



# INTERNATIONAL SEMINAR ON

## “ Advances in Technology for Dehydration of Food Products”

BY:

**P.L. KAUL**

Managing Director

Mariental India Private Limited

New Delhi

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## Genesis of DHD Technology

1. **Dehydration** of Food Products helps preservation by removing their inherent water content, that is responsible for the growth of microorganism and the quality spoilage.
2. Sun Drying and Curing of Food Products using natural sun and air flow as the driving force to evaporate water is practiced since ancient times.
3. This process has since been mechanized to make it a continuous operation with the use of a range of dryers operated with the help of process control instrumentation.
4. In the case of freeze-drying food is first deep frozen and then the water content in the form of ice molecules is evaporated directly by sublimation under high vacuum
5. Some of the other novel Dehydration techniques developed for Food Products, are going to be covered in my presentation today.

# Type of Industrial Dryers

- Batch / Continuous Dryers
- Spray / Flash Dryers
- Fluidised Bed Dryers
- Vacuum Dryers
- Ring and Rotary Dryers
- Vacuum Freeze Dryers
- Microwave Vacuum Dryers

Sun drying Of Vegetables & Chilies is a common sight on roof tops in Hilly Regions in Late Autumn



# Solar Dryers in Rural Community Service



# Illustration of a Modern Solar Dryer



## SOLAR DRIED PRODUCT

### MERITS

1. Low Processing Cost, because :
  - a) No cost of energy &
  - b) Insignificant cost of Manpower as it involves mostly the family's own womenfolk or the contract farm labor at nominal wages.
  - c) Relatively lower cost of packaging

### DEMERITS

- a) Operation possible only on tiny / households or small scale only
- b) The process is slow, hence capacity constraints
- c) Possibility of contamination / infection infesting the product
- d) Observing Q.C. procedures in difficult.

# A Modern Tray Dryer



# SINGLE BELT CONTINUOUS DRYER



# Advantages of Continuous Belt Dryer

1. That almost all physical parameters can exactly be coordinated with the products to be dried.
2. Drying temperature, processing time, air velocity and direction of air can be are selected for each product independently.
3. These single regulating zones can be separated with respect to the various processing parameters.

## MECHANICALLY DRIED PRODUCTS

### MERITS

- a) Large production capacities possible on continuous driers.
- b) Lower manpower involvement
- c) Q.C. as a function of the continuous belt drier vis-à-vis belt speeds, hot air supply & recirculation, the depth of the raw material bed & material of construction of the contact parts, very much possible.
- d) Process is simpler to handle, even by the semiskilled workers.

### DEMERITS

Quality of the finished products

- a) Hardness with shriveled skin
- b) Faded surface color
- c) Loss of flavor & food values
- d) Reduction in volume
- e) Reconstituting in boiling water takes long time
- f) Meet consumer resistance.

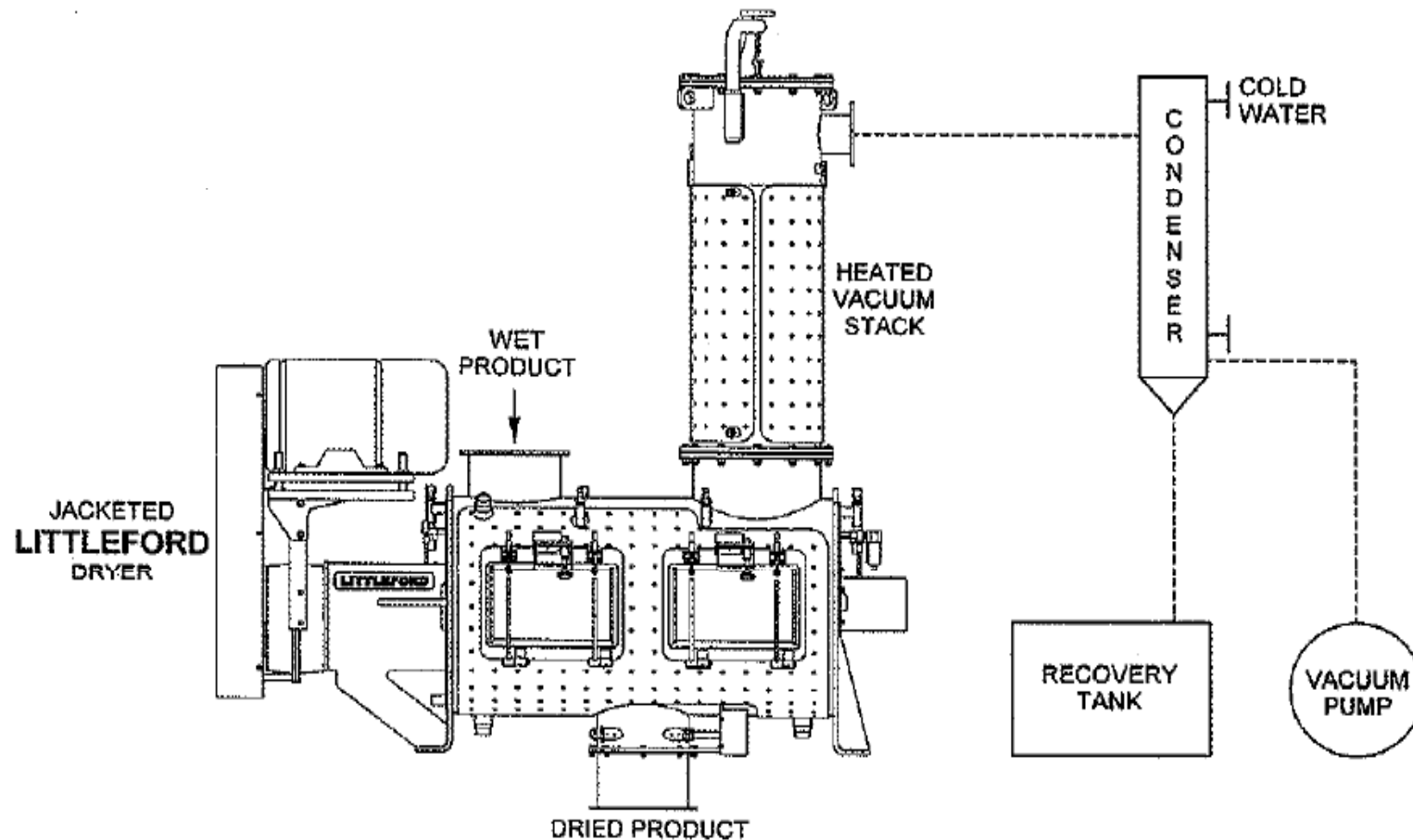
## NUTRITIONAL VALUE OF APRICOT AND DRIED APRICOT PER 100 G.

Characteristics	Fresh Apricot	Dried Apricot
Energy, kJ (kcal)	201 (48 )	1,009 (241 )
Carbohydrates, g	11	63
Sugars, g	9	53
Dietary fiber, g	2	7
Fat, g	0.4	0.5
Protein, g	1.4	3.4
Vitamin A, ug	96 (11%*)	180 (20%*)
Vitamin C, mg	1094(10%*)	2163 (20%*)
Iron, mg	10 (17%*)	1 (2%*)
	0.4 (3%*)	2.7 (22%*)

\*US recommendation for adults

# State-of-Art Technology for Mixing cum Vacuum Drying Process

## TYPICAL DRYING OPERATION



# Cutting Edge Technology Oriented Vacuum Dryer

## Littleford Advanced Drying Technology

**Littleford drying technology brings unmatched efficiency and economy to the drying function**

**Offers high-efficiency drying of suspensions, pastes, and bulk materials**

**Provides complete dispersion of agglomerates, lumps, and fiber bundles**

**Allows homogeneous mixing of dissimilar ingredients**

**Offers the capability of drying the product from a liquid state to a free-flowing powder in one process vessel**

**Permits liquid addition during processing**

**Adapts itself to effective recovery of costly solvents**

**Facilitates batch control sampling**

**Offers fast drying cycles and discharge**

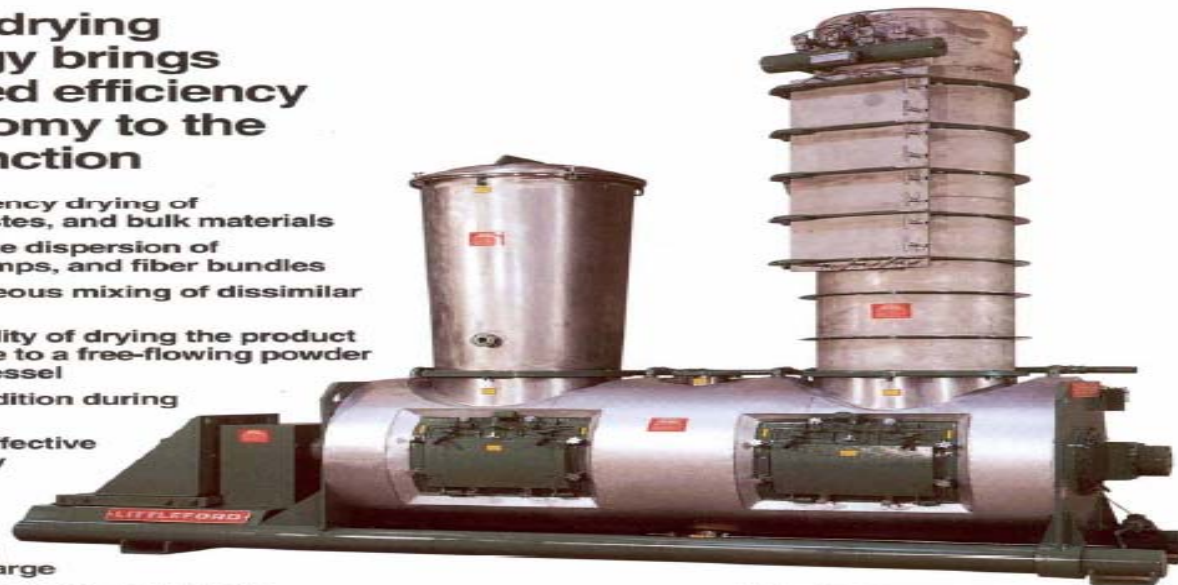
**Provides easy clean-out, along with minimum maintenance**

**Meets FDA and USDA sanitary design, if required**

**Allows efficient, complete drying of temperature-sensitive materials at low temperatures**

**Eliminates need for additional processing equipment and expense**

**Offers methods and designs which minimize explosive conditions, oxidation of the product, and overwetting the product during mechanically agitated drying**



*Littleford VT Ploughshare Vacuum Dryer.  
Capacity: 4,000 Liters*



*Littleford Unique Plow Shaped Mixing Tools*

**COVER PHOTO:**  
Littleford 20,000 Liter Ploughshare Vacuum  
Dryer with 5,280 Gallon Capacity, 400 HP  
Drive and two 150 FT. Pulse Back Filters

# Plough Shear Mixer cum Vacuum Dryer A Cutting Edge Technology



Littleford Mix Action Video.wmv

# VACUUM DRIED PRODUCTS

## MERITS

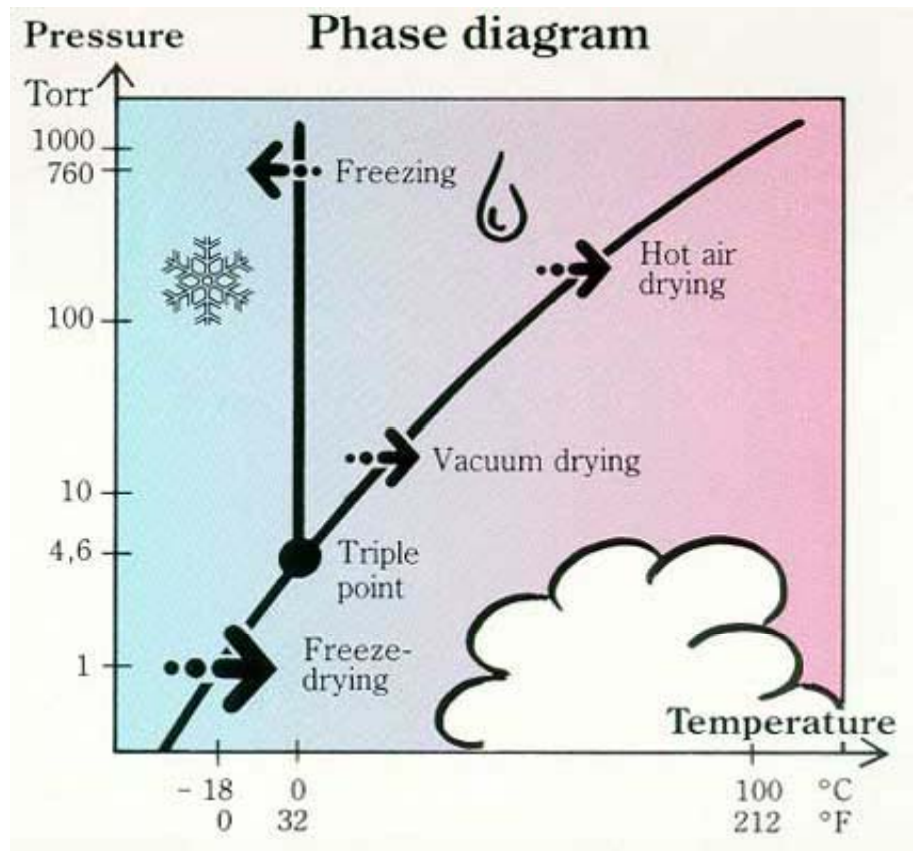
Vacuum dried products are superior in quality than air dried products as the liquid- vapour phase change takes place at a much lower temperature that helps retaining color, texture & food values to a greater extent than the air dried products

## DEMERITS

VD Products are relatively more expensive because

- a) The time of drying is relatively too long.
- b) Energy consumption is higher
- c) Maintenance of processing equipment is high.
- d) Data available on rate of drying of Food Products under vacuum is rather incomprehensive..

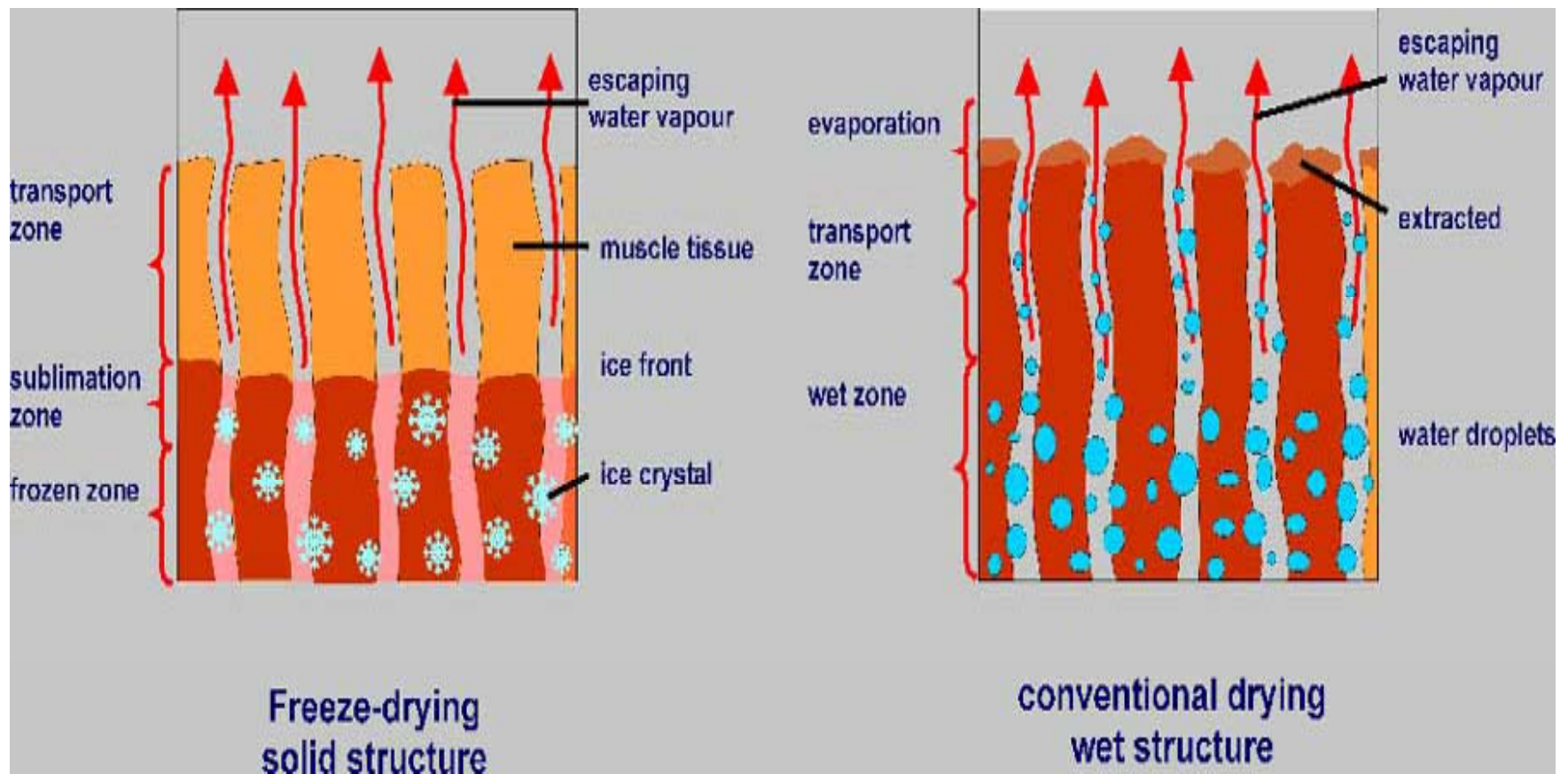
# Fundamentals of Freeze Drying



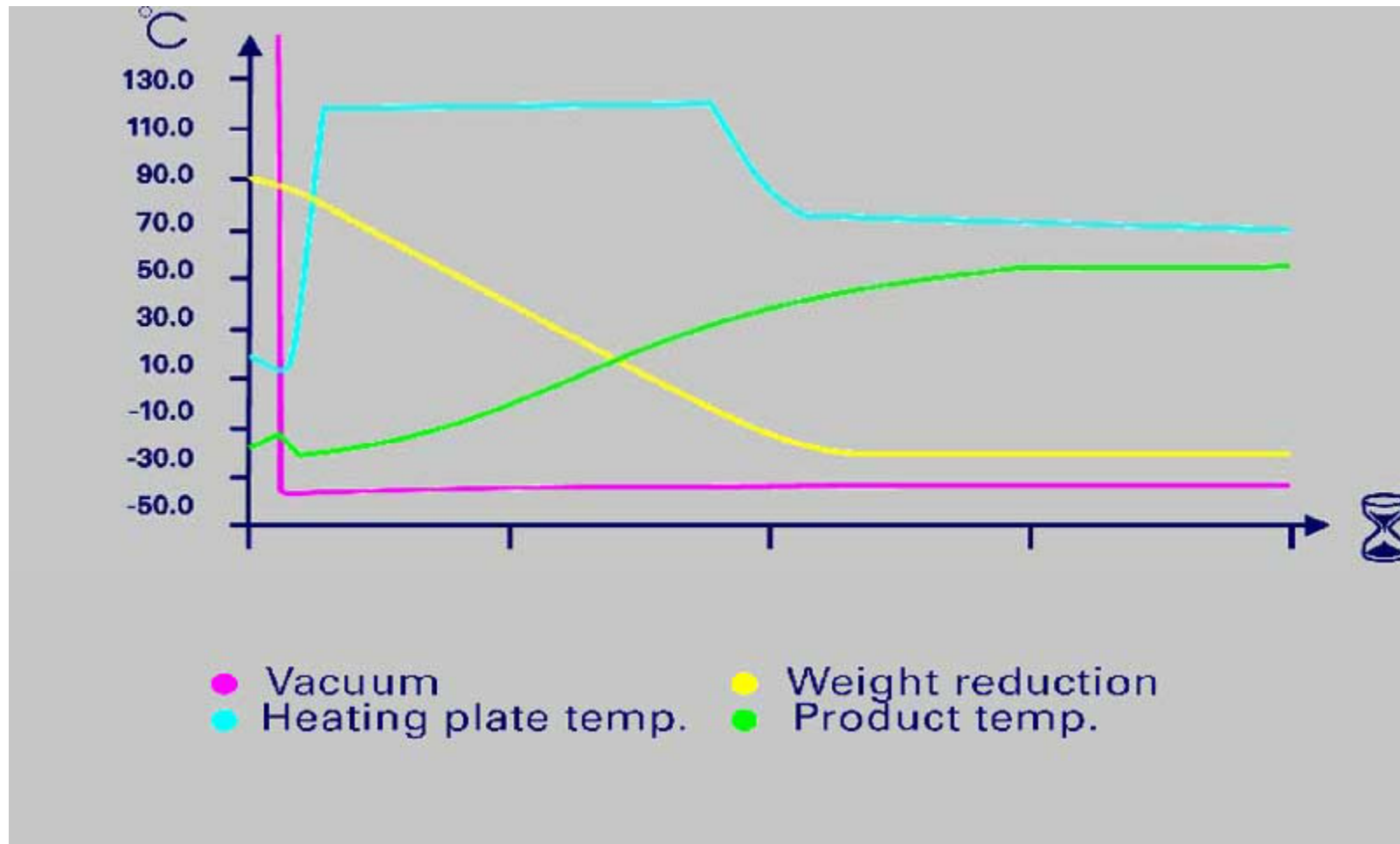
- The product is frozen before the drying process starts
- Drying takes place below the eutectic point
- No free water during the drying process - direct from ice to vapour (sublimation)

## Product structure

# Freeze-drying compared with conventional drying



# Freeze-Drying Process Profile

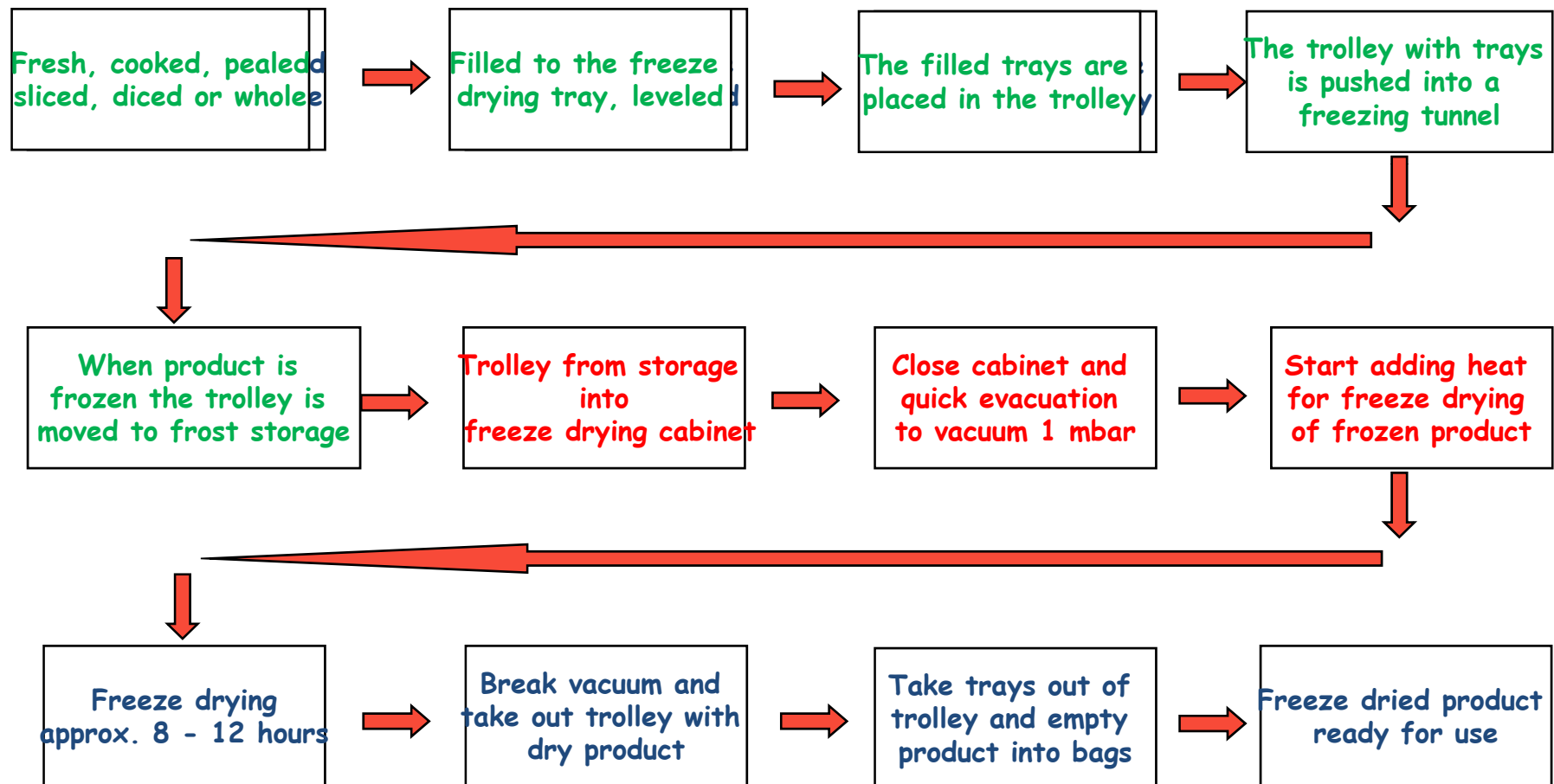


## The benefits of freeze-drying

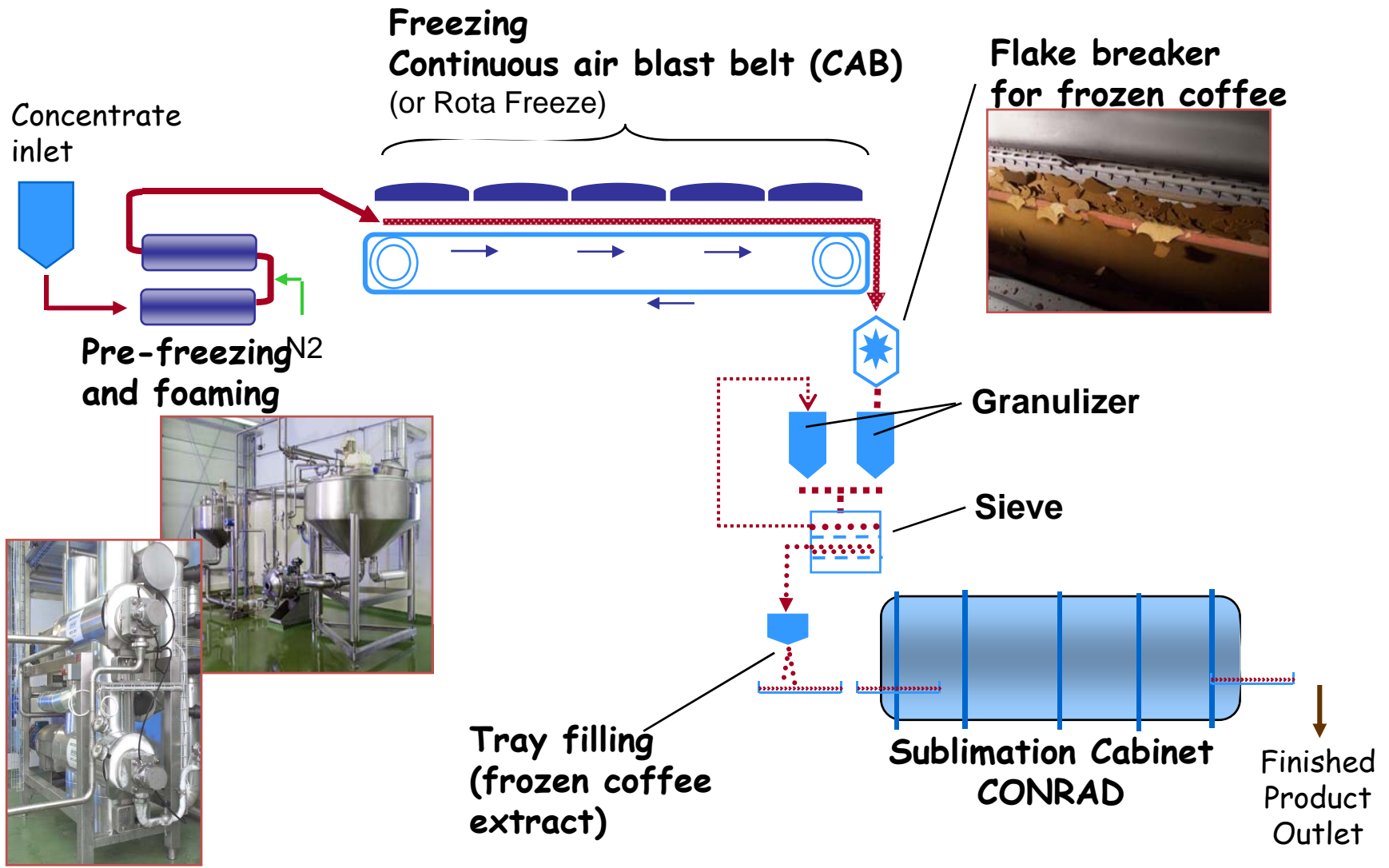
Original colour  
Original shape  
Aroma retention  
Re-hydrates instantly  
in cold or hot water  
Low content of micro-organisms  
No additives  
Long shelf life  
No need for refrigerated transport and storage  
Low product loss  
High market price



# Freeze-Drying Process for Fresh Products



# Freeze Dryer



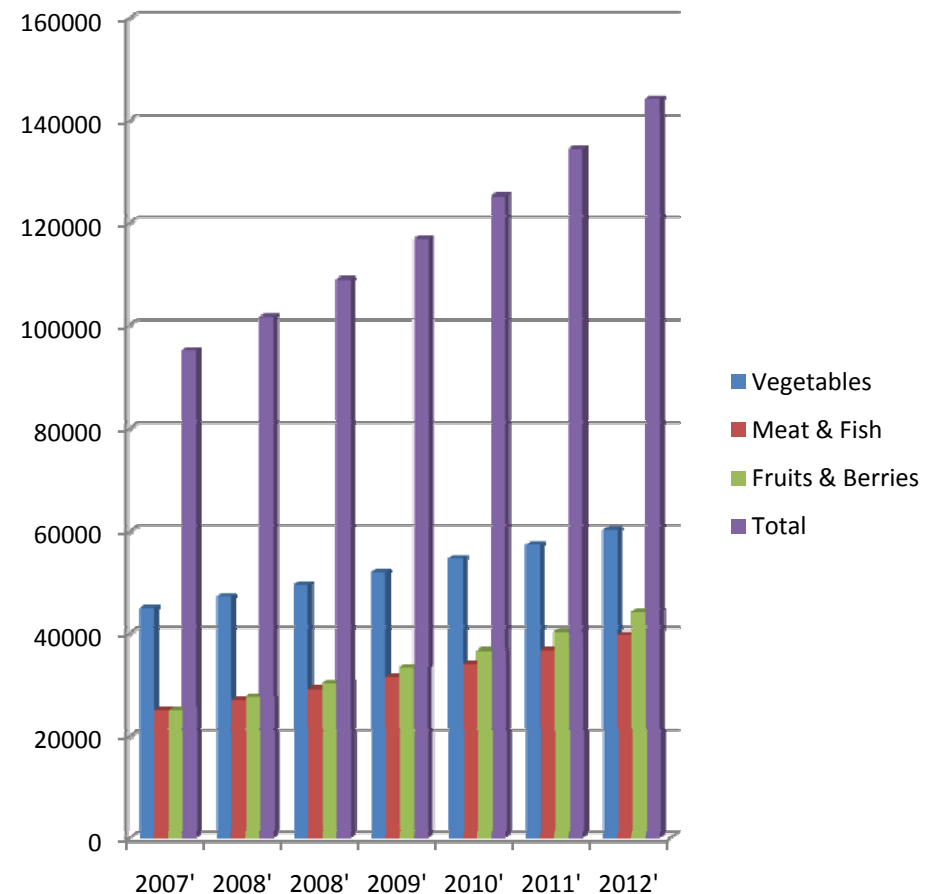
# RAY 30 S pre-assembled



## Market developments

'1000 Metric  
Tonns

- Freeze-dried foods equivalent to 1,45,000 tons
  - 60,000 tons of vegetables
  - 40,000 tons of meat and fish
  - 45,000 tons of fruit and berries
- 10,000 tons annual average growth.
- Market growth is expected in Asian and especially in the Chinese market.
- Low costs of freeze dried products will maintain or increase growth.
- Introduction of "Special K" from Kellogg's with red berries has given additional demand for 20.000 - 30.000 tons of strawberry and other red berries in the last 3 years.(Year 2004)
- New products like soup blocks in Asia is also giving increased growth.



## Freeze Drying of Strawberry An Economic Case Study

Calculation example: Strawberry produced in 4 - RAY 100, June 2004

Production capacity: 354,000  
kg/year

Investment:	Equipment	4,500,000 EUR	
	Install and start	500,000 EUR	
	Building	1,000,000 EUR	6,000,000 EUR

Production cost:

Frozen berry: (1,50 EUR/kg, 10 kg/kg) 15,00 EUR/kg

Energy: 1,17 EUR/kg

Capital: (8%, 15 year and 25 year) 1,58 EUR/kg

Staff and maintenance:	0,78 EUR/kg	18,54
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EUR/kg

Sales price:	22,00
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EUR/kg

Yearly profit: (22 %)  
1,225,000 EUR

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## Limitations Of Vacuum Freeze Drying

Even though VFD is a novel technique of preservation, It has the Economic Limitations in terms of its applicability on Food Products because ;

- The Process is Capital intensive
- VFD is mostly a batch Process and hence the production Capacities remain relatively smaller
- VFD is also Energy Intensive
- The Cost of maintenance is relatively much higher
- The effect of the higher capital cost , higher production cost & Lower Production Capacity leads to higher unit cost of the product.

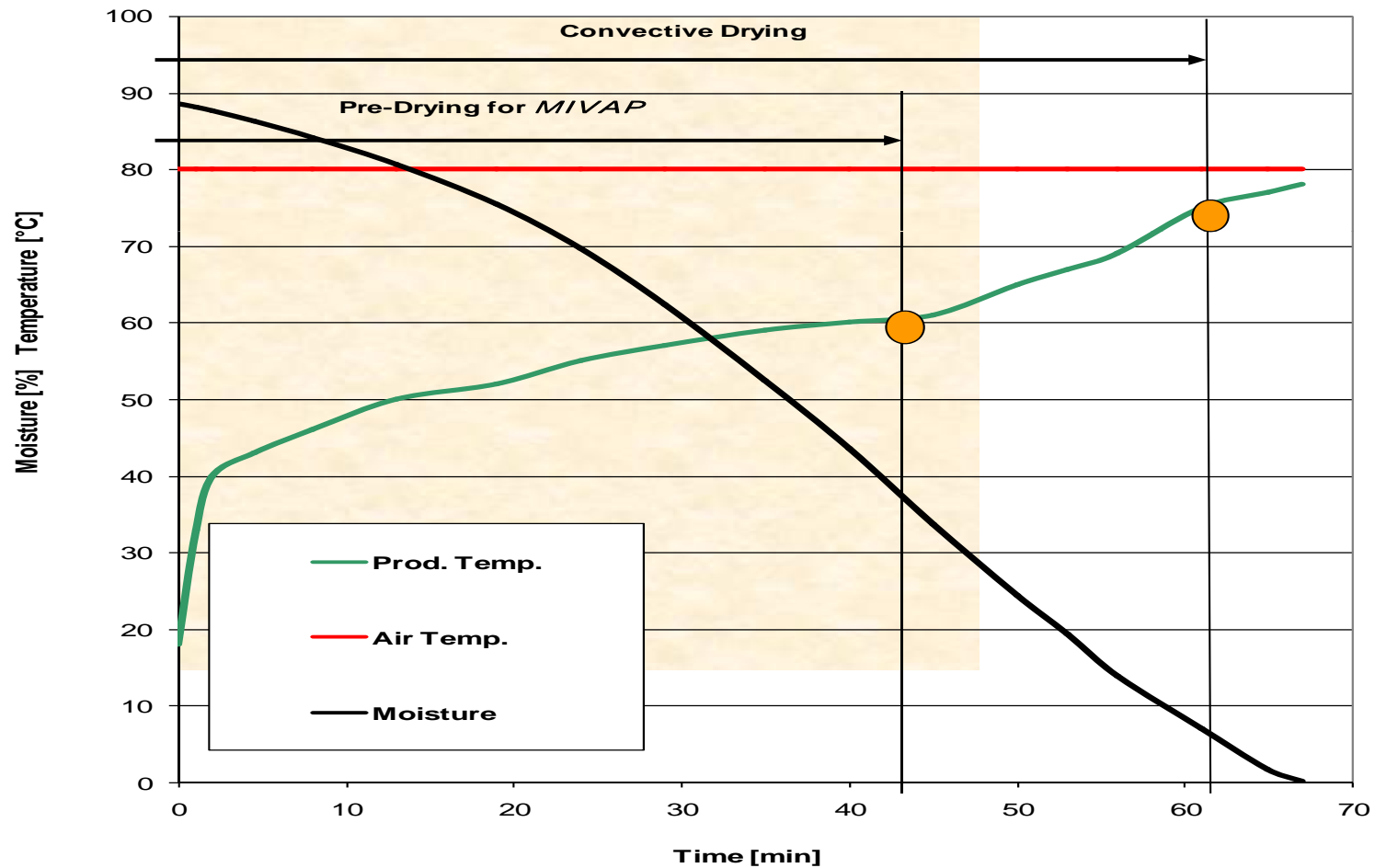
Hence the novel VFD Technology stays relevant to expensive and exotic food products and cater to only the niche elite consumer market.

# **MICROWAVE VACUUM DRYING PROCESS**

## **MIVAP**

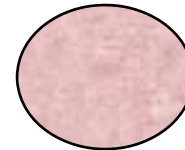
**An innovative  
Technology  
for the Production  
of high-quality  
Dehydrated Food Products**

# PRODUCT TEMPERATURE PROFILE DURING CONVECTIVE / MIVAP DRYING PROCESS



# THE MIVAP EFFECT

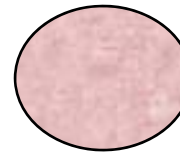
Fresh Product Shape



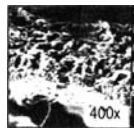
Shrunk Shape after  
Predrying



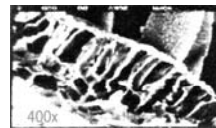
Puffing by vapour by  
Means of Microwaves  
At an absolute pressure  
Of 20 mbar



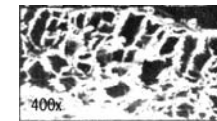
Cell structure ( 400 x )



Air dried



Freeze dried



MIVAP

# MIVAP™ -Process

Microwave-Vacuum-Drying



## 1. Products:

RAW PRODUCT

BROCCOLI  
CAULIFLOWER  
ONIONS

CARROTS  
POTATOES  
CELERY

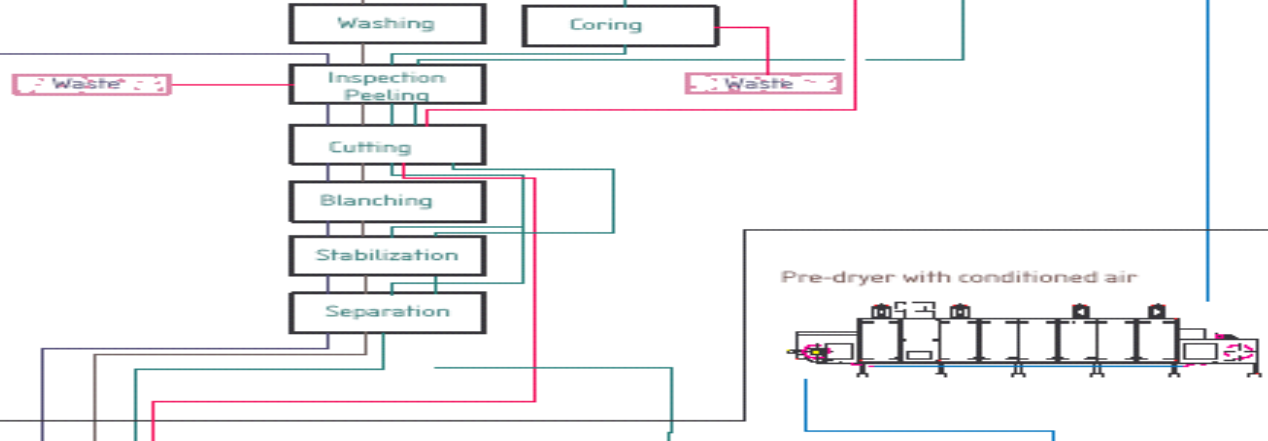
FRUIT:  
Pear  
Apples

MEAT

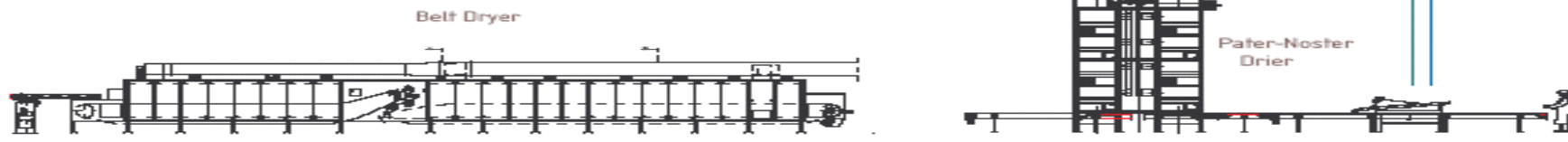
Products with  
high  
SUGAR CONTENT  
strawberry  
banana

IQF-FROZEN  
PRODUCTS

## 2. Preparation:

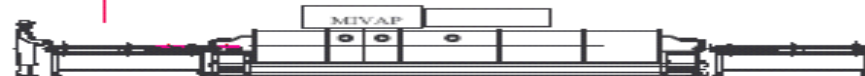


## 3. Predrying:



## 4. MIVAP™:

MIVAP™



## 5. After-Treatment:



## THE RAW PRODUCTS FOR MIVAP

- ❖ Fresh Farm Products
- ❖ Pre-processed IQF-Products
- ❖ Semi-dried Products
- ❖ Partially/Osmotically Dehydrated Fruit Products

Vegetables	Fruits	Others
Onions	Strawberries	Meat
Carrots	Banana	Cheese
Celery	Pineapples	Algae
Cauliflower	Apples	Fish
Potatoes	Cherries	Shrimps
Others	Others	Others

## INDUSTRIAL PLANT



# ADVANTAGES OF MIVAP\* OVER CONVENTIONAL DRYING METHOD



## ADVANTAGES

No restrictions as regards form and consistency

No mechanical force on the product (preservation of its form)

No contact of the product with parts of the unit

No transverse product contamination

No additional micro-biologic discharge of the product

A constant and reproducible product quality

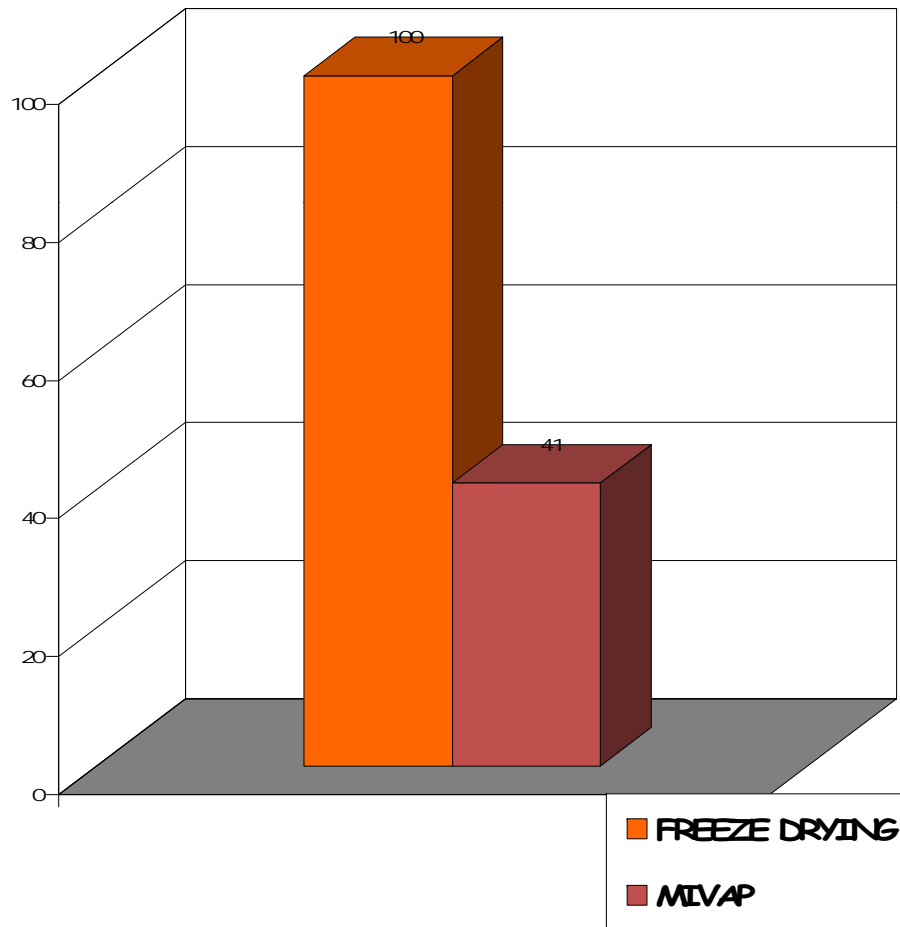
Direct product change possible (from tray to tray)

Minimum efforts for cleaning and thus high efficiency

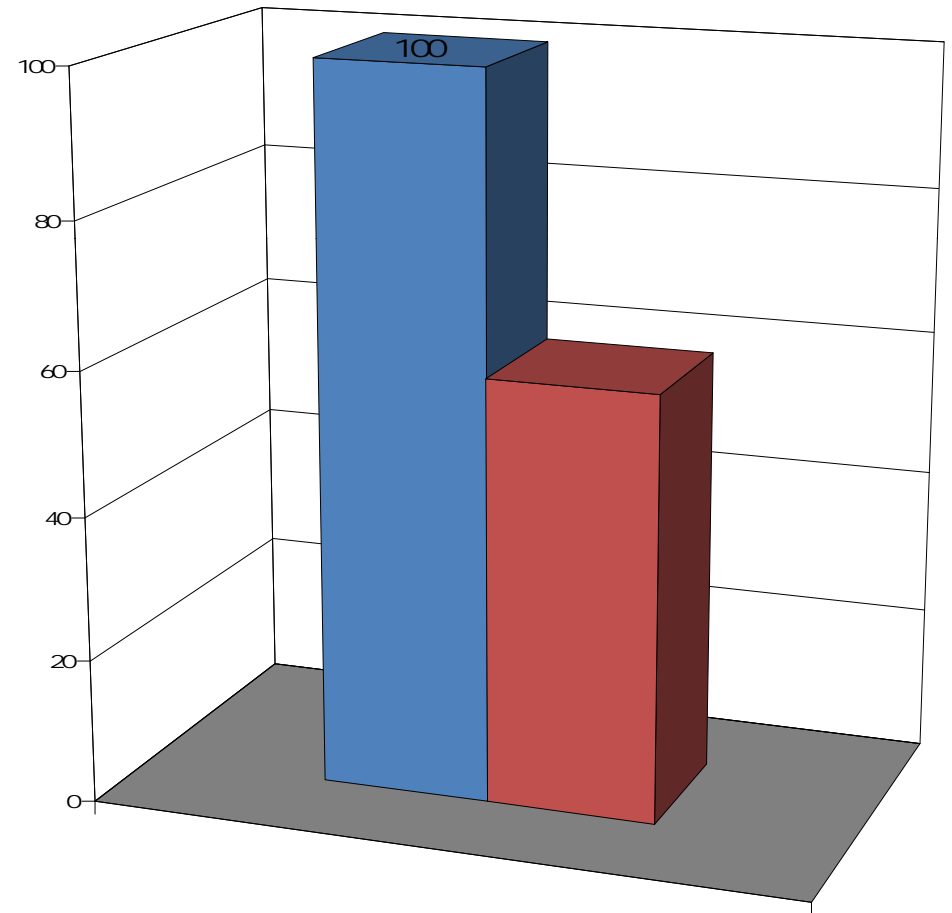
## NUTRITION COMPARATIVE TABLE (FOR BANANA)

*DAILY VALUE	MIVAP	FREEZE DRYING
Calories	111	100
Fat Calories	3	5
Total fat	0.3 g	0.5 g
Sodium	0 mg	0 mg
Total Carbohydrate	26 g	25 g
Dietary Fibre	2 g	2 g
Sugars	16 g	16 g
Protein	1.0 g	1.0 g
Vitamin A	0 %	< 2 % *
Vitamin C	4 %	4 % *
Calcium	2 %	0 % *
Iron	6 %	< 2 % *

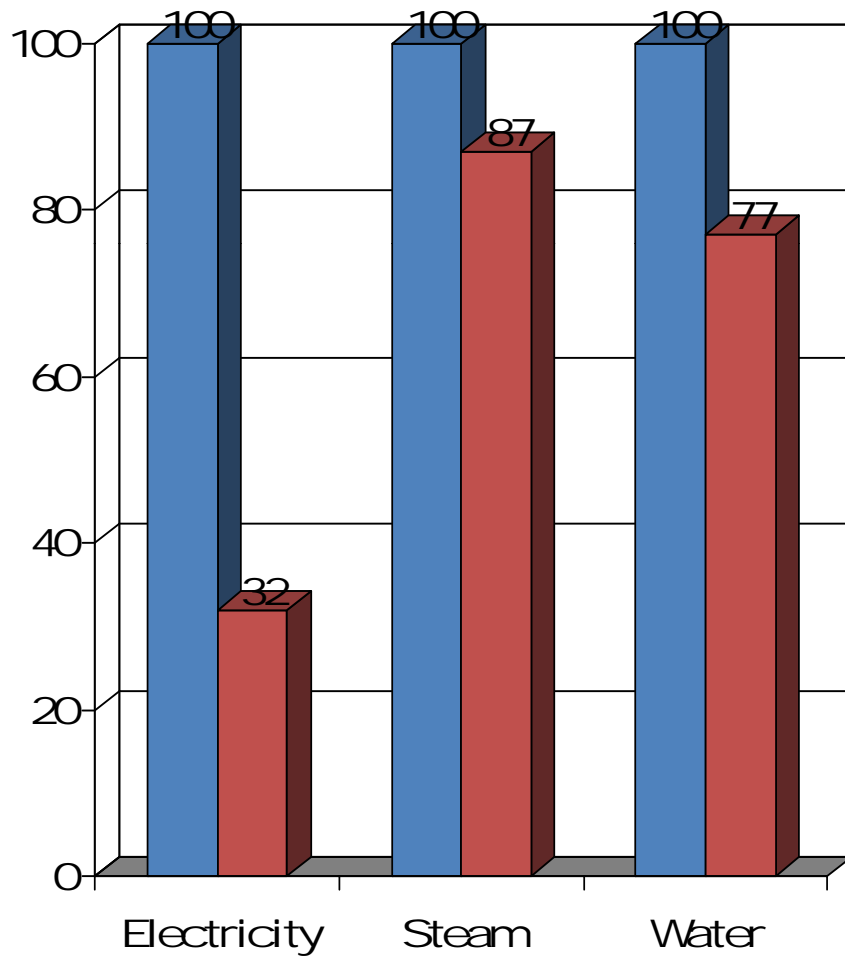
# TOTAL INVESTMENT



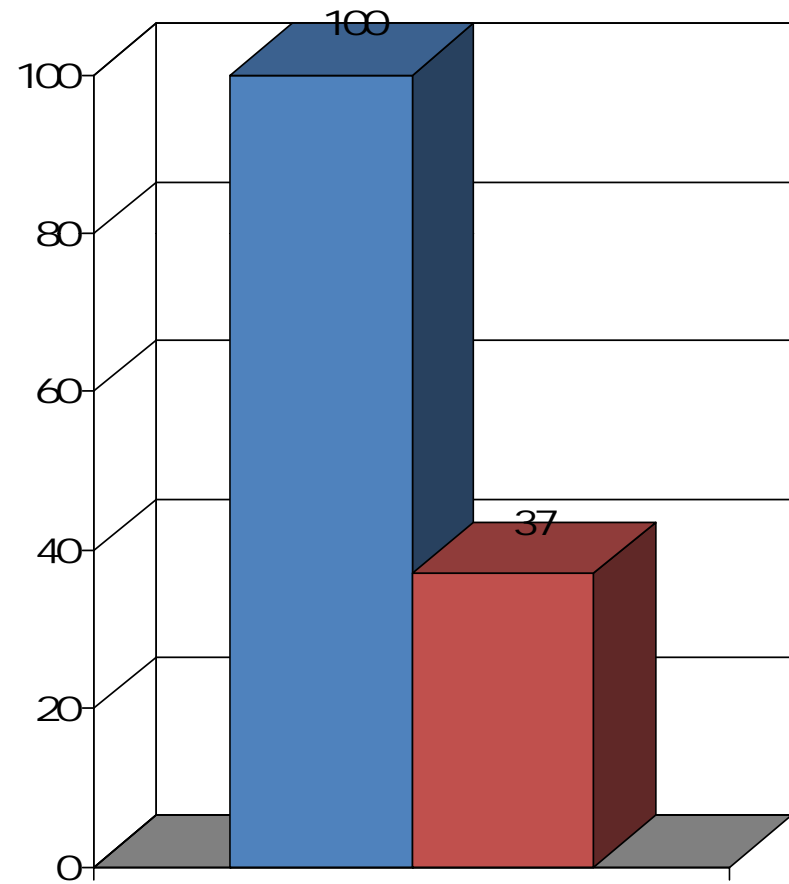
# TOTAL OPERATION COSTS



### CONSUMPTION OF EVAPOARTED



### COSTS/ kg COSTS WATER



■ FREEZE DRYING ■ MIVAP

## ECONOMIC COMPARISON OF TECHNOLOGIES

### VFD v/s MIVAP

	VFD	MIVAP
I. Raw material Input	Frozen Onions (IQF)	Fresh Onions
i. Raw Material	514 kg/hr	685 kg/hr
ii. Capacity (Finished product) kg/hr	51 kg/hr	51
iii. Equipment Cost (Approx.)	€ 6.0 mill.	€ 2.15 mill.
iv. Process Plant Covered Area m <sup>2</sup>	1750 m <sup>2</sup>	1200
ii. Utilities (Consumption Norm ,Avg.)		
- Power,	637 kWh / h	207 kWh /h
- Steam	922 kg/h	800
kg/h - Water		52 m <sup>3</sup> /h
40 m <sup>3</sup> /h		
v. Production Costs of Finished product	€ 8.53 /kg	€ 3.30 /kg
vi. Av. Sales Price	€ 11.00 /kg	€ 8.80 /kg
vii. Profit	€ 2.47/kg	€ 5.50/kg

## MIVAP PROCESSED PRODUCTS

