommended



Pulper/Finisher



Belt Press Juice Extractor

# SBT Juice Extraction

GROWING Opportunities



# Seabuckthorn Juice Extraction Contd.

## GROWING Opportunities

- **Juice Clarification**

- Fresh juice extracted can separate into three phases if not clarified:

- an upper cream phase,
- juice in the middle, and
- a sediment at the bottom

- In some jurisdiction pulpy juice is accepted by consumers



**Unclarified Juice**

# SBT Juice Extraction Contd.

## GROWING Opportunities

- **Juice Clarification**

- High speed centrifuge of the disk stack type is required for separation
- Sediment is removed from the bottom of the bowl by de-sludging mechanism
- Homogenization of the juice could remove any oil layer on the juice surface



Disk Stack Separator



Clarified Juice

## GROWING Opportunities

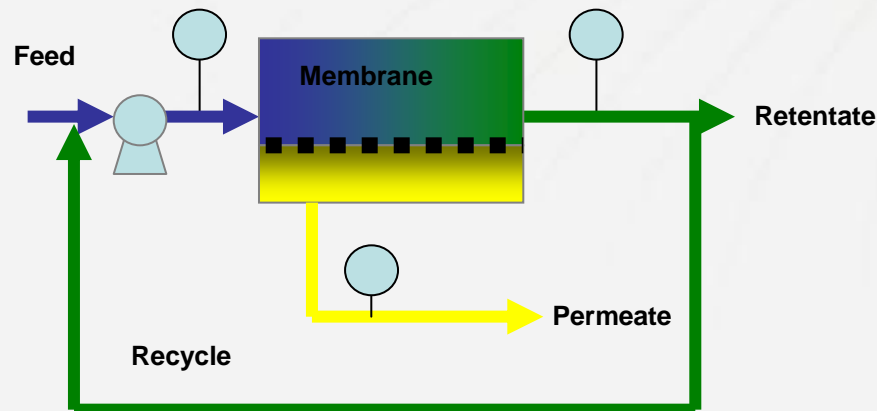
- Enzymatic Hydrolysis
  - Use of commercial proteolytic, pectinolytic and cellulytic enzymes during juice extraction:
    - To improve juice release from the tissue
    - To reduce juice viscosity and
    - To improve separation of suspended solids by centrifugation, sedimentation or filtration

# Other Technologies in Juice Processing

## GROWING Opportunities

- Membrane Filtration

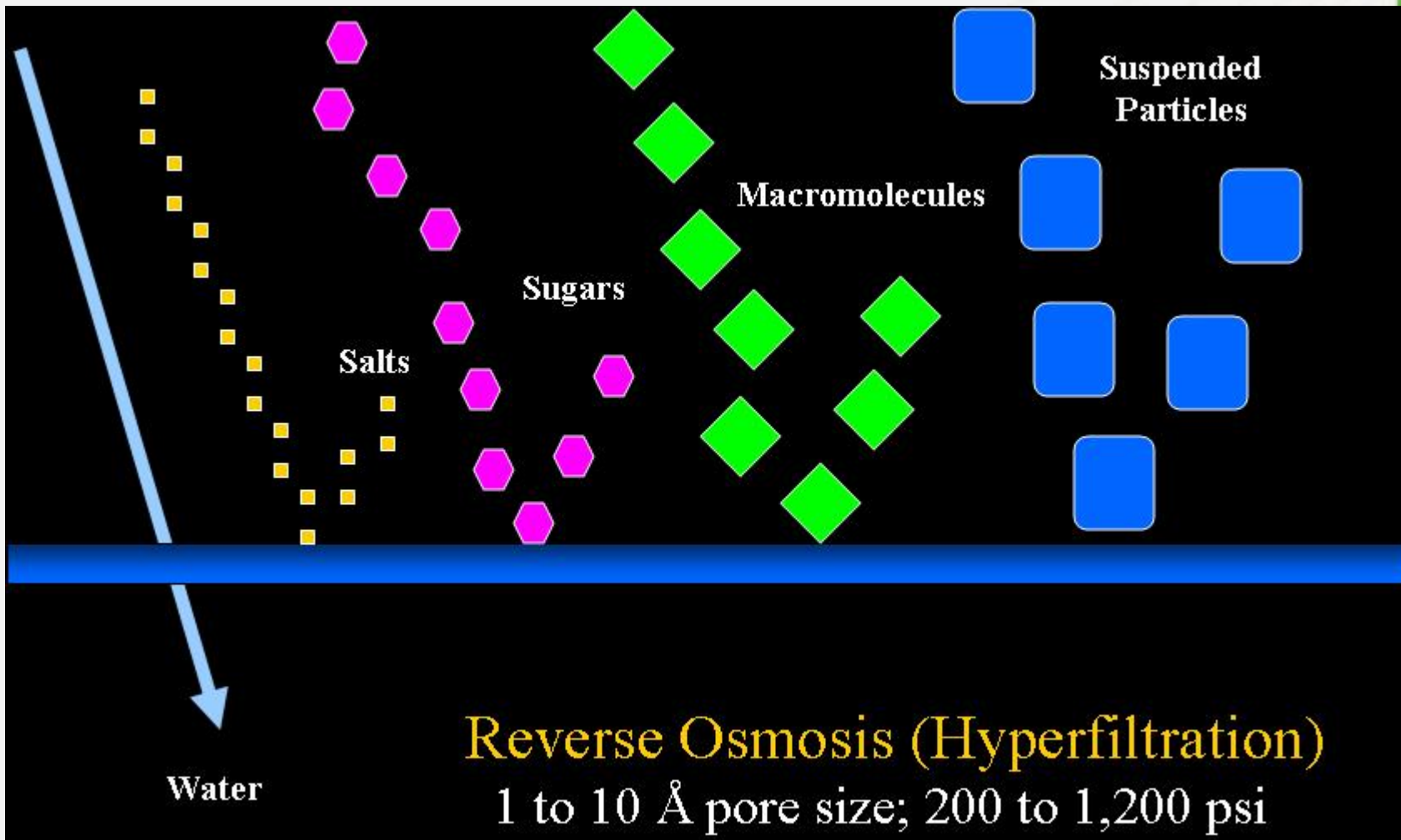
- The separation of components of a liquid or fluid using a thin barrier or film of material (membrane filter) through which fluids and solutes are selectively transported when a driving force is applied
- Membranes can be made of organic polymers or inorganic materials such as ceramics



**Membrane Filtration Schematic**

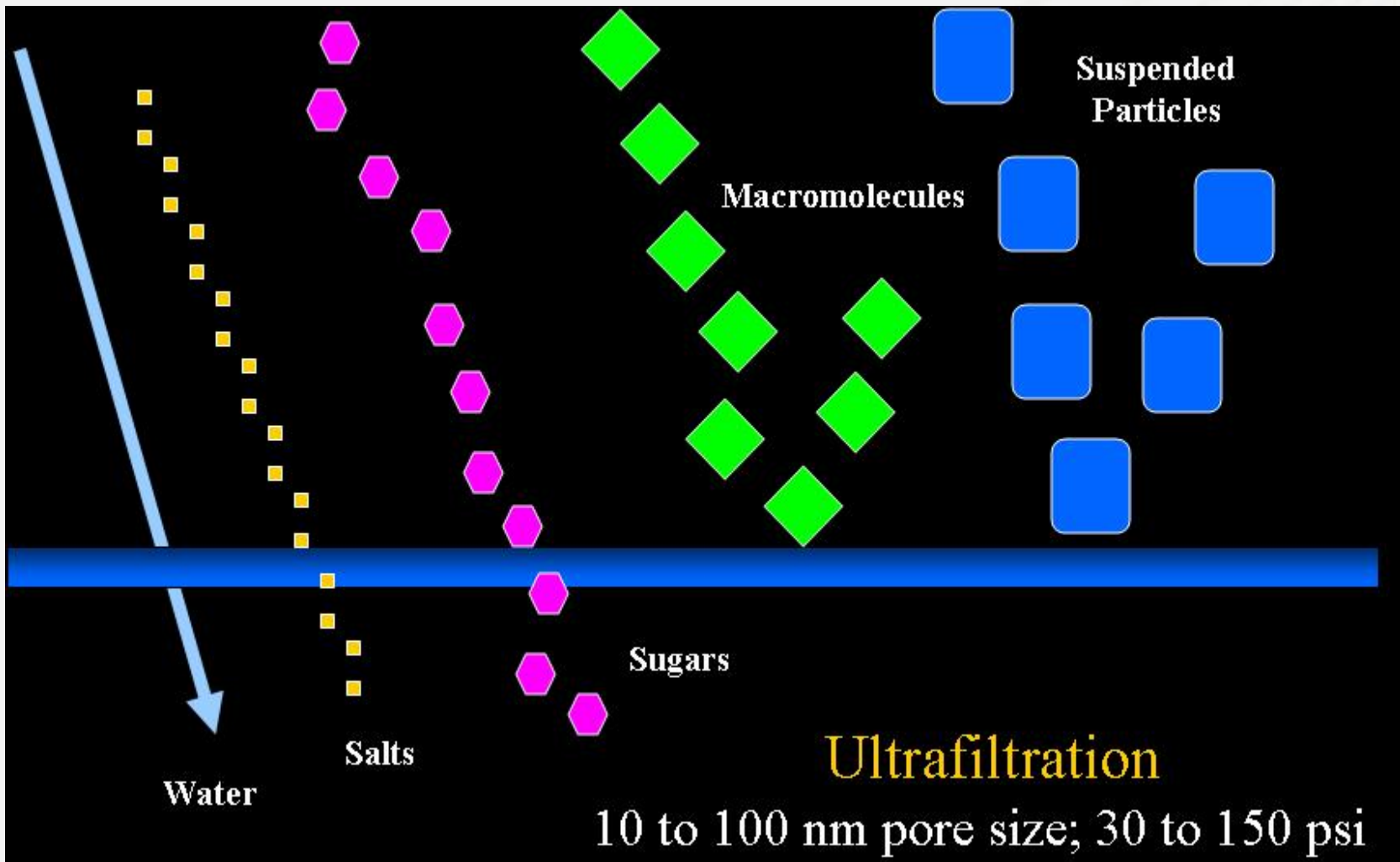
# Membrane Separation Categories

GROWING **Opportunities**



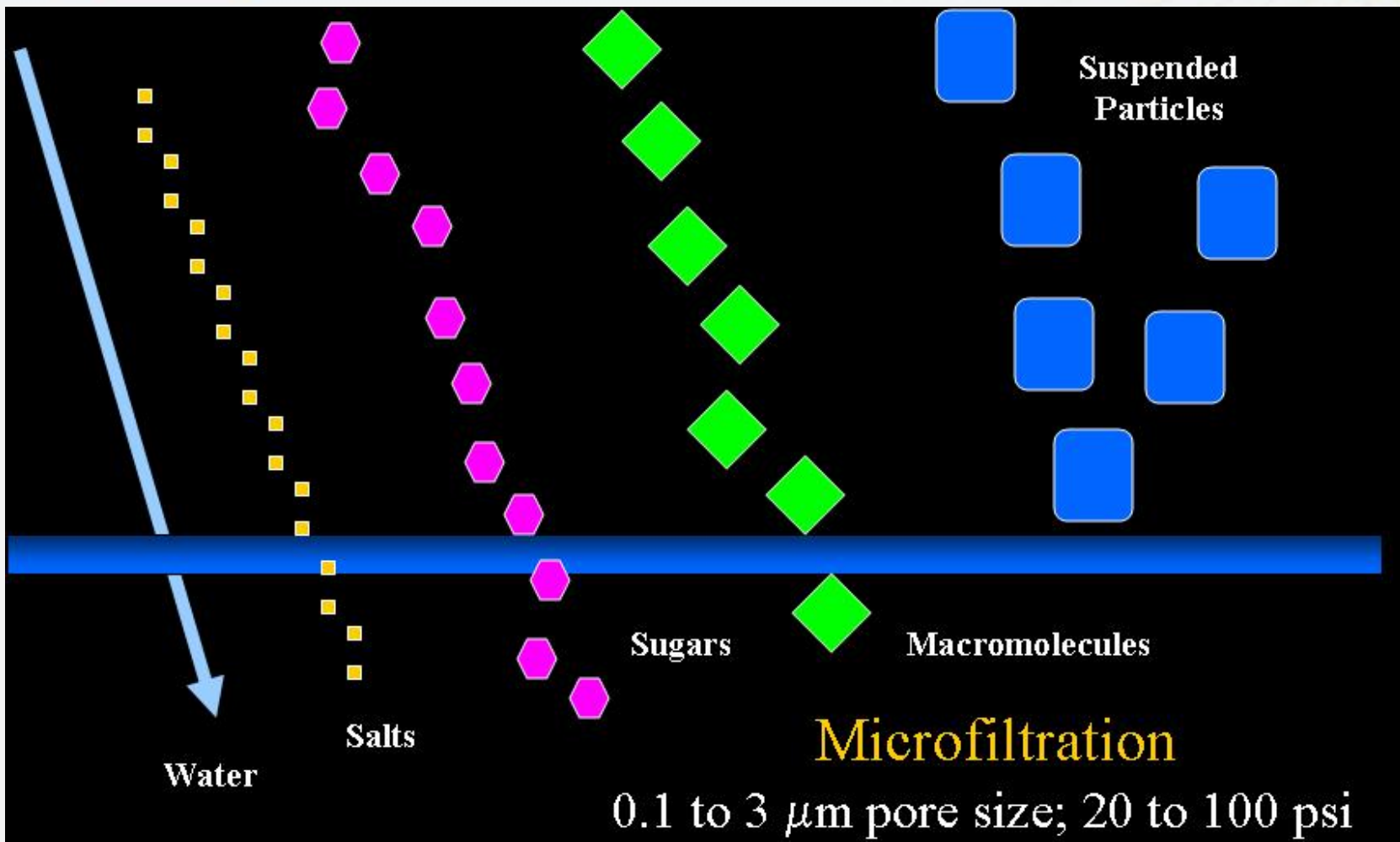
# Membrane Separation Categories

GROWING **Opportunities**



# Membrane Separation Categories

GROWING **Opportunities**



# SBT Juice Extraction Contd.

## GROWING Opportunities

### Juice Pasteurization

#### Methods:

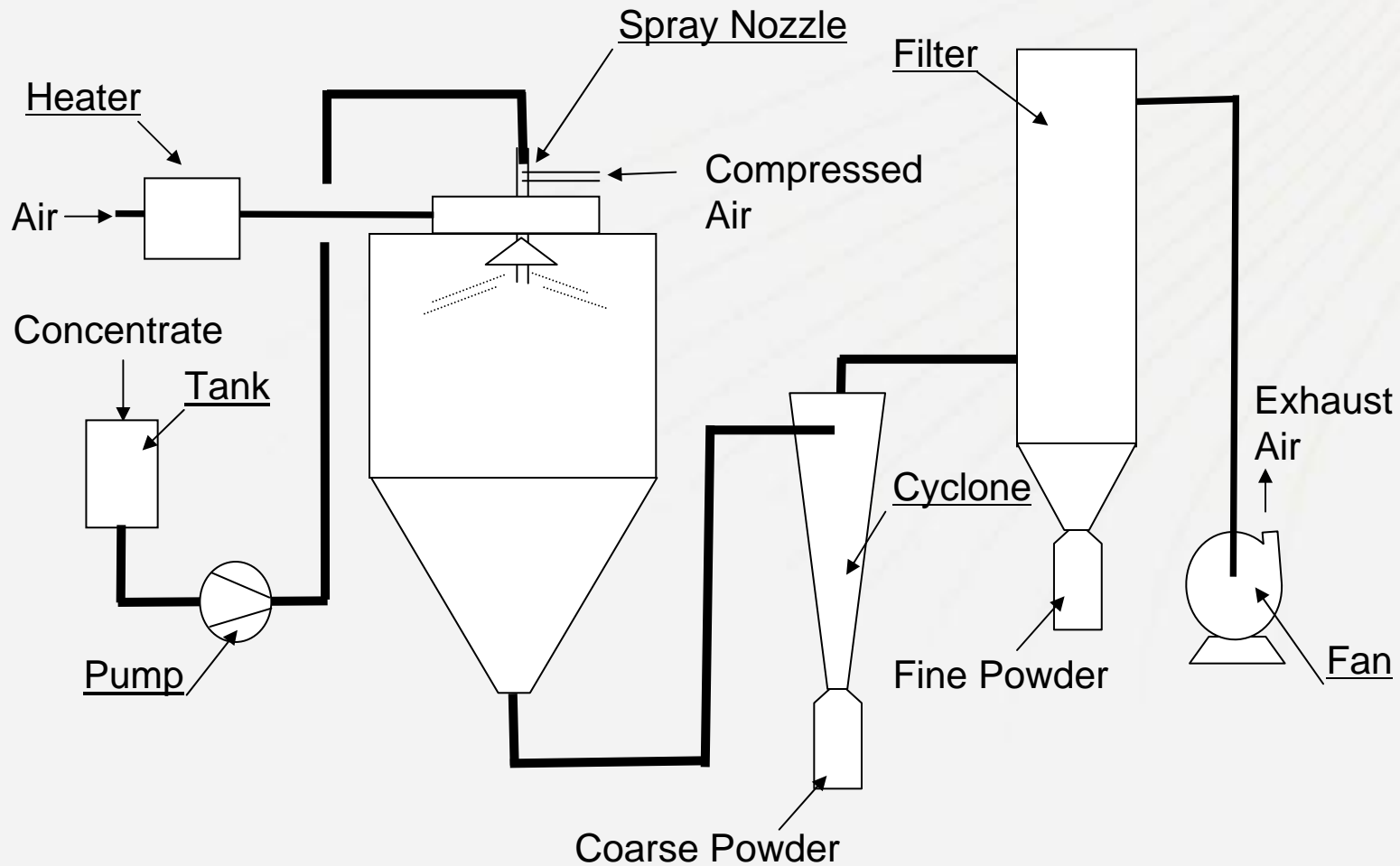
- High-temperature-short-time (HTST) at 80-90°C
- UHT Aseptic Processing
- HTST SBT juice could turn brown if stored for more than 6 months at 15-20°C
- Storage under at 2-4°C prolongs the shelf-life



Tetra Therm Aseptic Pilot System

# Spray Drying Process for SBT Juice

GROWING Opportunities



# Typical Characteristics of SBT Juice

GROWING **Opportunities**

<u>Component</u>	<u>Characteristic/Content</u>
Colour	Yellow
Yield	57 - 75%
Soluble solids	9.3 – 15.5 °Brix
pH	2.7-3.13
Vitamin C	150-709 mg/100mL
Organic acid (% malic)	3.5 - 4.4
Potassium	100-806 mg/mL
Sodium	17.7-89.8 mg/mL
Zinc	0.43-6.31 mg/mL

# Seabuckthorn Juice Products

## GROWING Opportunities



Juice



Wine



Liquor



Jam



SBT Juice

Sibu International

Samples of Christine Berger GmbH Products



SBT Beverages in Tetra Pak  
Seabuckthorn Indage Ltd. India



SBT Juice Powder

Produced at FDC

# SBT Oil Extraction

## GROWING Opportunities

### Extraction Technologies:

- Cold Press
- Solvent Extraction
- Supercritical Fluid Extraction
- Friolex Process
- Enzymatic Process
- Microwave Assisted Process

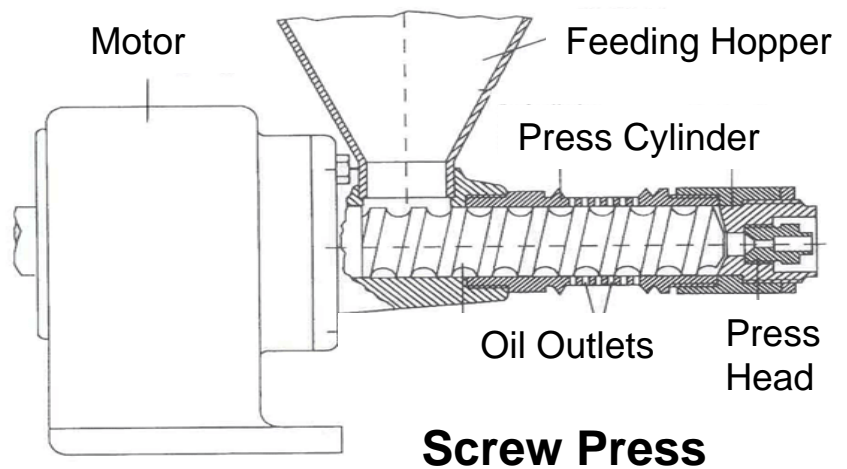


SBT Seeds

# SBT Oil Extraction Contd.

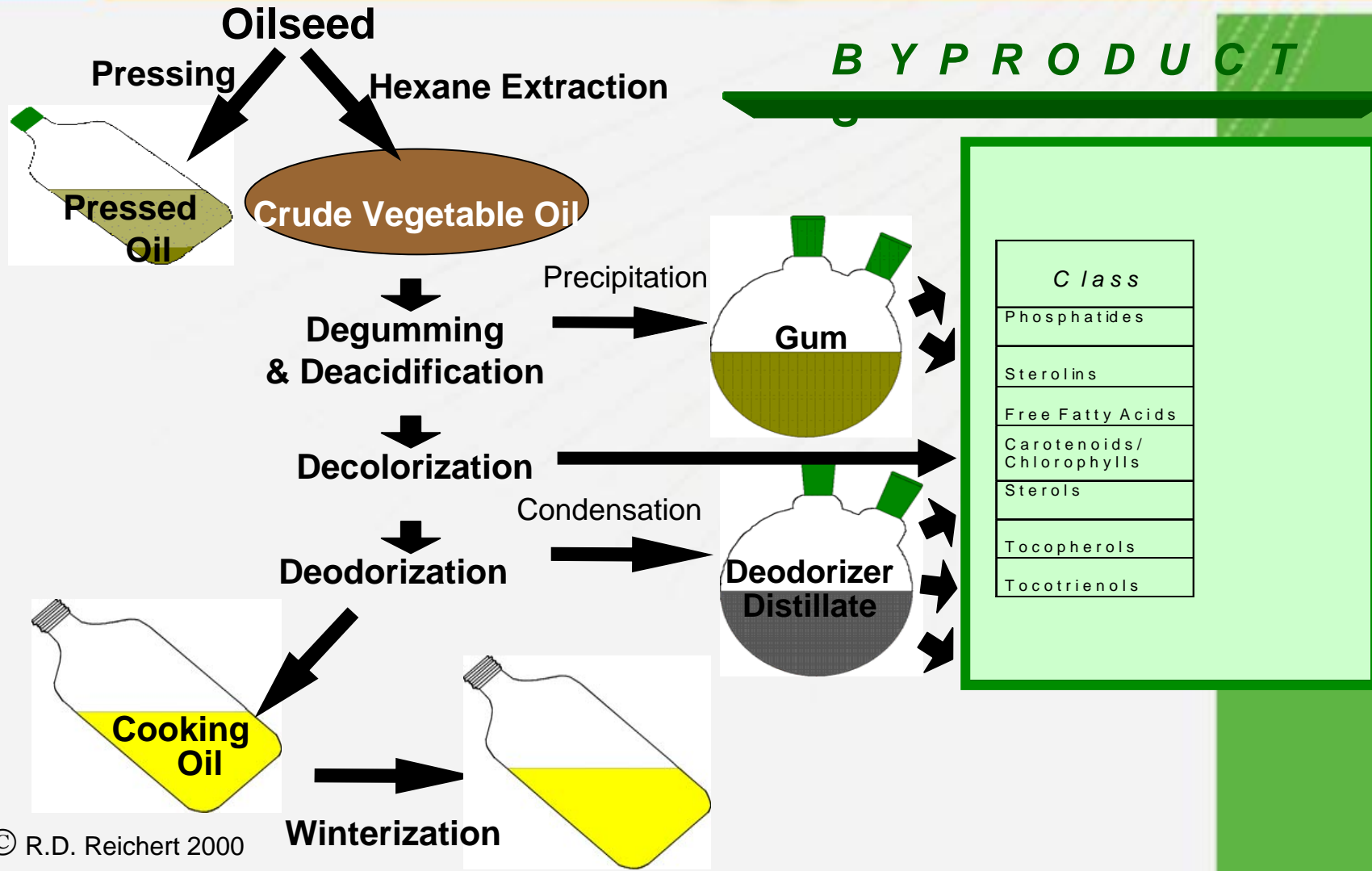
## GROWING Opportunities

- Cold Press Process
  - Expellers have rotating screw inside a horizontal cylinder
  - Screw forces the seeds through the cylinder gradually increasing the pressure
  - Oil escapes from the cylinder through small perforations
  - Temperature and pressure can be adjusted for efficient extraction and oil quality
  - Material preparation is important



# Solvent Extraction of Vegetable Oil

## GROWING Opportunities

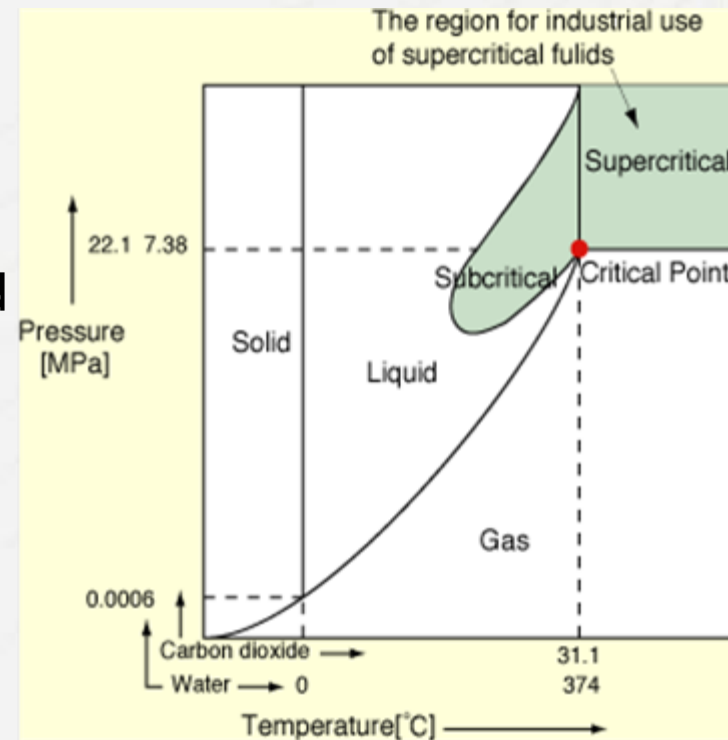


# SBT Oil Extraction Contd.

## GROWING Opportunities

### Supercritical Fluid Extraction

- Unique separation process
- Uses properties of gas or liquid above its critical temperature and pressure for extraction:
  - high density for good solvent power
  - low viscosity and diffusivity for appreciable penetrating power
- Commonly used gas is carbon dioxide

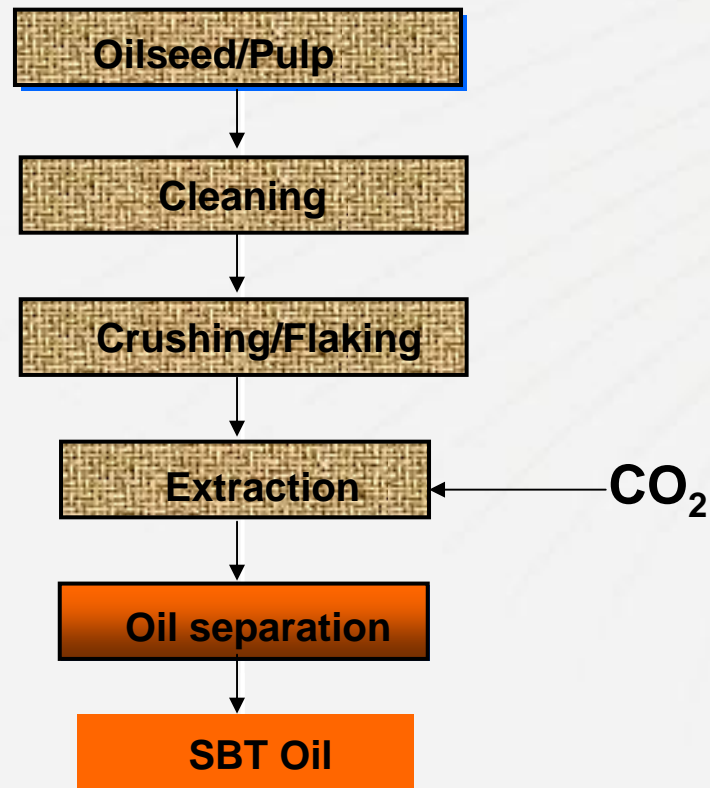


Phase Diagram

# SBT Oil Extraction Contd

## GROWING Opportunities

### Supercritical Fluid Extraction Process

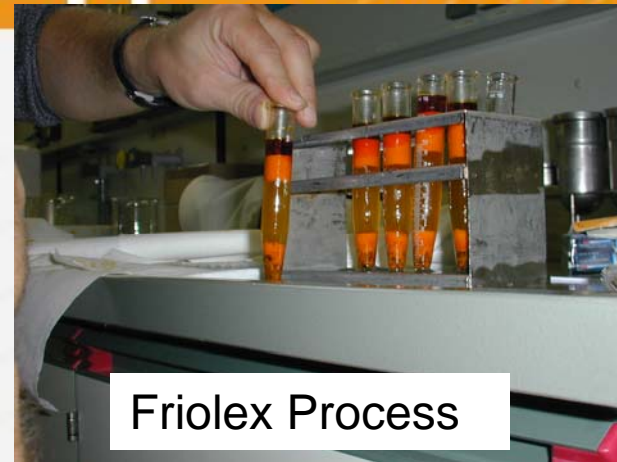


# SBT Oil Extraction Contd.

## GROWING Opportunities

### Friolex Process – Patented

- Centrifugal technology for oil recovery
- Water-based oil extraction process
- Uses alcohol as a processing aid to break down the emulsion
- A special decanter centrifuge for separating the oil from the meal
- Oil impurities are removed in a high speed separator
- Process is blanketed with an inert gas (nitrogen) for product quality



Friolex Process

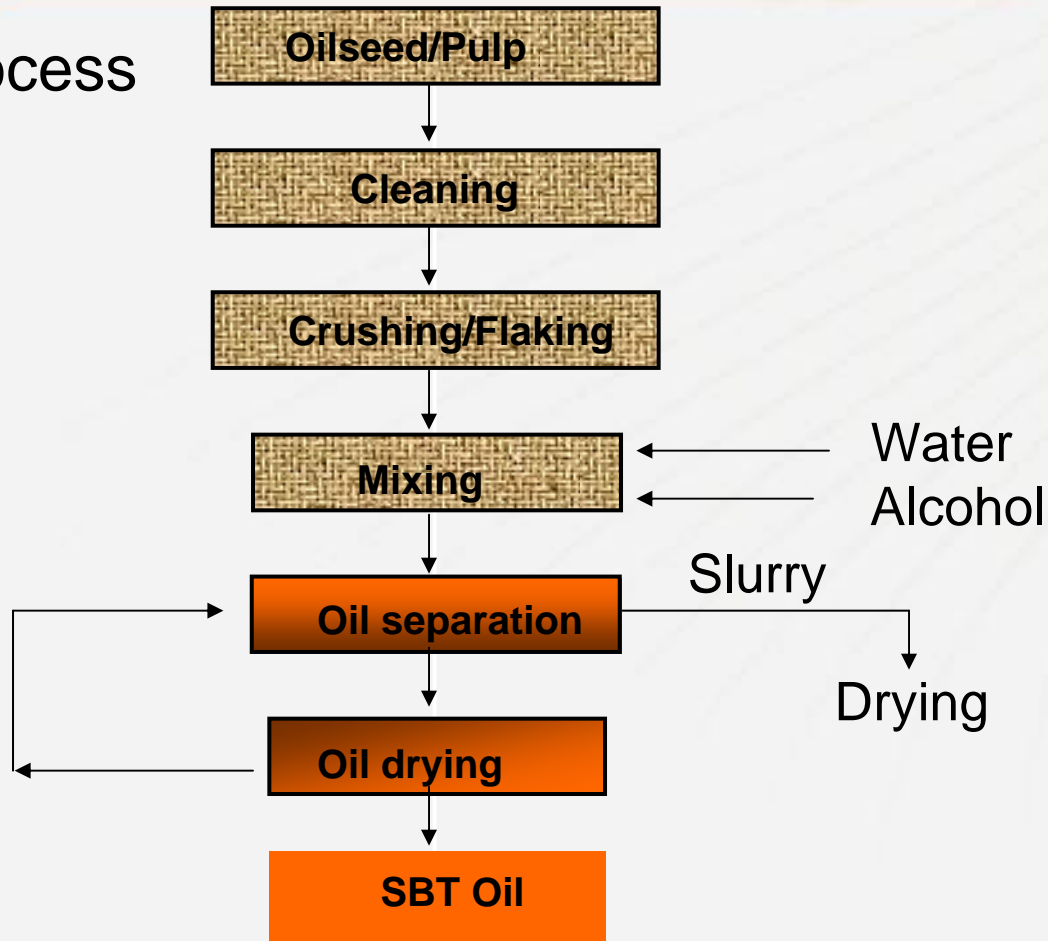


Westfalia Decanter Centrifuge  
Reproduced with permission

# SBT Oil Extraction Contd

## GROWING Opportunities

Friolex Process



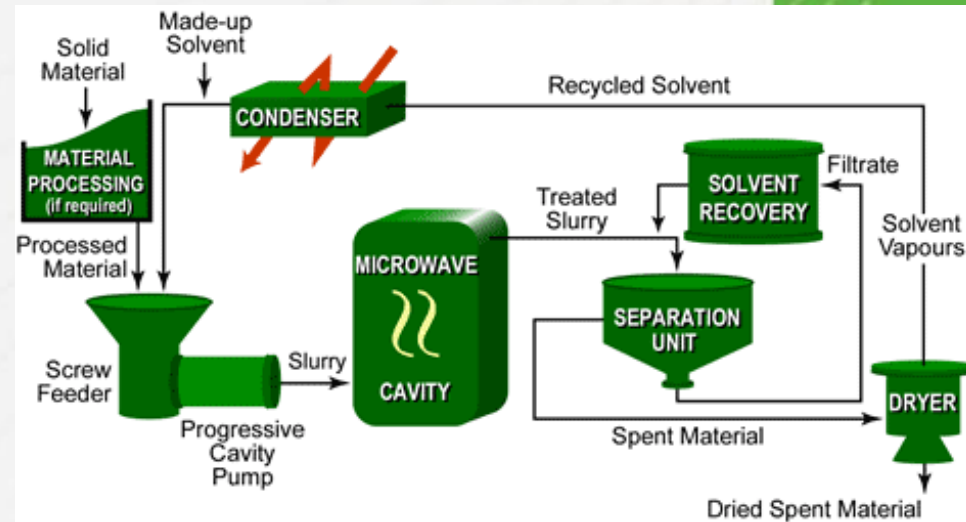
Reproduced from Westphalia Separation Industry Brochure

# SBT Oil Extraction Contd.

## GROWING Opportunities

### Microwave-Assisted Extraction

- Based on selective and localized heating of moisture in the material by microwaves
- Pressure builds up within the tissue leading to rapid mass transfer of the oil into the solvent
- The slurry is separated and the oil is purified
- The carrier solvent is selected so as to be transparent to microwaves – only the oilseed mass is heated.



**Microwave-Assisted Oil Extraction**

# Seabuckthorn Oil

## GROWING Opportunities

### Supercritical Omega 7



# Seabuckthorn Products

MARKETING Opportunities



Topical cream



Seabuckthorn lip balm



Encapsulated SBT oil extract

# SBT Leaves

## GROWING Opportunities

- SBT leaves contain nutrients and bioactives such as :
  - Carotenoids, sterols, flavonoids, fatty acids, minerals, vitamins and other phytochemicals
  - Can be processed into herbal teas, and extracts for pharmaceutical and cosmetic applications

# Drying of SBT Leaves

## GROWING Opportunities

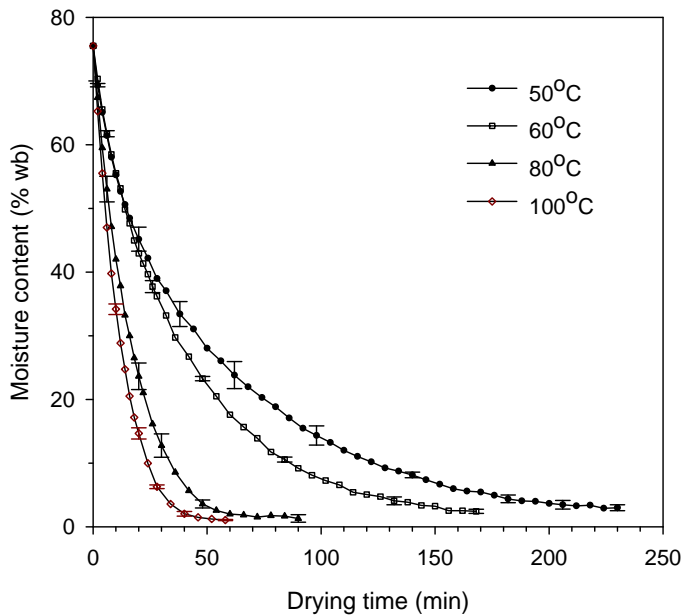
- Two Basic Technologies:
  - Convection Air Drying
    - Most basic yet effective and commonly used in the industry
    - Equipment such as a tray dryer e,g. Proctor and Schwartz Dryer



Tray Dryer

# Typical SBT Leaf Drying Results

## GROWING Opportunities



**Moisture changes of sea buckthorn leaves during convection drying at 50, 60, 80 and 100 °C.**

Drying Temperature (°C)	Equilibrium Moisture (%)	Total Phenolics (mg/100 g wb)
Fresh leaves	75.5 ± 1.2	1453 a ± 153
50	2.8 ± 0.7	1042 bc ± 77.5
60	2.2 ± 0.5	1123 b ± 23.6
80	2.2 ± 0.5	838 d ± 139
100	0.8 ± 0.3	870 d ± 61

**Total phenolics of fresh sea buckthorn leaves and leaves dried to the equilibrium moisture content of 50, 60, 80 and 100 °C.**

# Drying of SBT Leaves Contd.

## GROWING Opportunities

- Freeze Drying
  - Freeze drying, or lyophilization, is the process of removing water from a product by sublimation.
  - Freeze drying is an attractive option for drying of heat sensitive high-value products.



Freeze Dryer at  
FDC

Equipment consist of:

- drying chamber with shelves
- Condenser to trap removed moisture
- Cooling system to supply refrigerant
- Vacuum system to facilitate drying

# SBT Tea Product

## GROWING Opportunities



Tea Leaves



Tea Bar



Tea Soap

# Summary

## GROWING Opportunities

- Processing technologies, both current and emerging, have significant impact on the quality of seabuckthorn products
- It is important to evaluate the market potential of the products associated with each technology before implementation
- More research is required on processing technologies in order to maximize the quality and yield of seabuckthorn products

# Acknowledgements

## GROWING Opportunities

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# GROWING Opportunities



*Thank you !*

