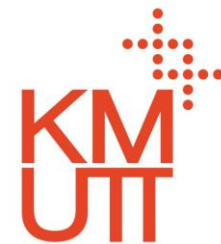


From Fundamental Research to Commercial Applications: How Basic Food Engineering Studies Become Commercial Realities

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King Mongkut's University of Technology Thonburi



65 Years of Wisdom
Crafting Sustainable Futures

game-changing

adjective

having a big effect on a situation so that the way it develops changes completely.

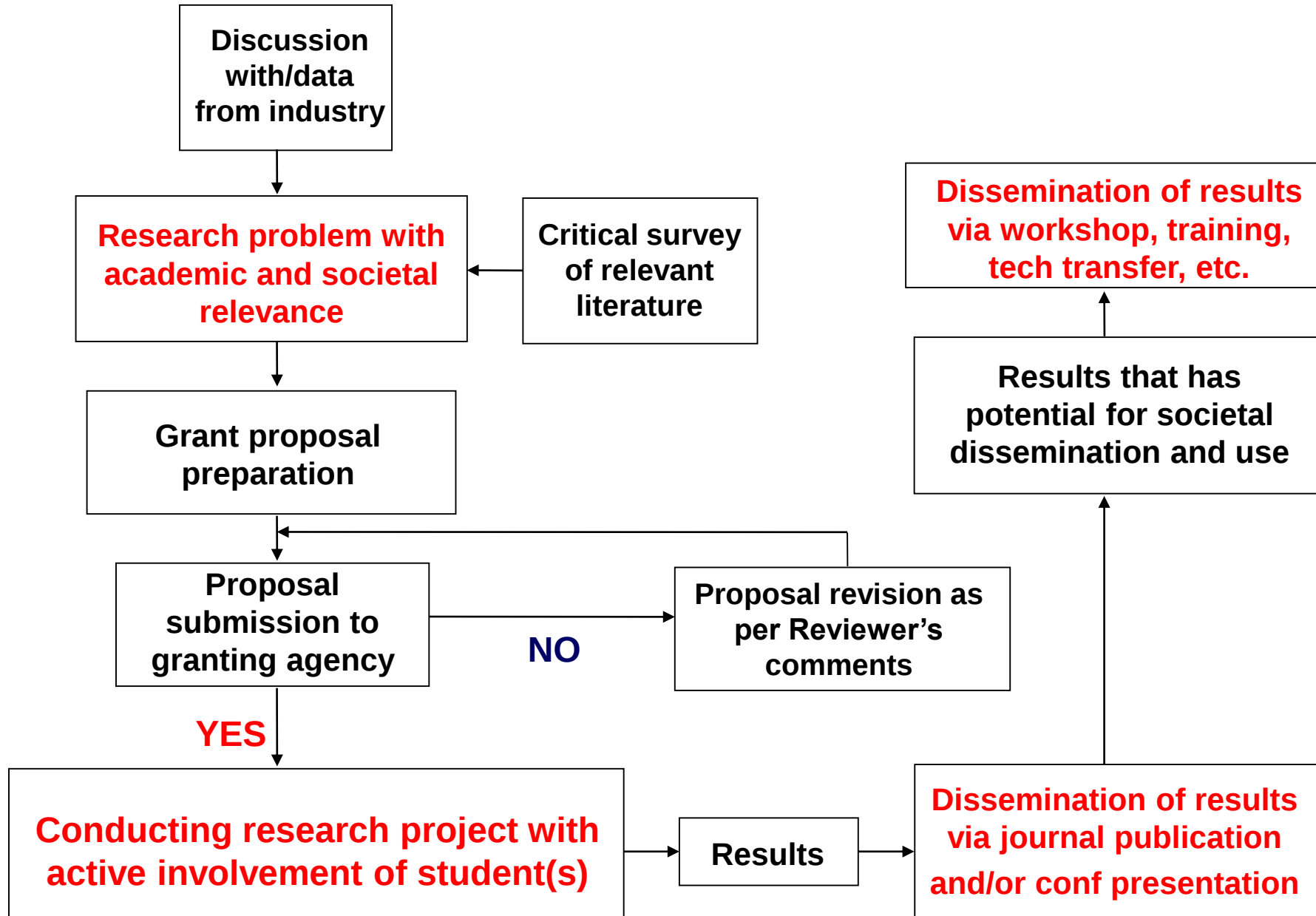
innovation

noun

a new idea or method, or the use of new ideas and methods; a new idea, design, product, etc.

Source: Cambridge Dictionary

How to achieve game-changing goal? Typical flowchart for research problem identification and project execution



The different objectives...

- Academic researchers are looking for results that are publishable
- Industry is looking for results that can be commercialized
- One is looking for fundamental results, while another is looking for applied (??) results
- How can the two parties be happy at the same time??

The different objectives...

- Problem that is either too fundamental or too applied would not lead to satisfied outputs
- Careful discussion from the start is needed
- Discussion should be done in terms of:
 - Objectives/Scope – fundamental and adequately usable (within interested time scale) results?? THIS NEEDS UNDERSTANDING FROM BOTH PARTIES
 - Project duration – be realistic!

The different objectives...

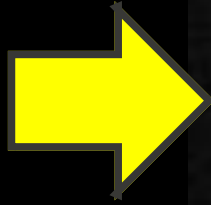
- Discussion should be done in terms of:
 - Project co-funding
 - Intellectual property (IP) rights and sharing – Funding agency can play a role here
 - Dissemination of results
- Academia should understand the need (and limitations) of industry and vice versa to create win-win situation and long-term collaboration

Conducting the project...

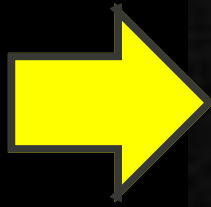
- Keep both parties' interests in mind – do not lose the objectives
- Prepare for unexpected situations
- Constant discussion and data sharing with industrial partner is suggested

Case Study 1: A New Approach to Solid Foods Drying

Typical drying of banana...

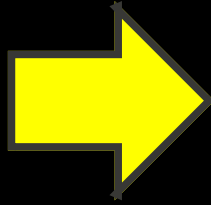


Typical drying of banana...

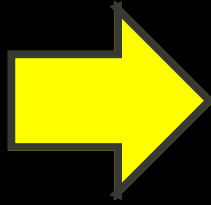


What if you don't like this??

What to do to get this dried banana?



What to do to get this dried banana?



Maybe we have to change the way we think...

What if we don't want to use hot air for drying??

- Vacuum drying? *May end up with pore collapse and poor texture?*
- Freeze drying? *Too slow and expensive? Oxygen may still be trapped in pores...*
- Microwave drying? *Non-uniform drying, not so easy to control?*
- Any other alternatives? *Superheated steam drying ☺*

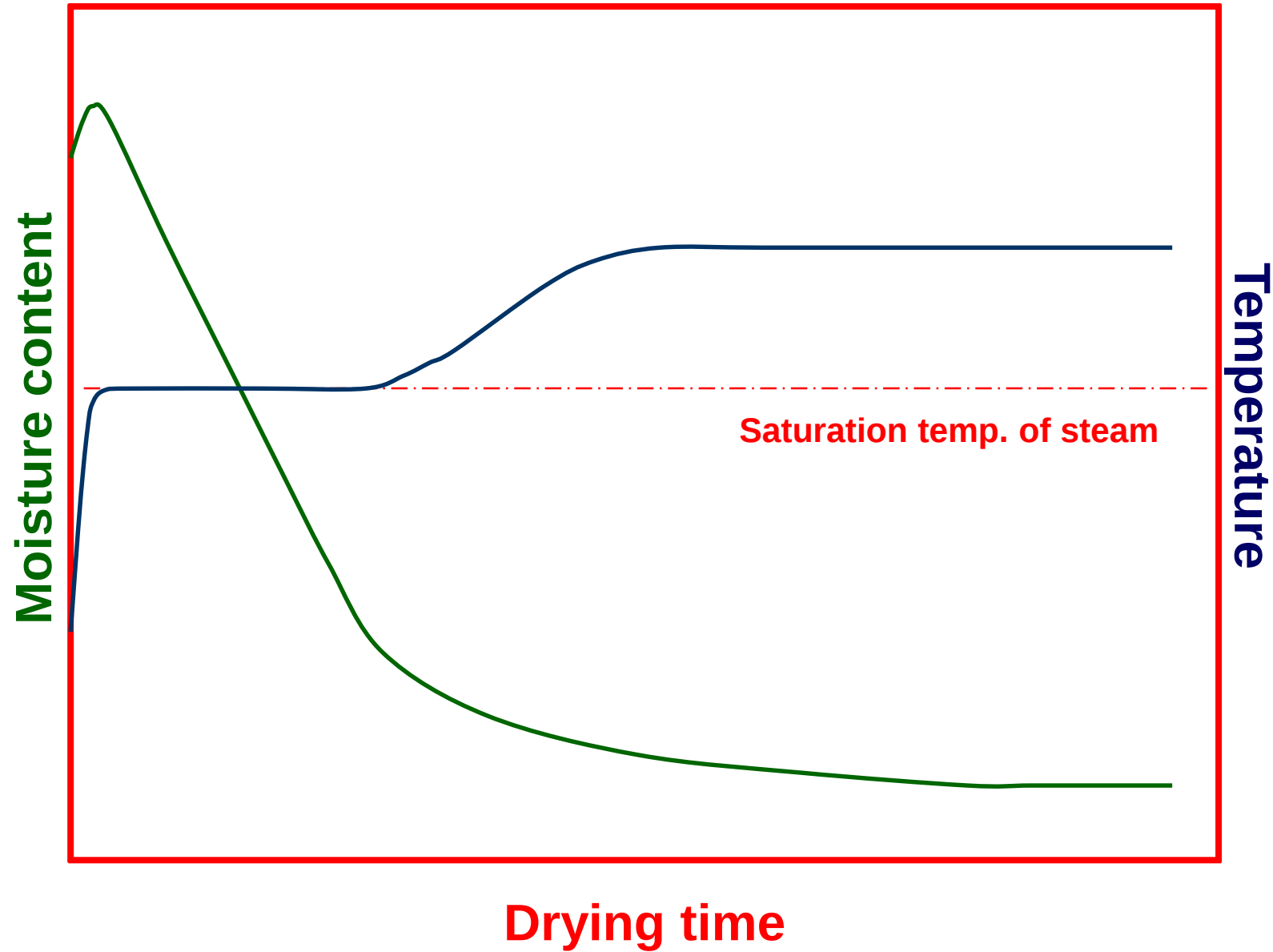
Superheated Steam Drying (SSD)

- Proposed over 100 years ago; received attention only during the past 30-40 years
- Uses steam in place of hot air or combustion/flue gases in a direct dryer
- More complex than hot-air drying system
- Better product quality (in most cases)

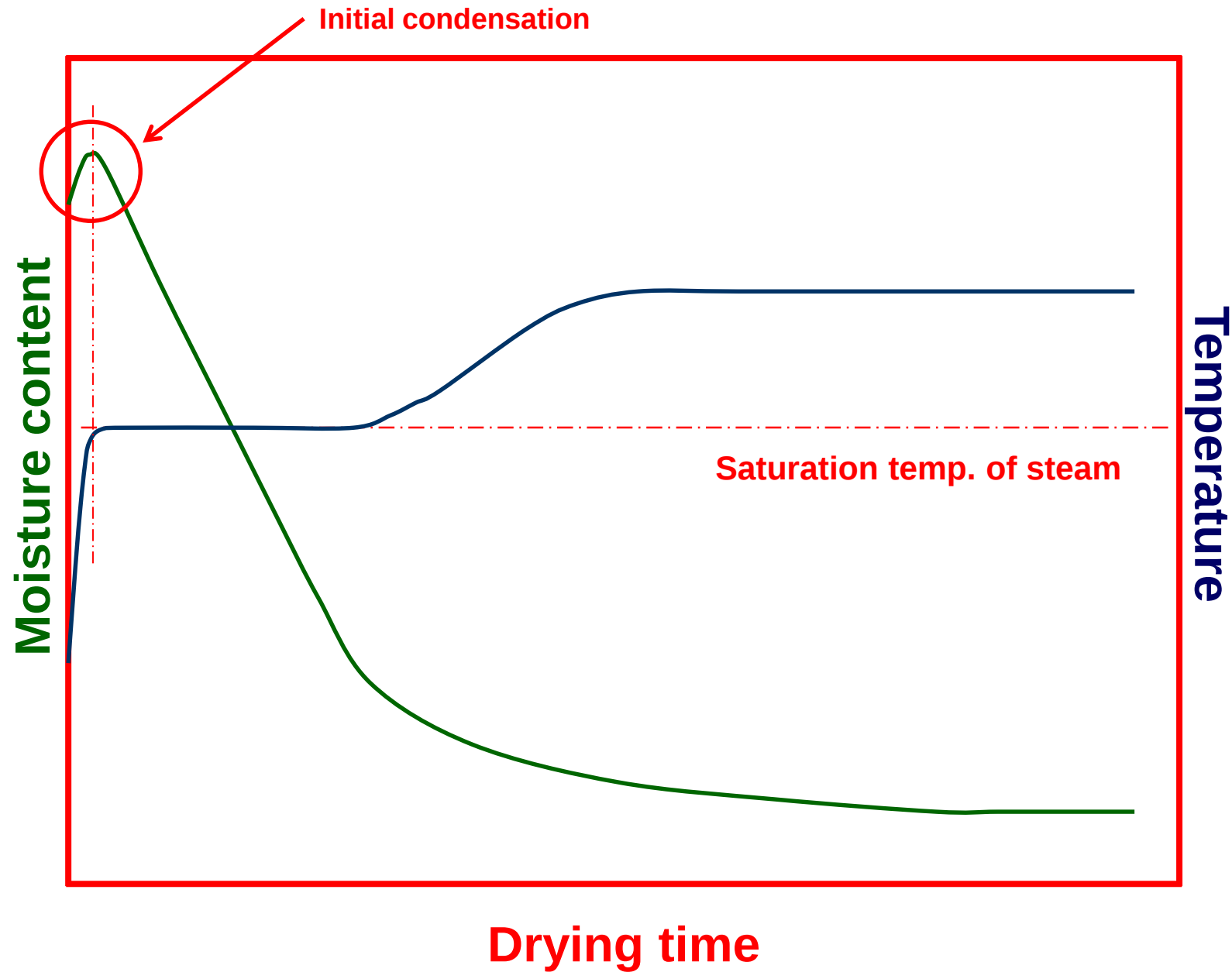
Superheated Steam Drying (SSD)

Important phenomena during SSD

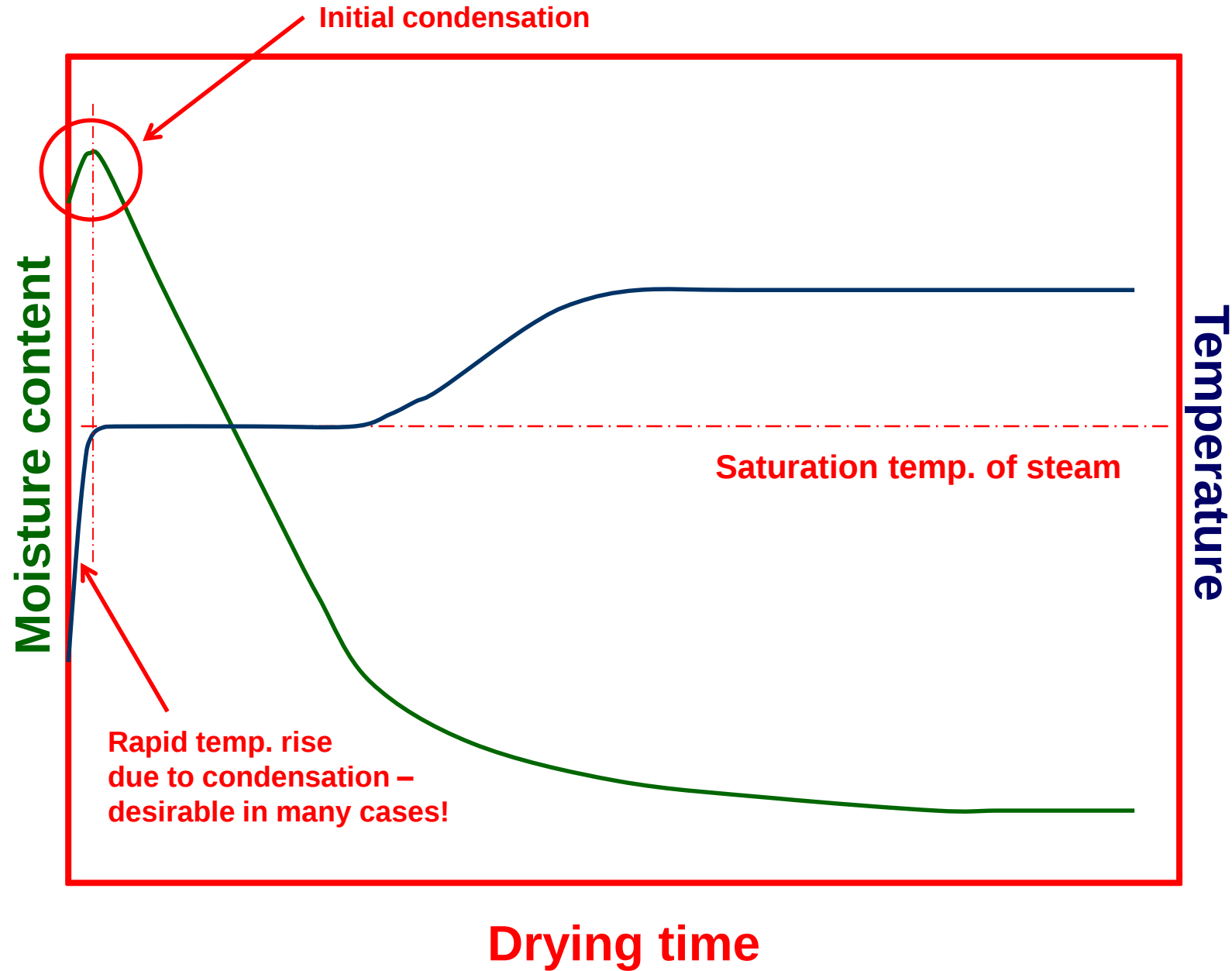
- Initial steam condensation, leading to:
 - Slight increase in MC
 - Rapid increase in surface temp.
- Absence of oxygen, resulting in:
 - No oxidation reactions, e.g., enzymatic browning, lipid oxidation, vitamin degradation



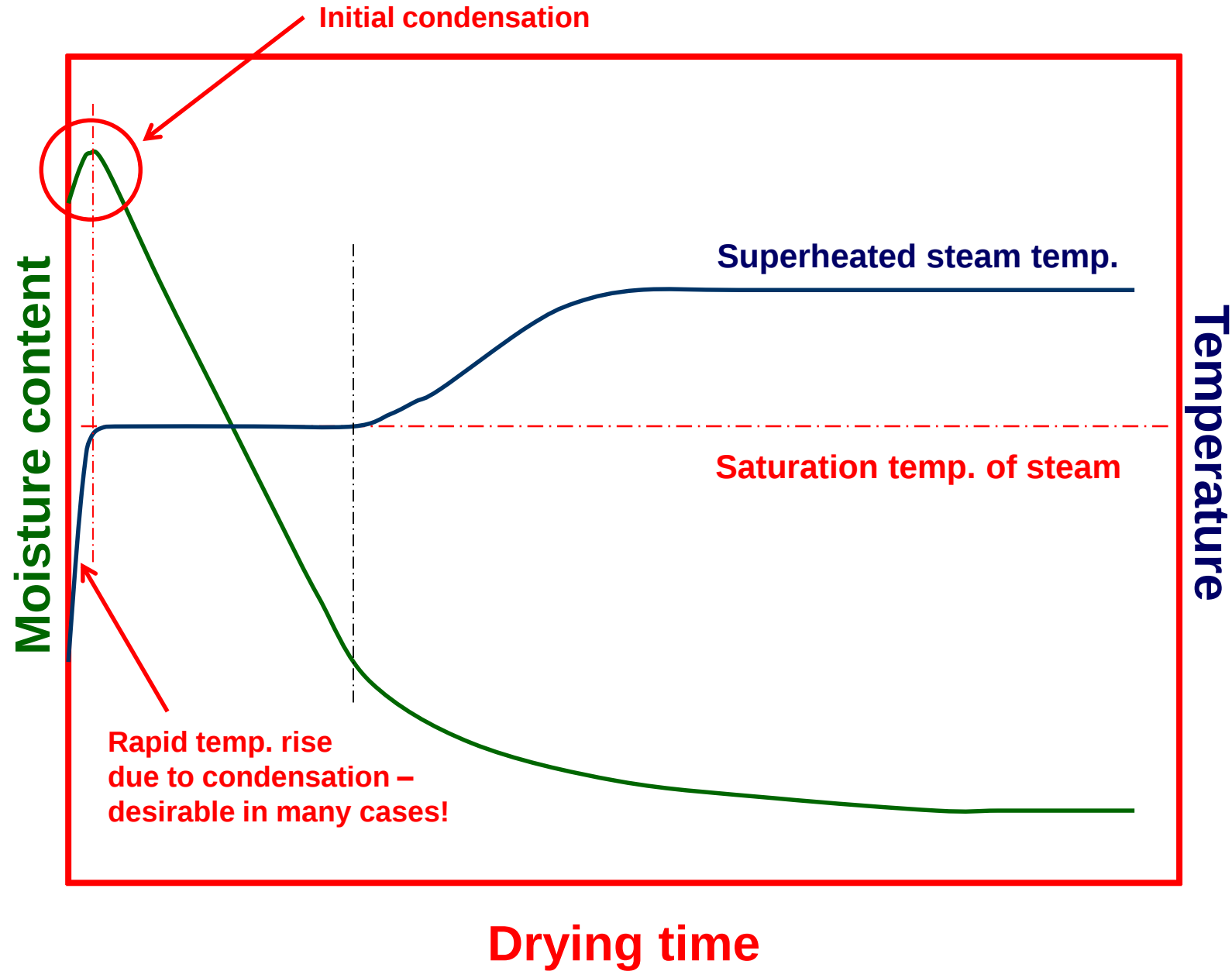
Typical evolutions of material MC and temp. during SSD



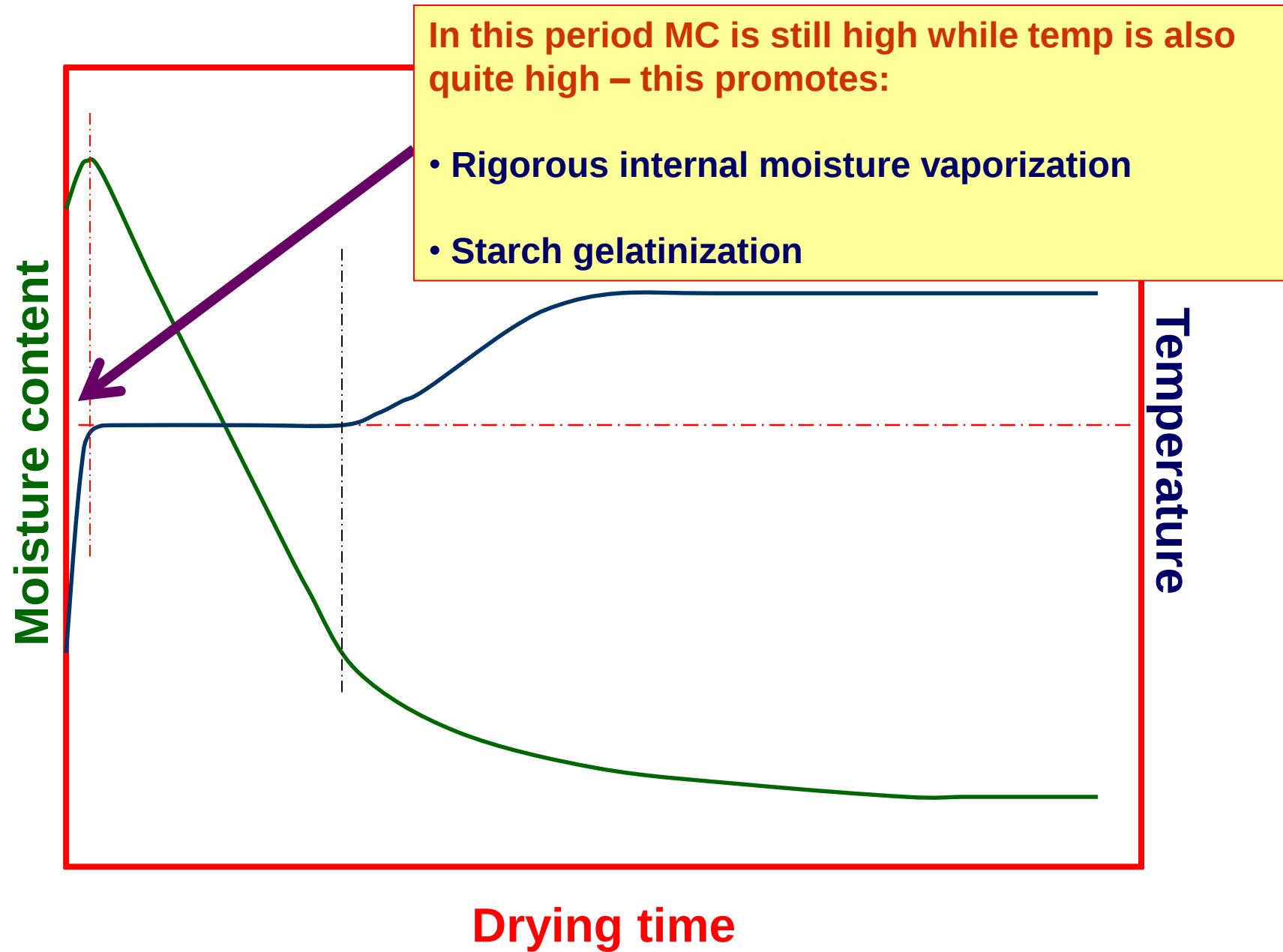
Typical evolutions of material MC and temp. during SSD



Typical evolutions of material MC and temp. during SSD



Typical evolutions of material MC and temp. during SSD



Typical evolutions of material MC and temp. during SSD

Some advantages of SSD

- SSD yields higher product porosity due to evolution of steam within the product - bulk density is thus lower while rehydration behavior is better
- Casehardened skin is unlikely to form in SSD
- No oxidative reactions possible due to lack of O₂; color and some nutrients are better preserved

Major limitation...

- Products that may be damaged at saturation temperature of steam cannot be dried in SSD

*Need exists for a low-pressure
superheated steam drying system for
heat-sensitive products*

Low-Pressure SSD (LPSSD)

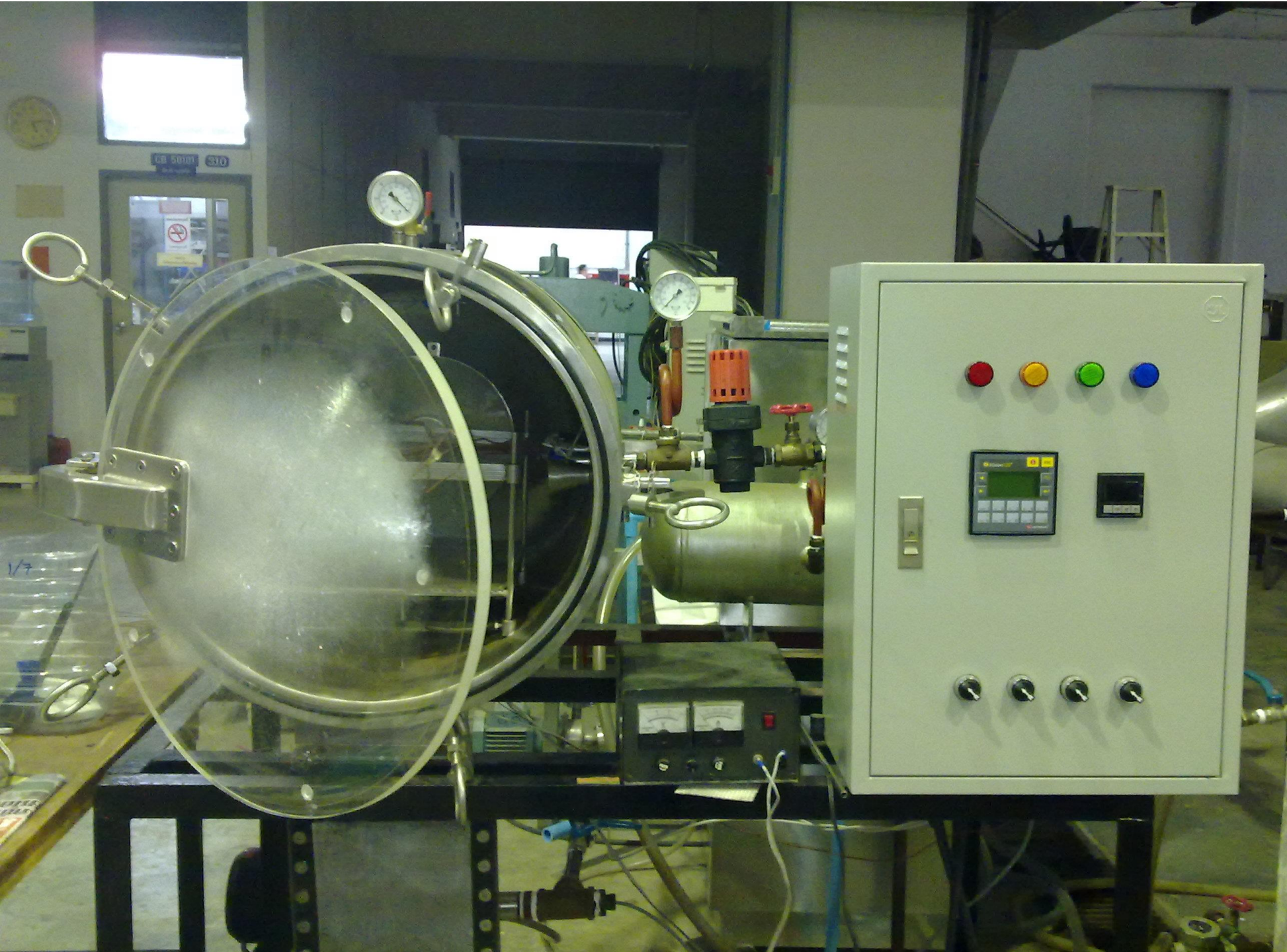
- Combines ability to dry product at low temperature with advantages of SSD
- Dryer is operated at reduced pressure
- Steam becomes saturated (and superheated) at lower temperature
- Suitable for heat-sensitive products, e.g., herbs, fruits and vegetables and other biomaterials

Low-Pressure SSD (LPSSD)

- Our research team has been working on Low-Pressure Superheated Steam Drying (LPSSD) since 2002
- Only one publication existed when we started
- No detailed system design, no quality analysis results
- Reported conceptual design was even incorrect!
- No available research experience; no expert in the area to consult

Low-Pressure SSD (LPSSD)

- After much effort (3+ years), LPSSD prototype was fabricated
- LPSSD is capable of producing dried fruits and vegetables of superior quality (compared to hot air drying and even freeze drying)
- Only a (very) small scale set-up was initially available





Hot air drying

LPSSD

- Better color is due to absence of oxygen in LPSSD system – no enzymatic browning
- Drying time in the case of LPSSD is shorter – less non-enzymatic browning as well

Selected outputs on LPSSD

- 25+ published articles in top-tier international journals
- 3 book chapters
- Top global contributing author on superheated steam drying (and top 10 on drying in general) as per Scopus on Feb. 11, 2026
- Consultant to international companies developing SSD processes e.g. Mars GmbH



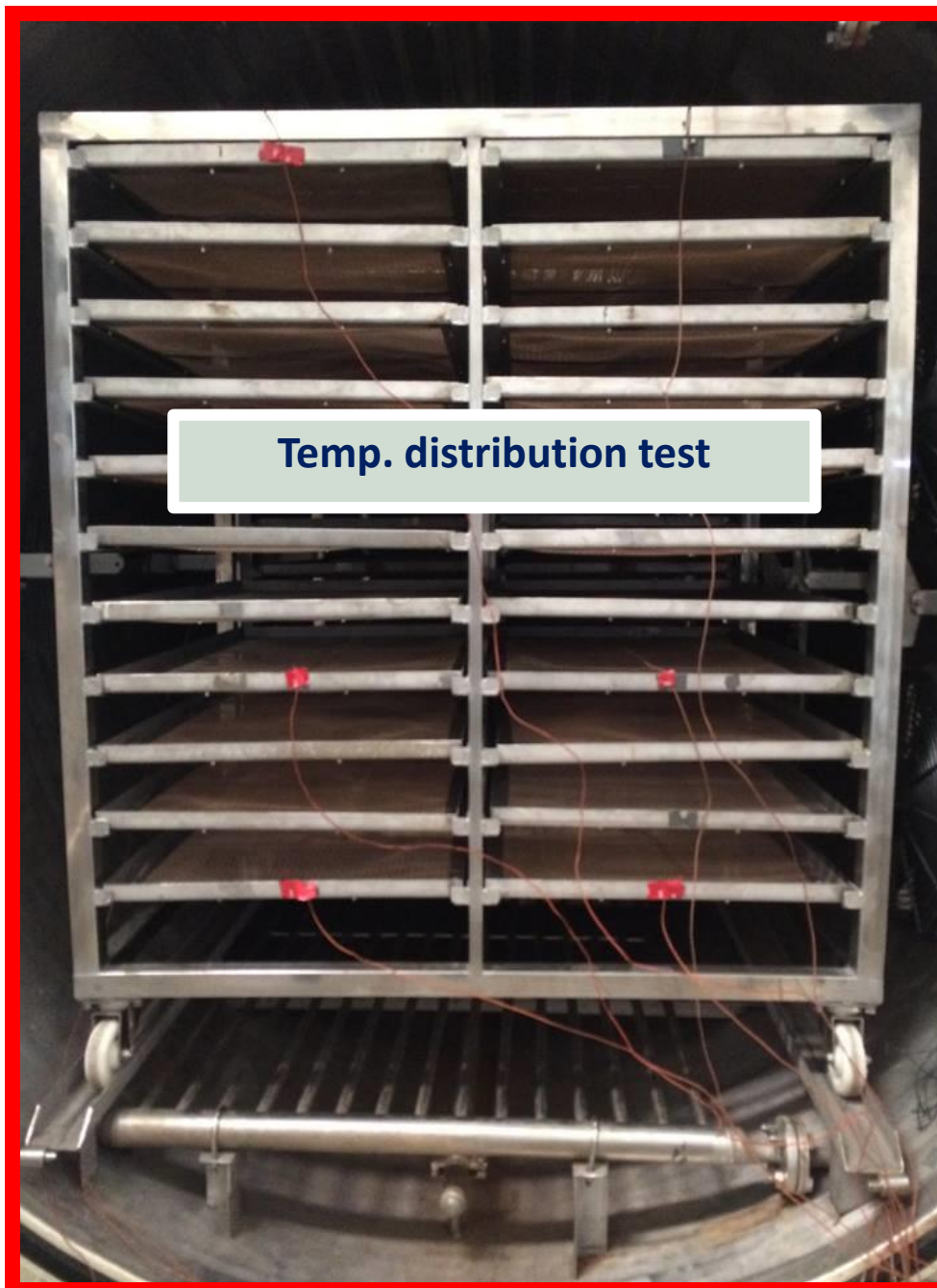
Young Technologist Award (2004)

Scaling up of LPSSD

- Natural Produces Co., Ltd. expressed interest in commercializing LPSSD for production of dried fruits and vegetables
- Such commercialization involved design, fabrication and testing of industrial-scale dryer
- Challenging task as no field experience on this technology was available!







Temp. distribution test













100% Real Young Coconut, Nothing Added!

Crisped to Perfection, Never Fried

No Sugar Added

Non-GMO

Gluten Free

Fiber-Rich (Natural Source)

Vegan Friendly

Durian

Steam-Crisped Chips

100% Real Thai Durian

No Sugar · No Oil · No Preservatives

Guilt-Free · Naturally Sweet · Rich in Fiber

Nutrition Facts

1 serving per container

Serving size 45 g

Calories	Per serving	165	Per container	165
Total Fat	5g	10%	1g	2%
Saturated Fat	0g	0%	0.5g	1%
Trans Fat	0g	0%	0g	0%
Cholesterol	0g	0%	0mg	0%
Sodium	0g	0%	15mg	3%
Total Carb.	35g	8%	70g	28%
Dietary Fiber	2g	7%	5g	21%
Total Sugars	15g	3%	30g	12%
Incl. Added Sugars	0g	0%	0g	0%
Protein	1g	2%	2g	8%
Vitamin D	0mcg	0%	1mcg	0%
Calcium	0mg	0%	30mg	2%
Iron	0.3mg	0%	0.6mg	4%
Potassium	350mg	8%	700mg	25%

100% Real Thai Durian

No Sugar · No Oil · No Preservatives

Guilt-Free · Naturally Sweet · Rich in Fiber

PureD

100% Real Thai Durian, Nothing Added!

Crisped to Perfection, Never Fried

No Sugar Added

Non-GMO

Gluten Free

Fiber-Rich (Natural Source)

Vegan Friendly

Real Durian Taste

Nutrition Facts

1 serving per container

Serving size 45 g

Calories	Per serving	165	Per container	165
Total Fat	5g	10%	1g	2%
Saturated Fat	0g	0%	0.5g	1%
Trans Fat	0g	0%	0g	0%
Cholesterol	0g	0%	0mg	0%
Sodium	0g	0%	15mg	3%
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Protein	1g	2%	2g	8%
Vitamin D	0mcg	0%	1mcg	0%
Calcium	0mg	0%	30mg	2%
Iron	0.3mg	0%	0.6mg	4%
Potassium	350mg	8%	700mg	25%

Coconut

Steam-Crisped Chips

100% Real Thai Young Coconut

No Sugar · No Oil · No Preservatives

Guilt-Free · Fiber-Rich · Naturally Aromatic

PureD

100% Real Banana, Nothing Added!

Crisped to Perfection, Never Fried

No Sugar Added

Non-GMO

Gluten Free

Prebiotic-Rich (FOS & Inulin)

Vegan Friendly

Superior Taste Award

Nutrition Facts

1 serving per container

Serving size 45 g

Calories	Per serving	165	Per container	165
Total Fat	5g	10%	1g	2%
Saturated Fat	0g	0%	0.5g	1%
Trans Fat	0g	0%	0g	0%
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Calcium	0mg	0%	30mg	2%
Iron	0.3mg	0%	0.6mg	4%
Potassium	350mg	8%	700mg	25%

Banana

Steam-Crisped Chips

100% Real Banana

No Sugar · No Oil · No Preservatives

Guilt-Free · Prebiotic-Rich · Award-Winning Taste

PureD

100% Real Banana, Nothing Added! Crisped to Perfection, Never Fried



No Sugar
Added



Non-
GMO



Gluten
Free



Prebiotic-Rich
(FOS & Inulin)



Vegan
Friendly



Superior
Taste Award



From lab to industry...

- It took almost 20 years from idea initiation to industrial realization
- Realized through concerted effort – perseverance, adaptation and application of research and field experience & strong belief and dedication of the whole team





**Outstanding Technologist Award
(2025)**

Case Study 2: Production of Low-Sodium and Potassium Fish Sauce

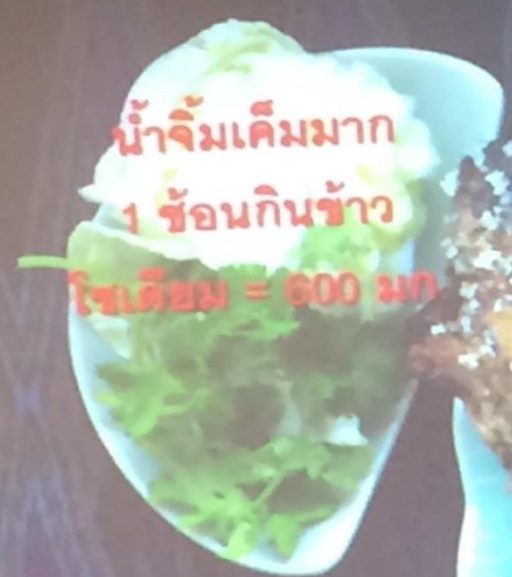
Fish sauce...

- Is an ingredient widely used in Asia
- Has specific flavor that gives pleasure to the senses of taste
- Contains high salt content (up to 25%)

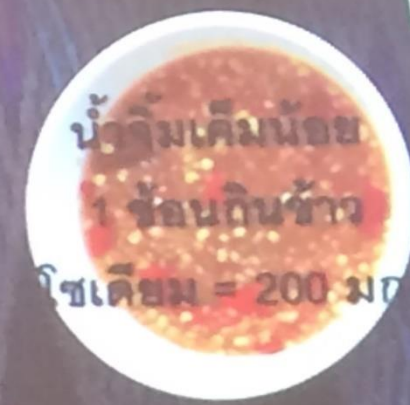
Sodium intake info

- RDI of sodium is not more than 2000 mg/day (~ 5 g salt/day)
- Most people consume too much salt, on average 9–12 g per day

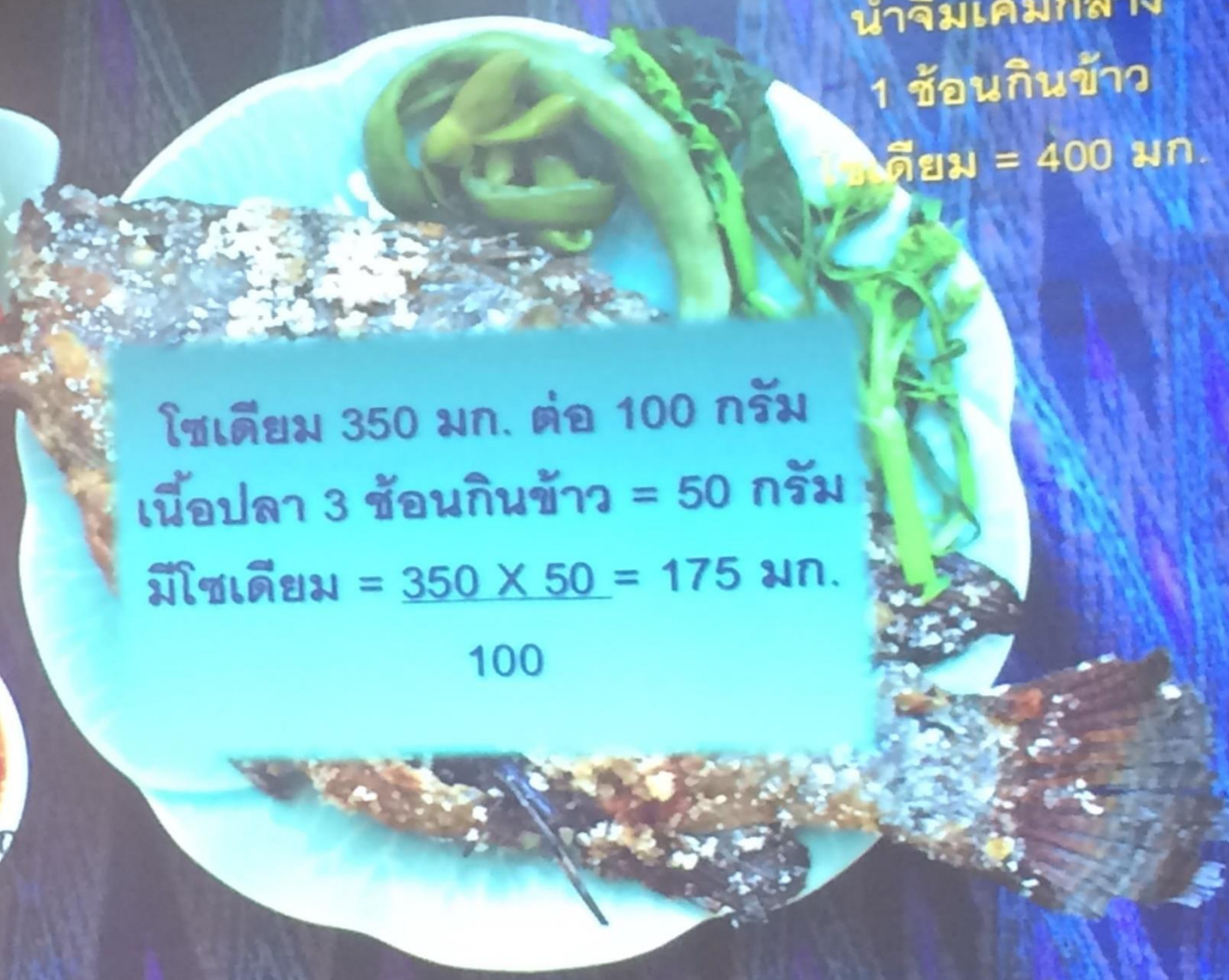
Source: WHO (2016)



น้ำจิ้มเค็มมาก
1 ช้อนกินข้าว
โซเดียม = 600 มก.



น้ำจิ้มเค็มน้อย
1 ช้อนกินข้าว
โซเดียม = 200 มก.



น้ำจิ้มเค็มกลาง
1 ช้อนกินข้าว
โซเดียม = 400 มก.

โซเดียม 350 มก. ต่อ 100 กรัม
เนื้อปลา 3 ช้อนกินข้าว = 50 กรัม
มีโซเดียม = $\frac{350 \times 50}{100} = 175$ มก.

How to alleviate the problem?

- Substituting sodium with potassium in fish sauces
- Potassium-based fish sauce is still unsuitable for patients with kidney problem



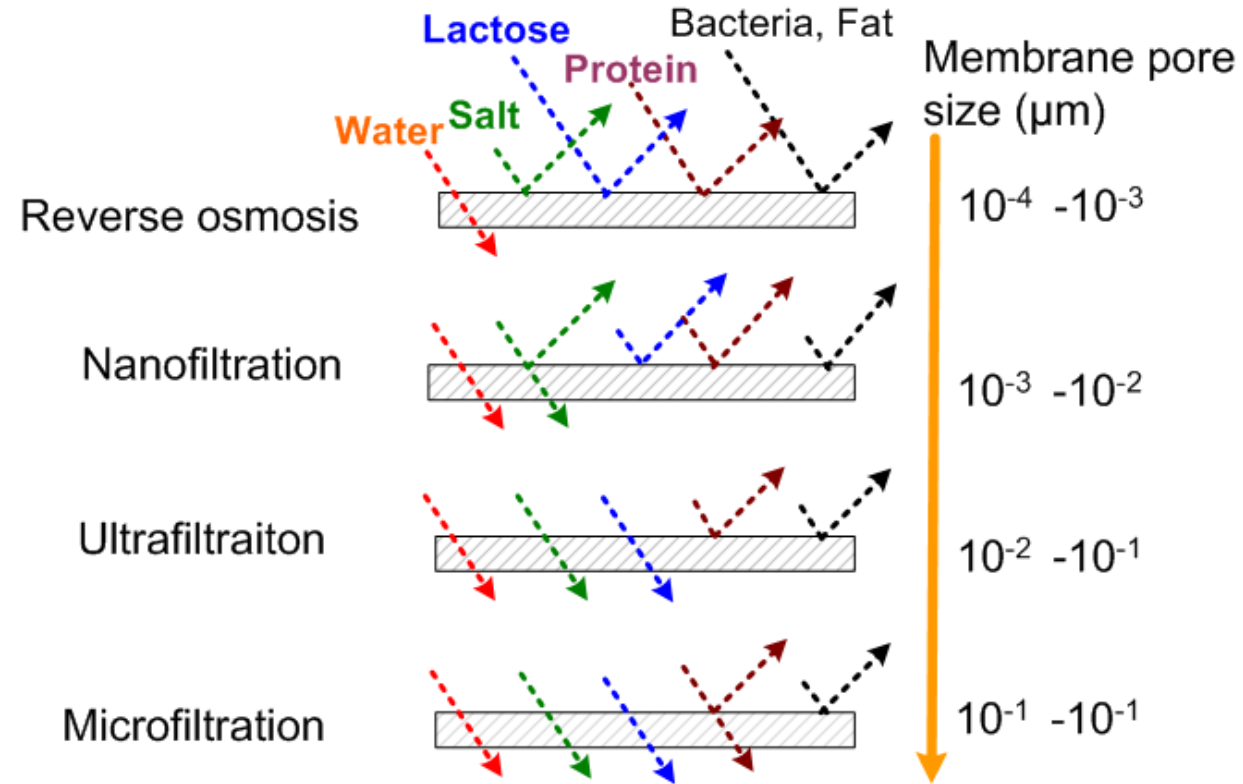
ผลิตภัณฑ์ลดโซเดียม

(ไม่เหมาะสำหรับผู้ป่วยโรคไตและโรคหัวใจ)

Membrane separations

- Membrane separation??
 - Microfiltration
 - Ultrafiltration
 - Nanofiltration
 - Reverse osmosis

Membrane separations

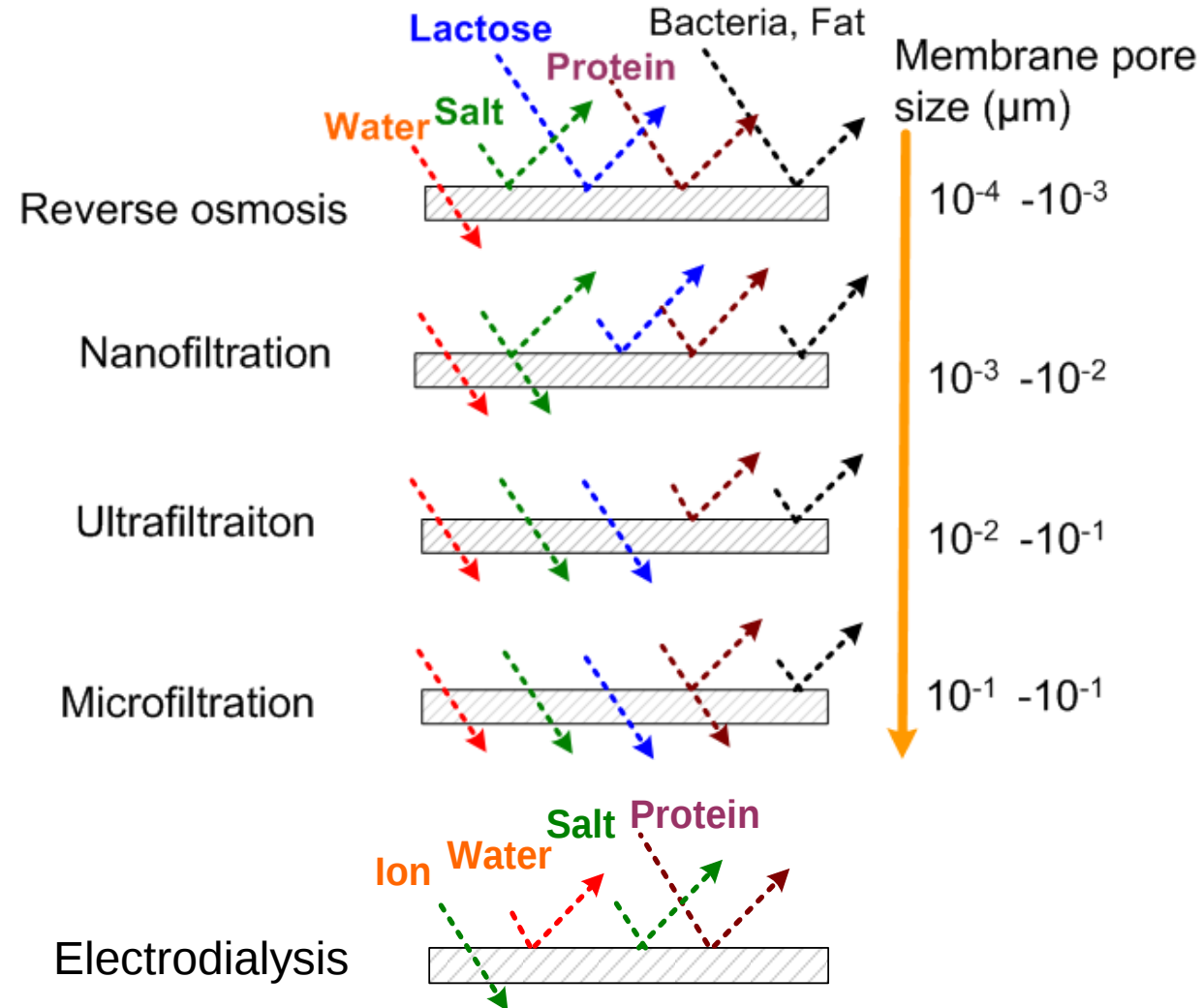


Source: Baker (2004)

Electrodialysis (ED)

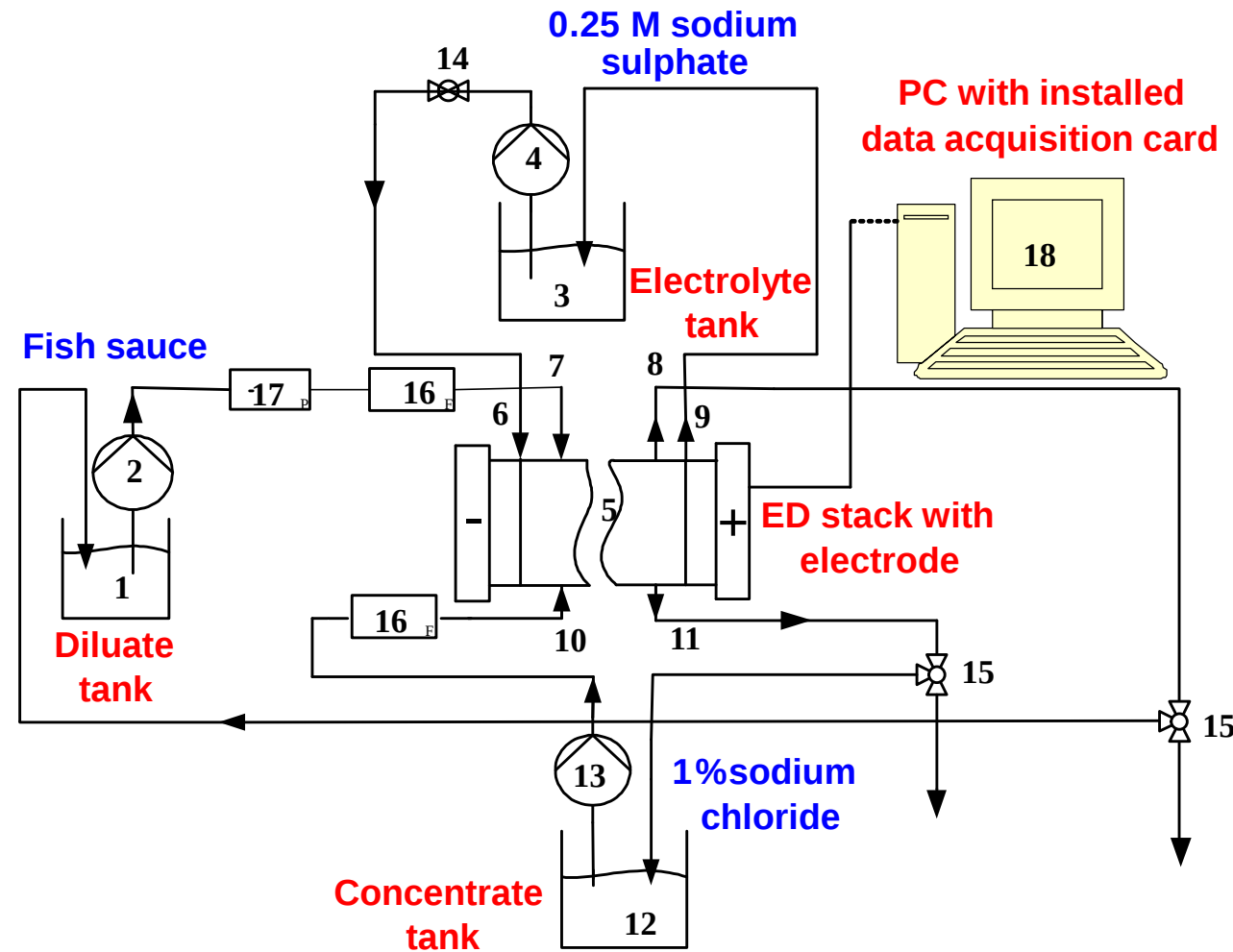
- Separation techniques in which ion-exchange membranes and electric potential are used to separate ions from aqueous solution
- Separation is based on charge instead of size

Membrane separations



Source: Baker (2004)

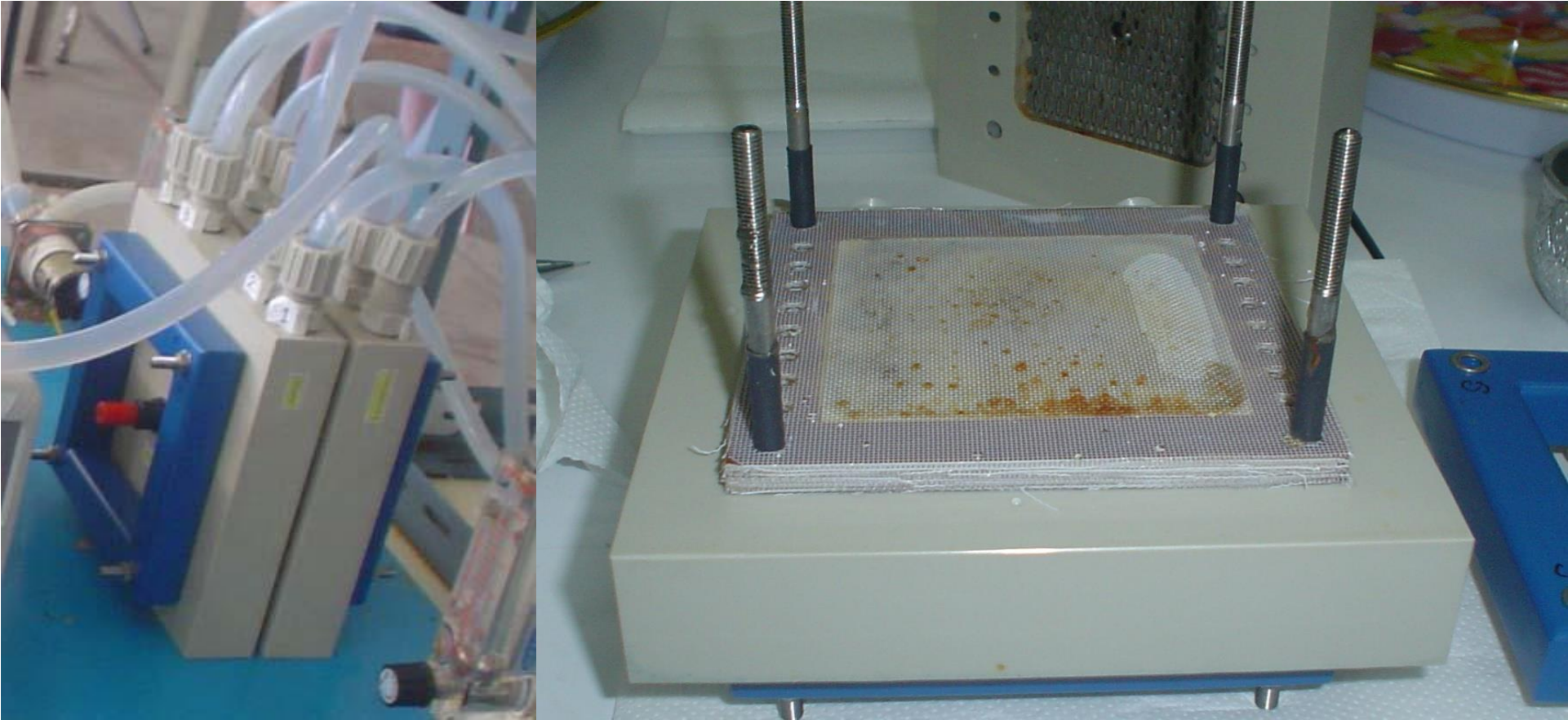
Schematic diagram of the ED system



Source: *J. Food Sci.*, 74: E363-E371 (2009)

ED stack

- No. of membrane 5 cell pairs
- Active membrane area 64 cm²/cell pair

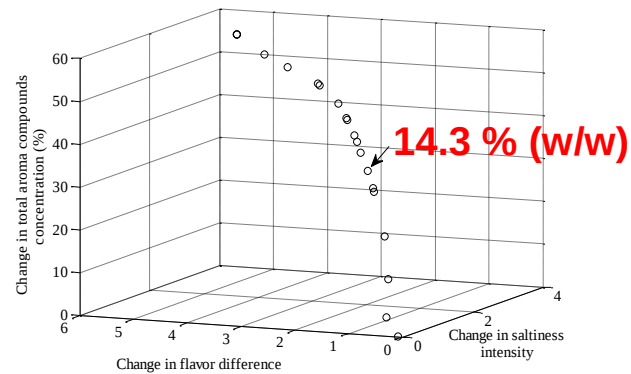
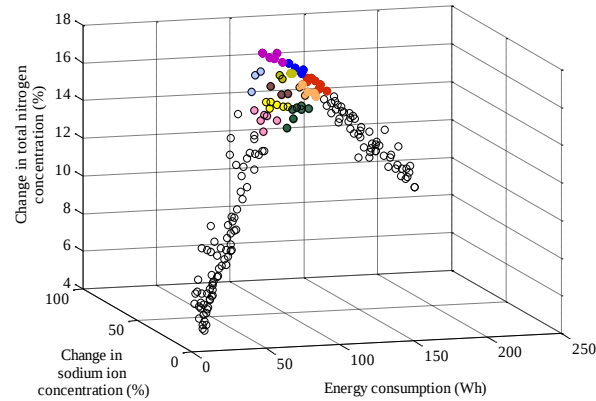


Lab-scale ED

- Batch recirculation system
- Concentrate: NaCl
- Electrolyte: NaSO₄
- Production: 1 kg/batch (~ 200 min to get 14% salt conc.)



Multi-objective optimization was then performed to arrive at optimum salt conc.

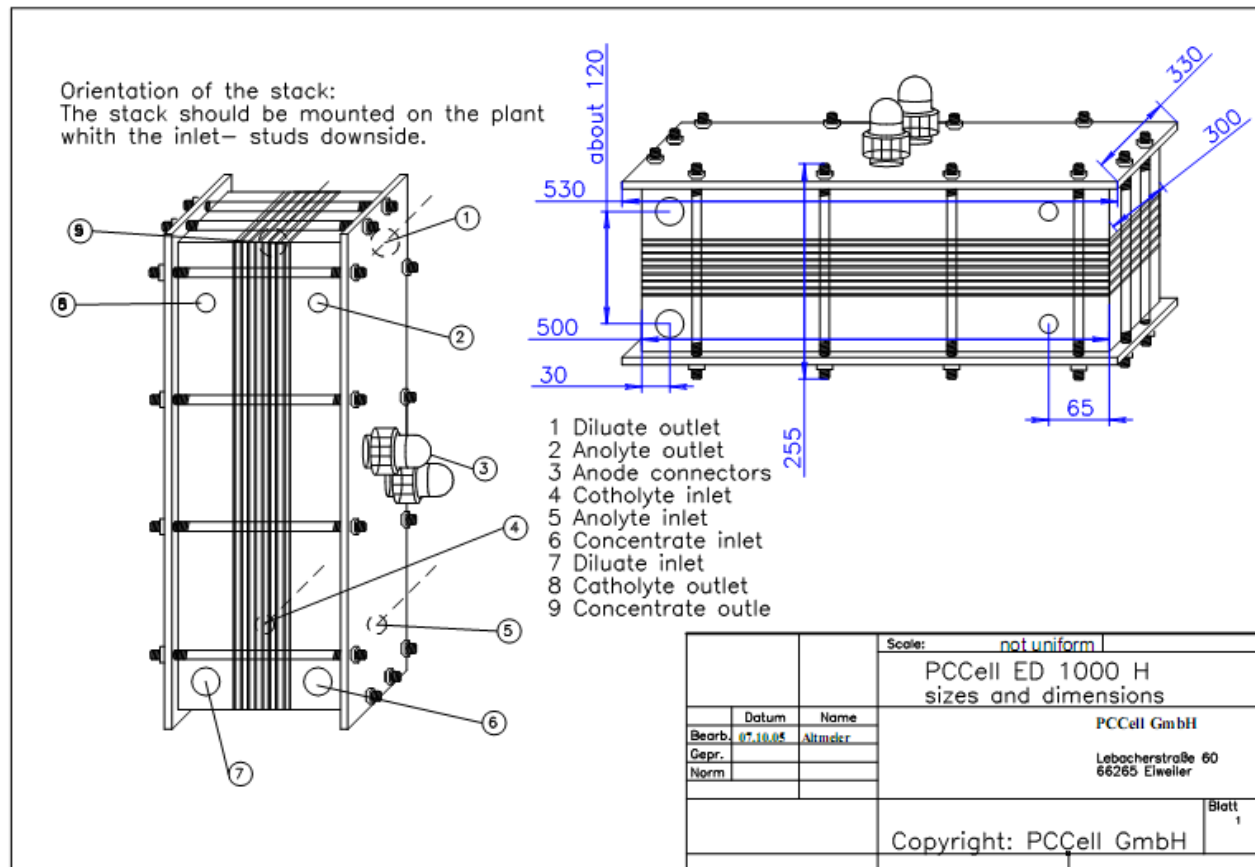


**Optimum salt concentration
is around 14% (w/w)**

Source: *J. Food Sci.*, 74: E363-E371 (2009); *J. Food Sci.*, 76: S451-457 (2011); *Food Bioprocess Technol.*, 6: 2695-2707 (2013)

ED stack

- No. of membrane 50 cell pairs
- Active membrane area 1000 cm²/cell pair









SANTE'
sauce

น้ำปลาแท้ลดโซเดียม ตราชองเต้ซอส
ลดโซเดียมและโพแทสเซียม 40% เทียบกับน้ำปลา
สูตรปกติ (น้ำปลาสูตรปกติมีโซเดียม 1,560 มก./15 มล.
และโพแทสเซียม 53 มก./15 มล.)

เกิดจากผลงานวิจัยนานกว่า 10 ปี โดยนักวิจัยไทย



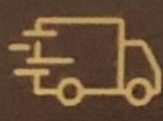
น้ำปลาแท้



เทคโนโลยี
ลดเกลือ



บรรจุขวด



ส่งมอบผลิตภัณฑ์

ส่วนประกอบ : หัวน้ำปลาแท้ 100% (ปลาไส้ตัน 72% และเกลือ 28%)
วัตถุดิบปรุงแต่ง (กลีเซอรอล)

ผลิตโดย : บริษัท เอ็นเอฟ อินเตอร์ฟู้ด จำกัด
16 ซอยสุขสวัสดิ์ 30 แขวงบางปะกอก เขตราชบุรีบูรณะ
กรุงเทพฯ 10140

จัดจำหน่ายโดย : บริษัท ชูพีเรียร์ โปรดักส์ อินเตอร์เนชั่น จำกัด
128/1 ซอยสุขุมวิท 23 ถนนสุขุมวิท แขวงคลองเตยเหนือ
เขตวัฒนา กรุงเทพฯ 10110

ข้อแนะนำในการเก็บรักษา : เนื่องจากผลิตภัณฑ์
มีเกลือต่ำ จึงควรเก็บในตู้เย็นหลังจากเปิดใช้ครั้งแรก

ข้อมูลสำหรับผู้แพ้อาหาร : มีปลา อาจมีตัวเหลือง แป้งสาลี หอยนางรม ซัลไฟด์

SANTE'
sauce

น้ำปลาแท้ลดโซเดียม

ลดโซเดียมและโพแทสเซียม 40%

FISH SAUCE

Low Sodium



ไม่ใช่โพแทสเซียมแทนโซเดียม

ไม่มีน้ำตาล • ไม่ใส่วัตถุกันเสีย • ไม่ใส่สี

ปริมาณสุทธิ
200 มล.

ข้อมูลโภชนาการ

หนึ่งหน่วยบริโภค : 1 ช้อนโต๊ะ (15 มิลลิกรัม)
จำนวนหน่วยบริโภคต่อขวด : ประมาณ 13

คุณค่าทางโภชนาการต่อหนึ่งหน่วยบริโภค
พลังงานทั้งหมด 10 กิโลแคลอรี (พลังงานจากไขมัน 0 กิโลแคลอรี)

ร้อยละของปริมาณที่แนะนำให้บริโภคต่อวัน*		
ไขมันทั้งหมด	0 ก.	0 %
ไขมันอิ่มตัว	0 ก.	0 %
คอเลสเตอรอล	0 มก.	0 %
โปรตีน	2 ก.	
คาร์โบไฮเดรตทั้งหมด	0 ก.	0 %
ใยอาหาร	0 ก.	0 %
น้ำตาล	0 ก.	
โซเดียม	830 มก.	42 %

ร้อยละของปริมาณที่แนะนำให้บริโภคต่อวัน*			
วิตามินเอ	0%	วิตามินบี 1	0%
วิตามินบี 2	0%	แคลเซียม	0%
เหล็ก	2%		

*ร้อยละของปริมาณสารอาหารที่แนะนำให้บริโภคต่อวันสำหรับ
คนไทยอายุตั้งแต่ 6 ปีขึ้นไป (Thai RDI) โดยคิดจากความต้องการ
พลังงานวันละ 2,000 กิโลแคลอรี

ความต้องการพลังงานของแต่ละบุคคลแตกต่างกัน ผู้ที่ต้องการ
พลังงานวันละ 2,000 กิโลแคลอรี ควรได้รับสารอาหารต่างๆ ดังนี้

ไขมันทั้งหมด	น้อยกว่า	65 ก.
ไขมันอิ่มตัว	น้อยกว่า	20 ก.
คอเลสเตอรอล	น้อยกว่า	300 มก.
คาร์โบไฮเดรตทั้งหมด		300 ก.
ใยอาหาร		25 ก.
โซเดียม	น้อยกว่า	2,000 มก.

พลังงาน (กิโลแคลอรี) ต่อกรัม : ไขมัน = 9 ; โปรตีน = 4 ; คาร์โบไฮเดรต = 4



10-1-05563-5-0178

วันผลิต/ควรบริโภคก่อน : ดูที่บรรจุภัณฑ์





ครั้งแรกที่ลด ทั้งโซเดียม และโพแทสเซียม ในน้ำปลา 40%

- ไม่ใช้โพแทสเซียมแทนโซเดียม
- ไม่มีน้ำตาล
- ไม่ใส่วัตถุกันเสีย
- ไม่ใส่สี



ORDER NOW

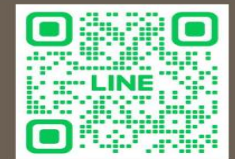
LAZADA



SHOPEE



LINE ID: @sante.sauce



น้ำปลาแท้ลดโซเดียม ตรา **ซองเต้** ชอส

คำแนะนำ: ควรเก็บในตู้เย็นหลังจากเปิดใช้ครั้งแรก เนื่องจากผลิตภัณฑ์มีเกลือต่ำและไม่ใส่วัตถุกันเสีย

Well, that was not the end...

- Launching a new product is an art – not exact science
- Need survey on market status, competitors' positions, consumer behavior/acceptance, etc. **Long and expensive process indeed!**
- Also need serious dedication by the company – need priority from management

Challenges and problems

- Company sometimes does not have expertise and resources to do the job
- Funding agency can again play a role here
- External parties may be brought in – market analysis team, business planning team, etc.
- Academic researchers **should** stay involved in all the steps towards commercialization

Closing remarks

- Successful academia-industry research collaboration is entirely possible
- Need mutual understanding and agreement even before the project starts
- Multi-disciplinary team is needed to ensure success
- Need to distinguish between research and service (or consultation)!

Closing remarks

- Venture capital investment is becoming more popular
- More opportunities for high-tech start-up companies

**In the US, average time from
conceptualization to commercialization is
17 years!**

But we cannot afford **NOT** to do it!

Thank you!



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