AITC course 2023 : The application of a parabolic greenhouse solar dryer together with raw material preparation techniques to extend shelf-life and enhance quality of agricultural products

Packaging for Dried Foods

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Art

Science

Marketing

Consumer

Engineering

Technology

https://www.generalbeverage.co.th/en/vitaday/

Packaging development steps

STEP 1
Determine Product/Package Requirements

- Requirements of food
- Requirements of production
- Requirements of marketing

STEP 2
Select Package Materials and Equipment

- Identifying options
- Cost and availability
- Identifying potential issues
- Regulation compliance

STEP 3
Evaluate Prototype packages

- Shelf-life testing
- Distribution testing
- Production/package interaction testing

STEP 4
Test In the Market

- Confirm costumer acceptance and monitor feedback
- Refine package/process design if necessary

https://inewtrition.com/food-packaging/?utm_source=rss&utm_medium=rss&utm_campaign=food-packaging

Food packaging materials

Glass

Metal

Combined materials

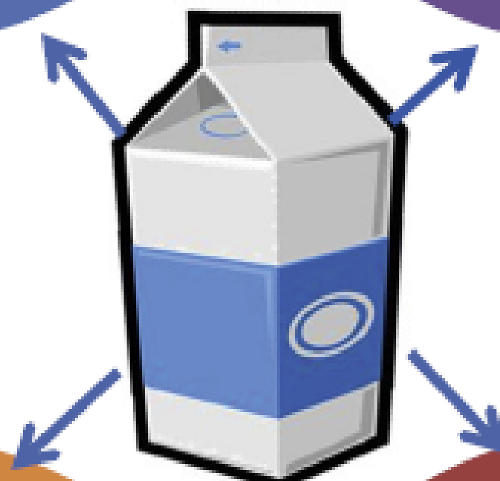
Paper and board

Plastic

Food Packaging functions

Protection
(Oxygen, moisture, microorganisms, dirt, chemical contaminants, toxins, etc.)

Containment
(Prevent mixing, bruising, act as transportation medium for liquid foods, reduction of vibration and mechanical shock)



Convenience
(Easy opening, processing by microwave or retorting)

Communication
(Nutrition labeling, price, product ingredients, product life, storage conditions, etc.)

Wani et al. (2014)

Factors affecting food deteriorations and spoilage

Intrinsic factors

- pH
- Water activity
- Oxidation-reduction potential
- Nutrient content
- Antimicrobial constituents
- Biological structures

Packaging technology

Extrinsic factors

- Temperature of storage
- Relative Humidity
- Gases in the environment

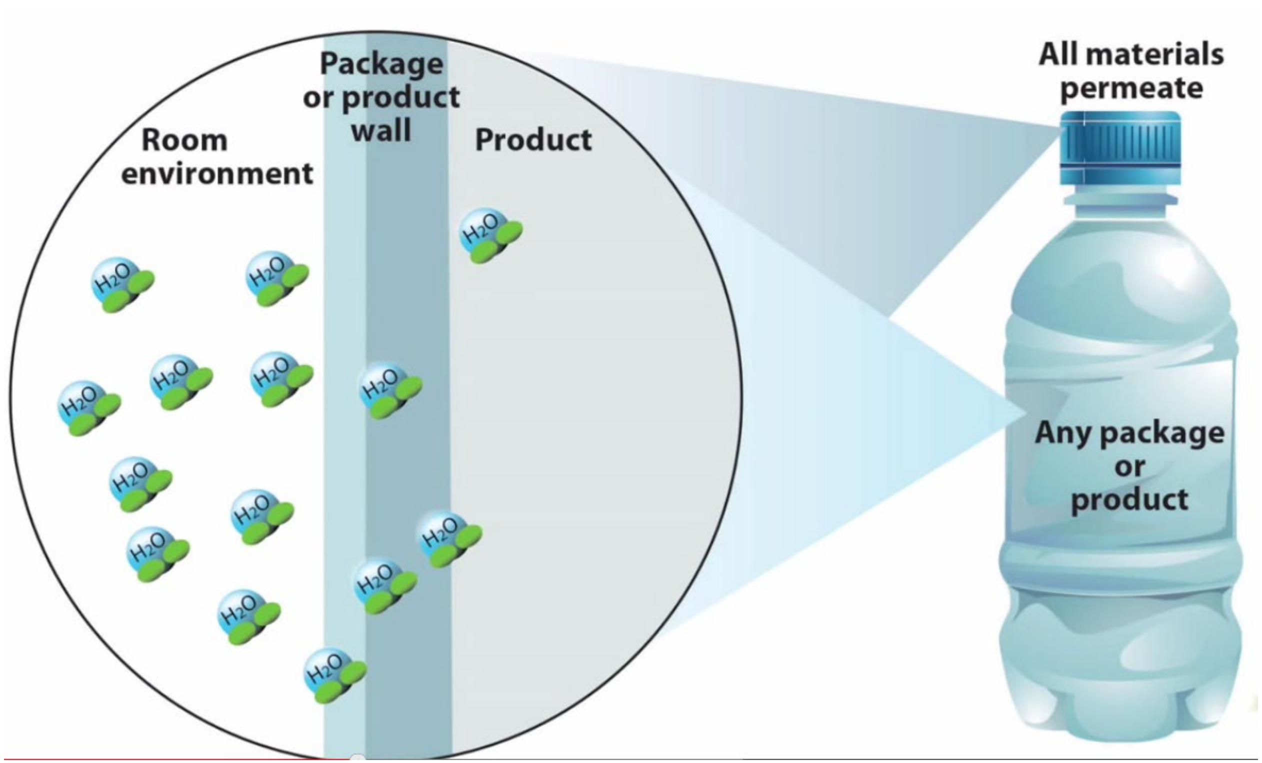
Processing factors

Implicit factors

https://microbenotes.com/factors-affecting-the-growth-of-microorganisms-in-food/

Package permeability

- ➢ Transfer of molecules through packaging
- ➢ Permeability affects shelf-life
  - ❑ Water vapor permeability
  - ❑ Gas permeability



Packaging Materials

Packaging Technology

https://www.packagingstrategies.com/articles/94290-new-technology-emerges-for-extending-shelf-life-of-natural-foods

Packaging of Dried Products

Snack and dried food products

- Potato chips, Pretzels, Peanuts, Popcorn, Pork rinds, Extruded snacks, Cookies and crackers, Seeds and nuts, Dried meat snacks, etc.
- Breakfast cereal
- Powder e.g. milk powder, coffee

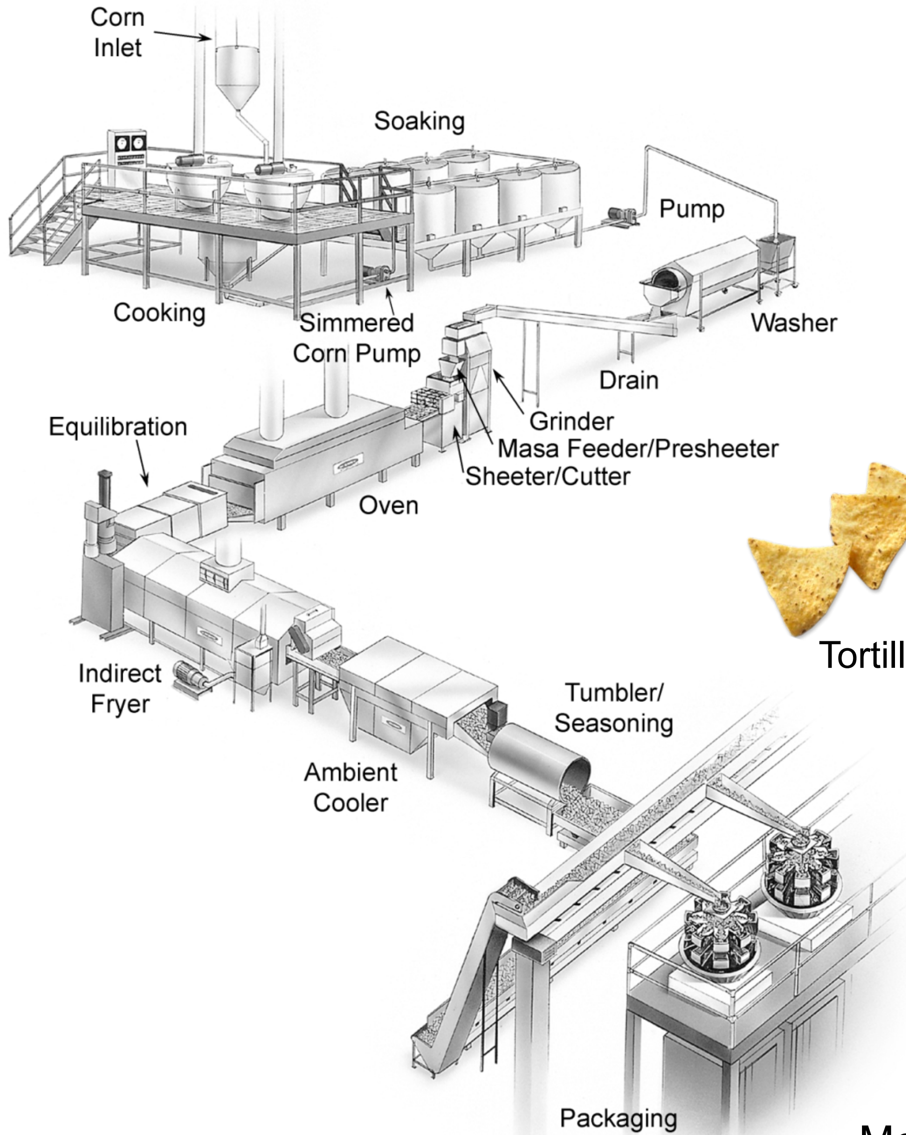
Characteristics of snack products

- Low moisture, a_w
- Crispy
- Hygroscopic: glazed sugar-based coating, fruit mix
- Long shelf-life
- Sensitive to humidity

Snack processing

LOAD OF POTATOES
↓
Storage
↓
Destoning
↓
Peeling
↓
Washing
↓
Sorting & Trimming
↓
Slicing
↓
Washing
↓
Frying
↓
POTATO CHIPS
↓
Color Sorting
↓
Inspection
↓
Seasoning
↓
Packaging
↓
Casing
↓
SHIPPABLE PRODUCT
↓
Shipping & Distribution

Gould (2001)

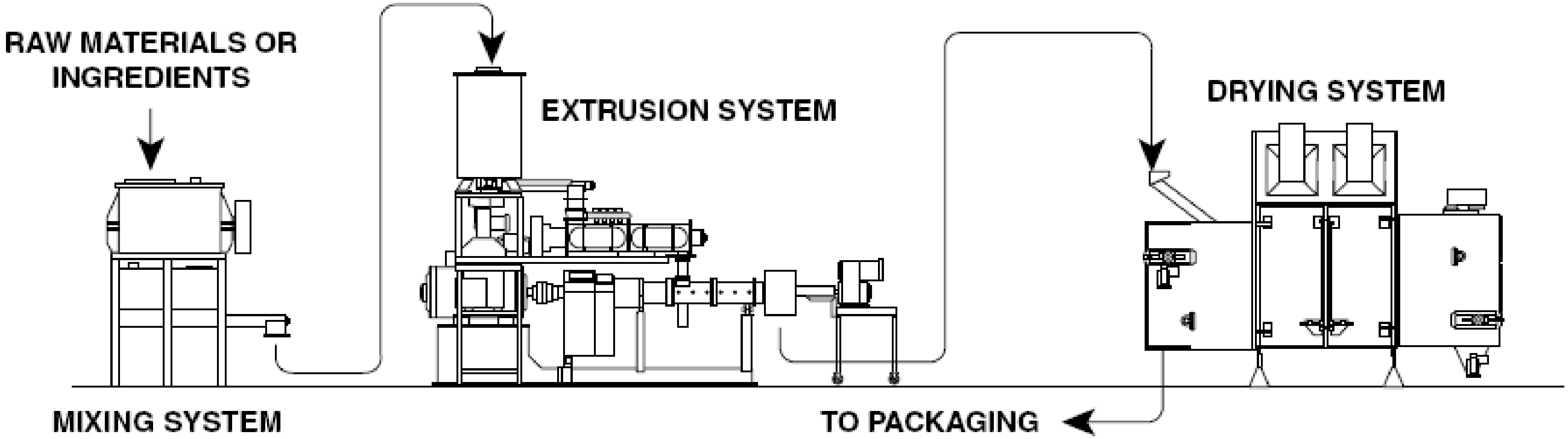


Tortilla chips

Mehta (2001)

Snack processing

- Frying
  - Oil content
- Extrusion and puffing
  - Light, low bulk density
- Drying
  - Structure modification: Porous, dense, powder

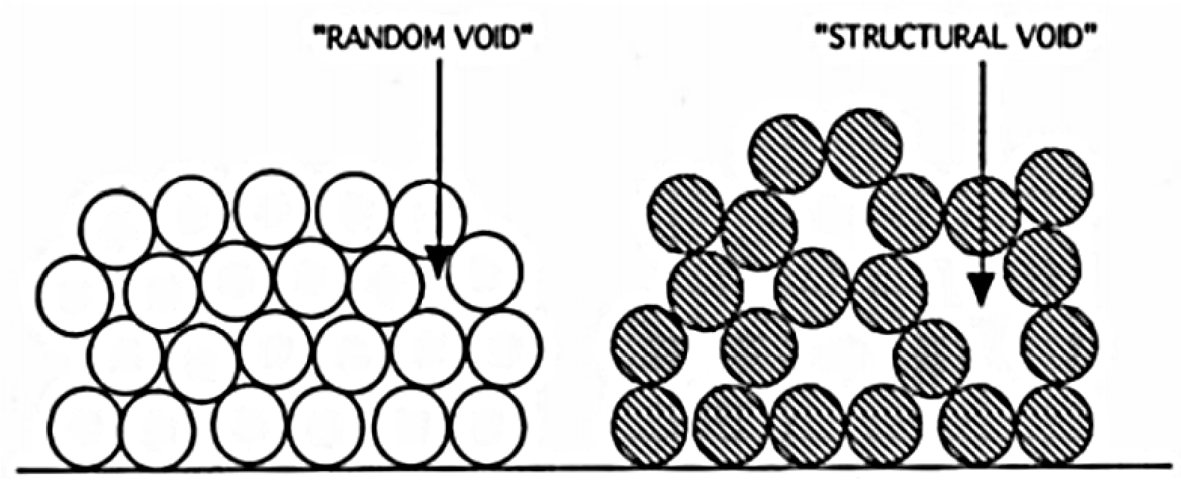


DIRECT EXPANDED SNACK FLOW DIAGRAM

Huber (2001)

Density

- Density/ Mass density = mass/ volume
- Bulk density = weight of many particles of the material divided by the total volume they occupy. The total volume includes particle volume, inter-particle void volume, and internal pore volume



Peleg (2006)

Filling and packaging

Package style

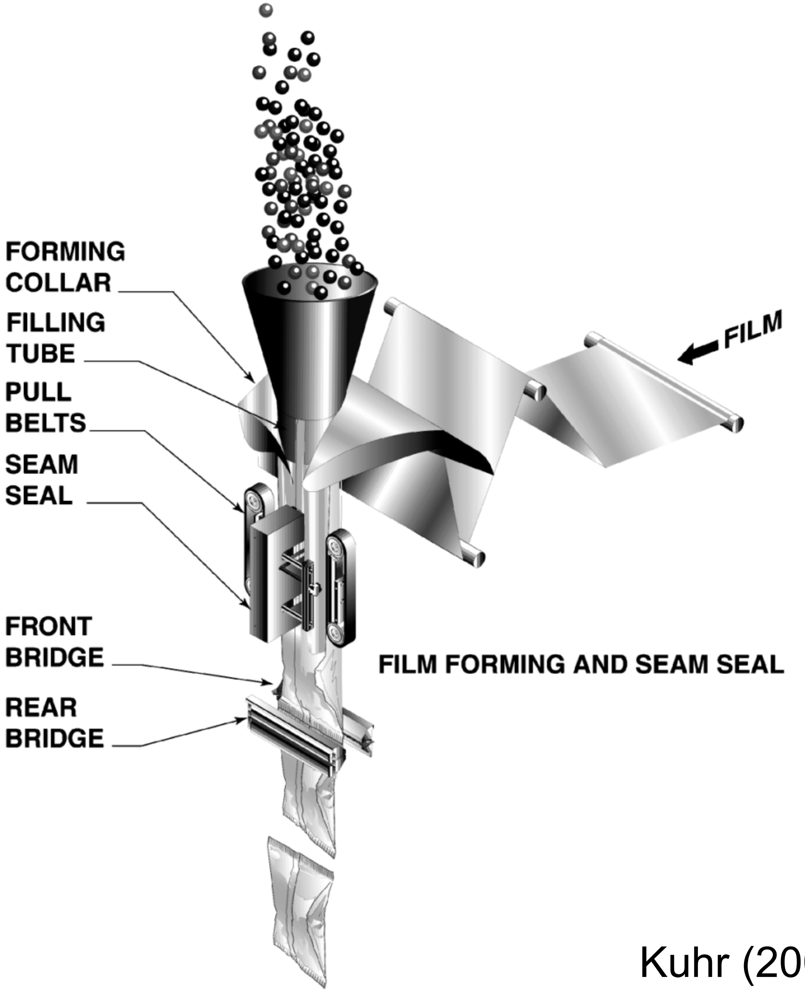
- Flexible bags
  - Premade bags
  - Pillow pouches
  - Flat-Bottom/Standup Styles
  - Special bag features:
    - Hangup styles: integrated punched hole for peg-board (hanger)display
    - Headers: extended seal areas at the top of the bag, provide additional flat, graphic message space in an area that does not contain product.
    - Label applicators: attach preprinted labelst
    - Leaflet inserters: can insert leafletsan d couponsint o the bag along with product
    - Recloseable pouch features
- Cartons

Filling and packaging

- Packaging operation affected by product characteristics e.g. dust, fines, stickiness, piece size, piece weight and product volume

Production rate:

- Bag machine
- Filler
- Product



Kuhr (2001)

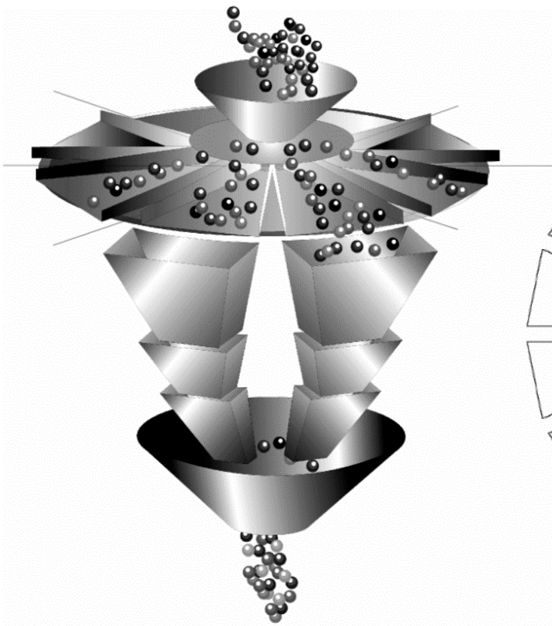
Filling and packaging

- Gross filling
  - Rarely used for snack foods due to inherent speed limitations and inaccuracy
  - Product is filled to a prescribed level
- Volumetric filling
  - adjustable volumetric cup
  - high production rates
  - Simple to operate, maintain
- Auger filling
  - screw contained inside a tube
  - Suitable for powdery or fine-grained products
  - Accuracy is dependent on bulk density of product
- Net weight filling
  - most accurate means of filling
  - Combination weigher: radial or linear

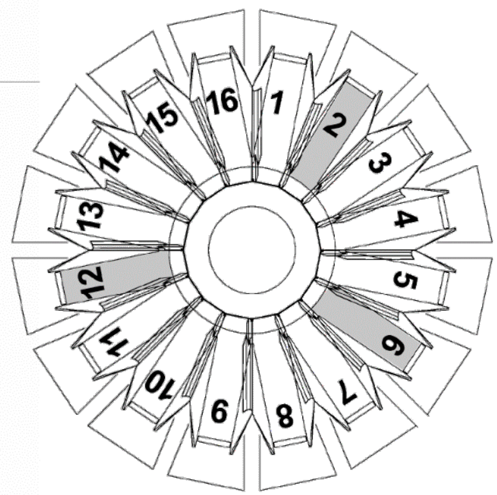
Auger filler

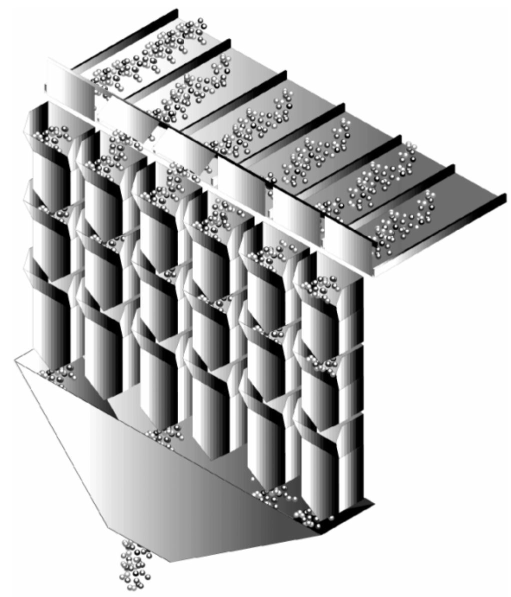
Filling and packaging

- The computer selects and combines filling from multiple scales to most accurately meet the desired package target weight
- Speed and accuracy are partly dependent on number of scale or weigh cells. More scales give the computer more potential combinations for achieving better accuracy and are able to recover more quickly between package cycles



RADIAL COMBINATION WEIGHER

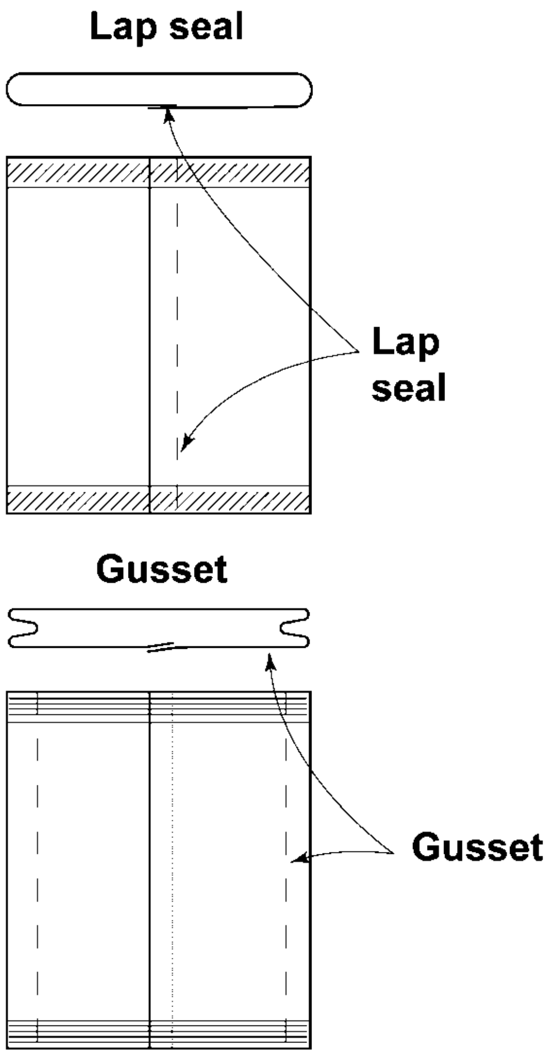




LINEAR COMBINATION WEIGHER

Kuhr (2001)

Flexible bag



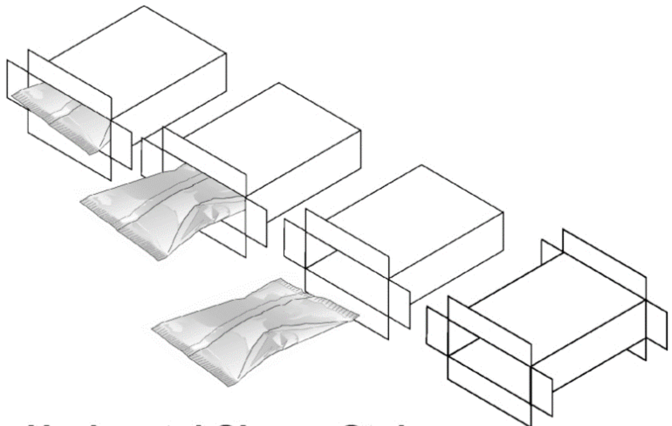
The configuration of the film seal is determined by

- ❑ Material type
- ❑ Product characteristics
- ❑ Machine type

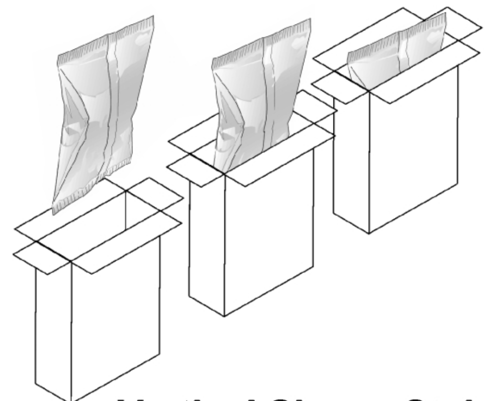
Kuhr (2001)

Cartons

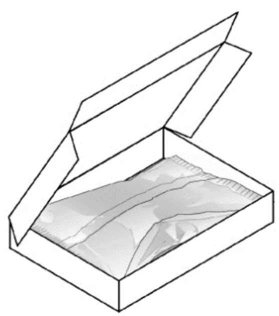
- Snack foods are seldom filled directly into cartons because of the need for an hermetic environment.



Horizontal Sleeve Style



Vertical Sleeve Style



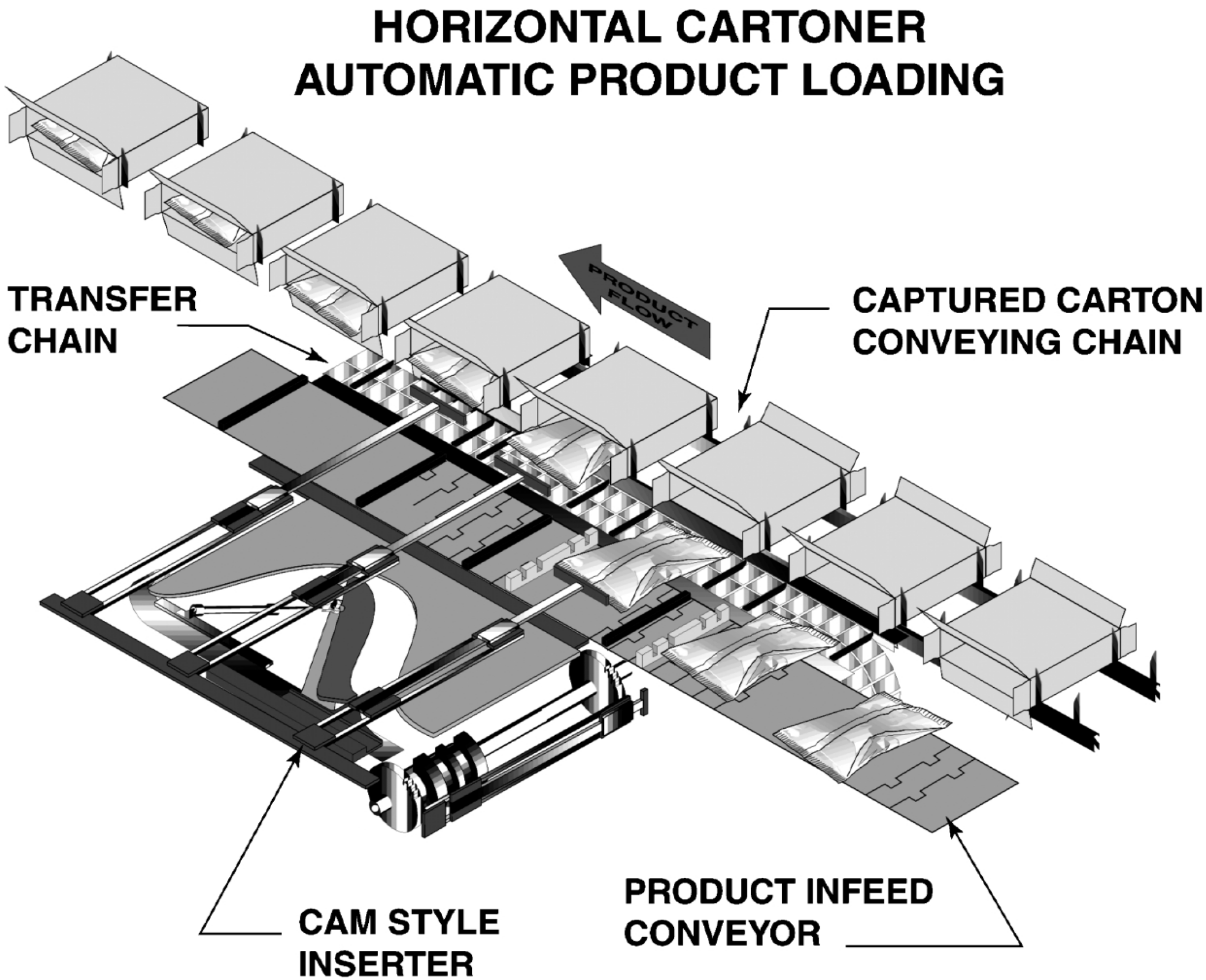
Top Load Carton Style

Bag-in-box

➢ Pouches often incorporate gussets, or tucks, on both sides to maintain a rectangular shape of the filled pouch to simplify inserting it into the carton

Kuhr (2001)

End loading bag-in-box



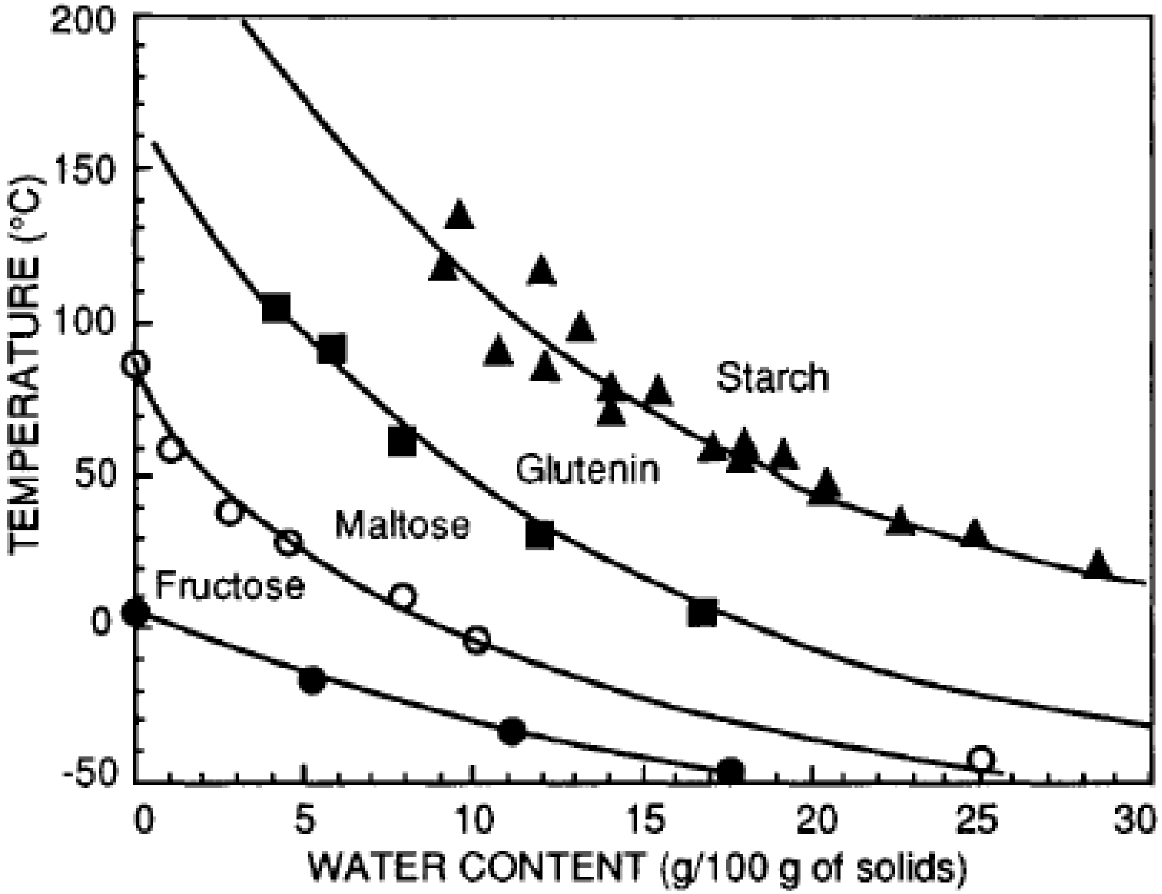
Kuhr (2001)

Snack and dried food deteriorations

- ❑ Dried foods: low a_w that prevent microbial growth
- Moisture gain resulting in loss of crispness, sticking powder
- Lipid oxidation: rancidity, off-flavor/odour, accelerate browning
- Loss of vitamin and color
- Breakage, cracking
- Loss of aroma from flavored products
- Non-enzymatic browning

- ❑ Packaging technologies to preserve quality
- N_2 flushing: to remove oxygen, and sealed with a pillow headspace to help cushion fragile products against breakage
- Oxygen and moisture scavengers

Glass transition temperature T_g



T_g of solids depends on **molecular weight and water**

Moisture related physic-chemical changes of foods

- Loss of crispness as a function of a_w and hence water content
- Glassy snacks transform into rubbery snacks once T_g decrease to well below room temperature due to water plasticization

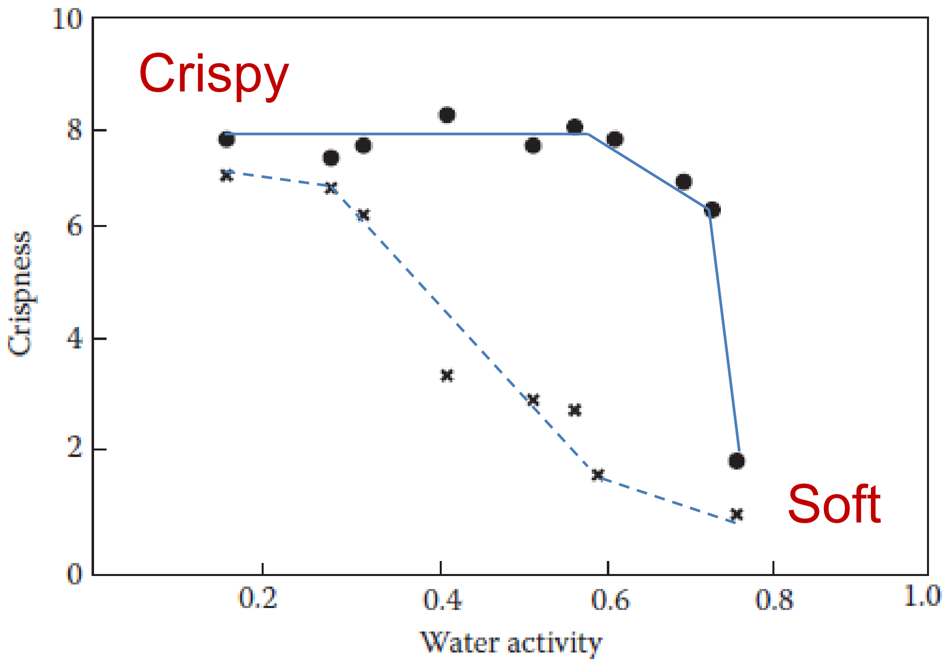
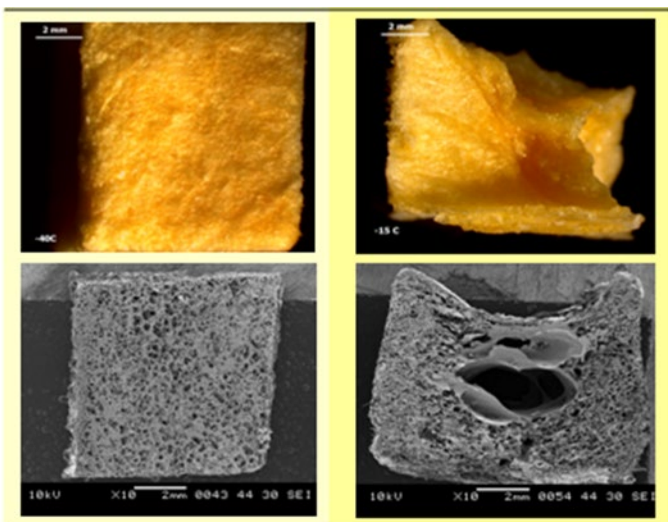


FIGURE 20.1 Sensory crispness of expanded starch-based extrudates versus a_w (● without sucrose; x with 20% sucrose). (From Valles-Pamies, B. et al., *J. Sci. Food Agric.*, 80, 1679, 2000.)

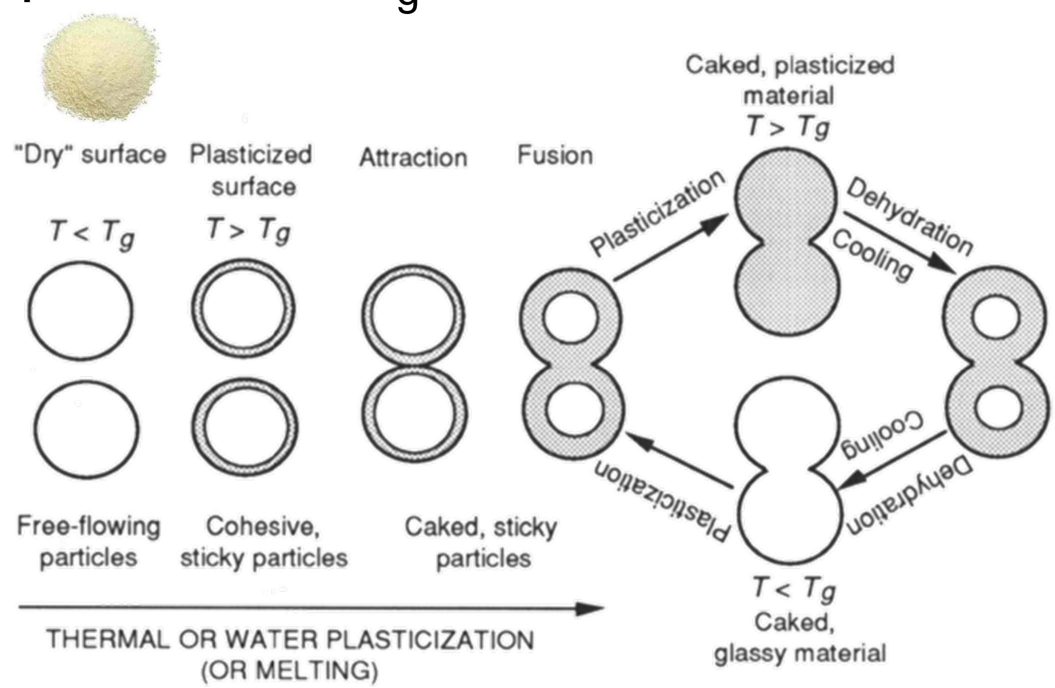
Robertson (2013)

Moisture related physic-chemical changes of foods

- The storage of foods in the rubbery states accelerates physic-chemical changes including: crystallization, sticking of powder, structural collapse
- The rate of reaction depends on $T-T_g$



Structural collapse and shrinkage of dried foods



Stickiness of milk powder

Packaging requirements

- Light barrier
  - brown-colored glassine paper, brown pigmented plastic layers in co-extruded films which blocked about 80% of ambient light.
  - Metallized films are superior light barrier, typically blocking >99% of light.
- Grease proofness due to high oil content
- Flavor and aroma barrier
- Moisture barrier
- Oxygen barrier
- Puncture resistance

(Package Outside)

Graphics Carrier
Printed Image
Adhesive Layer
Barrier Layer
Sealing Layer

(Package Inside)

Packaging of snack and dried foods

- Rigid packaging: carton, metal can, glass jar
- Flexible packaging
  - OPP/CPP
  - Matte-finished OPP and special coating techniques (applied to the outside surface of OPP film) are available
  - Metallized film: metCPP/OPP, metOPET/PE
  - PVDC coated OPP; ON e.g. K-OPP/PE, K-ON/PE, K-ON/CPP
  - Cellulosic materials (cellophane and glassine paper)
  - Aluminium laminates: high valued products e.g. milk powder

➢ Home-use popcorn: barrier to eliminate the possible loss of moisture, which is critical to successful popping.

DRIED FRUITS
ORIGINAL FLAVOR
NO SUGAR ADDED
VARIETIES OF VITAMINS INCLUDED
UP TO 18 MONTHS SHELF LIFE

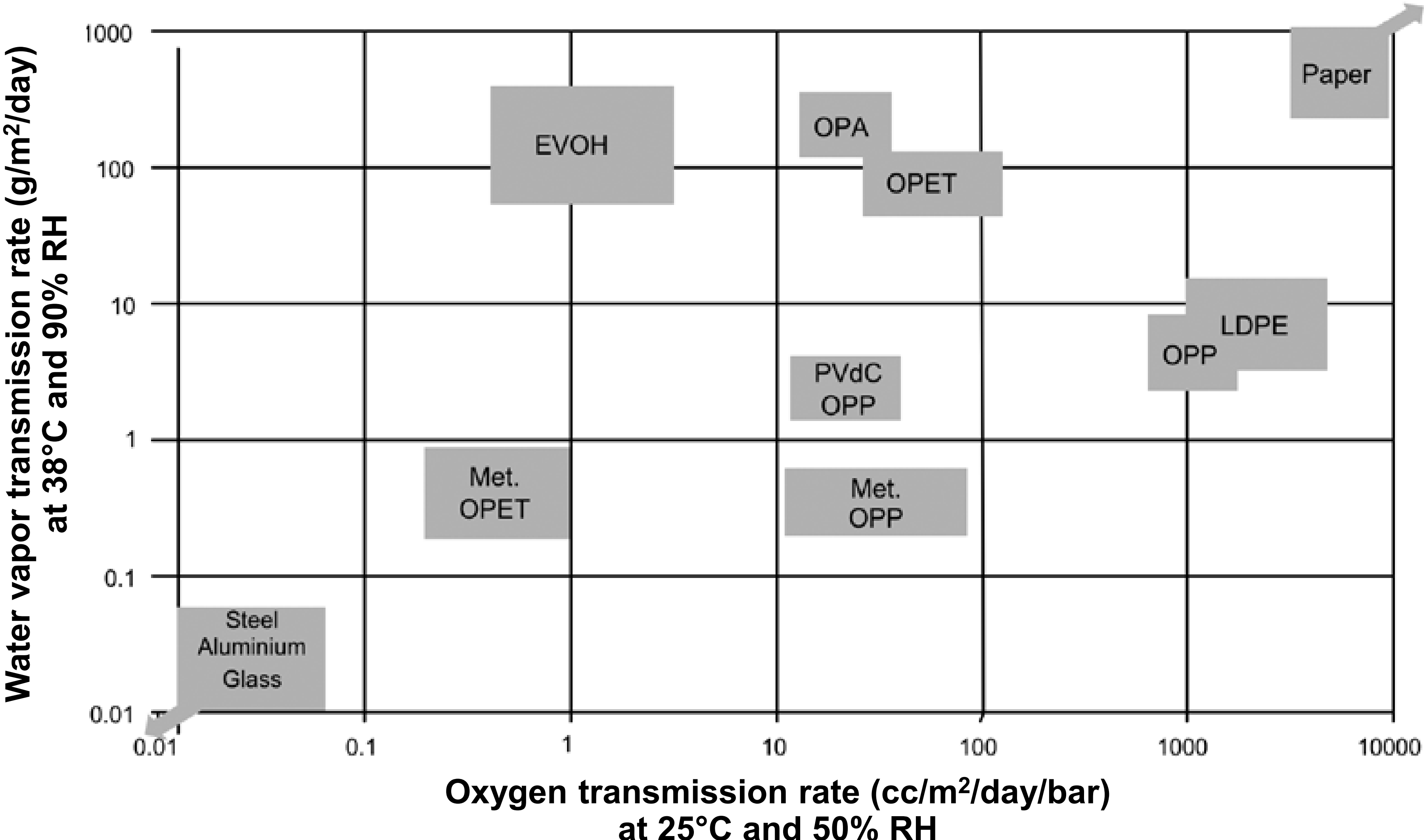
PASTA MACARONI
CUSTOMIZATION
BOBST
PASTA FARFALLE
CUSTOMIZATION
BOBST
PASTA PENNE
CUSTOMIZATION
BOBST

TIPA

noor Best
Corn
Mixed berries
Strawberry
Apricot
Apple
Banana

PREMIUM DESIGN
HIGH QUALITY
COFFEE BAG
MOCK-UP
PREMIUM QUALITY COFFEE BAG DESIGN

Permeabilities to water vapour and oxygen



Dixon (2011)

Table 2. *Comparison of properties of web materials*

Material		Tensile strength[1]	Light barrier	Heat sealing	Heat resistance	Dead-fold	Relative cost[2]
40–70 g/m²	Paper	+++	+	0	++++	++	++
6.3–12 µm	Aluminium foil	+	++++	0	++++	++++	+++
15–30 µm	OPP film	+++	0	0[5]	++	+	+
15-20 µm	Met. OPP film	+++	+++	0[5]	++	+	++
12–19 µm	OPET film	+++	0	0[5]	+++	+	++
12 µm	Met. OPET film	+++	+++	0[5]	+++	+	++++
12–20 µm	OPA film	++++	0	0[5]	+++	+	++++
30–70 µm	Blown LDPE film[3]	+	0	++++	+	+	+++
40–70 µm	Cast PP film	++	0	++++	+	+	++++
3–10 µm	EVOH layer[4]		0	0	+	+	+++

1 Strength is compared at the actual thicknesses indicated.
2 Relative cost is compared for thinnest grade mentioned.
3 In this case, "LDPE" includes not only low density polyethylene but also linear low density polyethylenes and copolymers with vinyl acetate etc.
4 Would not be used on its own; must be supported by other layers made of different resins. The relative cost reflects this.
5 Based on monolayer films; coextruded or coated films could be heat-sealable.

Dixon (2011)

Barrier properties of films

Coating on single-component film:

Oxygen barrier and moisture barrier performance is greatly enhanced by coating with PVDC latex.

Type of film	Thickness (μm)	Oxygen permeability *2) ($mL/m^2/0.1\ MPa/day$)	Water vapor permeability *3) ($g/m^2/day$)
K-OPP *1)	23	4	4
OPP	20	1300	7-8
Nylon	15	80	300
PET	12	80	45
LDPE	40	2000	9-12
HDPE	40	1500	3-6
CPP	40	2000	6-12

*1) 20 μ OPP film with 3 μ coating of Asahi Kasei PVDC latex L803C

*2) Results with JIS K7126B at 20°C, ≈70%RH

*3) Results with JIS K7129 at 40°C, 90%RH

https://acpvdc.com/en/latex_property.html

Film sample	Oxygen permeability *1) (ml/m2/0.1 MPa/day)	Water vapor permeability *2) (g/m2/day)
K-OPP/PE	10.0	3.1
OPP/CPP	>100	5.7
Ny/PE	>100	9.4

Ham

Film sample	Days
K-OPP/PE	20
OPP/CPP	14
Ny/PE	9

Peanuts

Film sample	Days
K-OPP/PE	8
OPP/CPP	4
Ny/PE	3

Yuepin (Chinese confection - Yuebing)

Film sample	Days
K-OPP/PE	35
OPP/CPP	22
Ny/PE	15

Soft cake

Film sample	Days
K-OPP/PE	22
OPP/CPP	10
Ny/PE	10

Results with JIS K7129 at 40°C, 90%RH

Film samples

K-OPP/PE: 20 µm PVDC-coated OPP/15 µm PE/25 µm LLDPE

OPP/CPP: 20 µm OPP/dry lamination adhesive/20 µm CPP

Ny/PE: 15 µm nylon/dry lamination adhesive/50 µm LLDPE

https://acpvdc.com/en/latex_property.html

Conclusions

- Packaging design for dried foods
  - Graphic and structural design
  - Characteristics of dried products
  - Quality deteriorations
  - Target shelf-life
  - Material selection : Multilayer/ monolayer

THANK YOU

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