



IMPROVE

**Oxidation is Destroying
Plant Protein Quality:**

Ways to Prevent it

**BRIDGE2FOOD
EUROPE**

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| June 4, 2025



We innovate for our clients in understanding and enhancing alternative proteins.

Presentation Plan



1. Defining quality of protein ingredients
 1. What ingredients?
 2. What properties?
2. **Focus on oxidation:** How is oxidation impacting quality of the ingredients?
 1. Protein ingredient components and their sensibility to oxidation
 2. What solutions?
3. IMPROVE ecosystem presentation

Protein ingredients Overview



	Seeds	Flour / Meal	Concentrate	Isolate
Protein %	20 to 30%	20 to 50%	50 to 75%	> 80%
Process	PB dry processing	PB dry processing	PB dry & wet processing Yeast wet processing	Plant based wet processing Yeast and bacterial wet processing
Allegation	Clean Label	Clean Label Rich in fibers	Clean Label Rich in fibers	Ultra-transformed Rich in proteins
Market price	Low	Low	Moderate	High
Usage example	Plant based milk	Bakery, Pastry	Meat analog	Egg and casein replacers
%proportion use	Up to 50%	Up to 50%	Up to 50%	<5%



Defining Protein Ingredient Quality



Nutritional properties

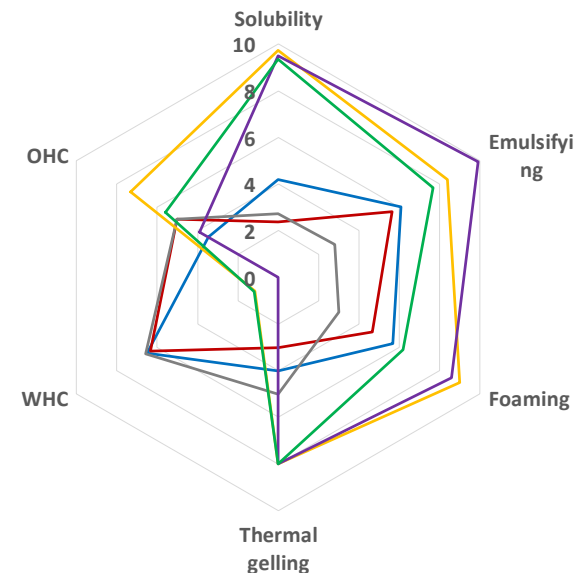
- ❑ Protein & essential AA content
- ❑ Digestibility
- ❑ Purity, absence of ANF
- ❑ Allergenicity

Functional properties

- ❑ Interaction with water & oil
- ❑ Emulsifying capacity
- ❑ Foaming & Gelling capacity
- ❑ Texturing ability

Sensorial properties

- ❑ Taste (beany, bitter, astringent)
- ❑ Smell (green, earthy)
- ❑ Texture (particle size, color, viscosity)



The challenge of taste



Category	2024 dollar sales	Dollar sales growth (2023–2024)	2024 unit sales	Unit sales growth (2023–2024)	Average retail price change (2023–2024)
Plant-based milk	\$2.8 B	-5%	721 MM	-4%	-1%
Plant-based meat and seafood	\$1.2 B	-7%	195 MM	-11%	+4%
Plant-based creamer	\$760 MM	-4%	153 MM	-4%	0%
Plant-based meals	\$442 MM	-17%	84 MM	-18%	+2%
Plant-based protein liquids and powders	\$450 MM	+11%	30 MM	+13%	-2%
Plant-based yogurt	\$400 MM	+1%	143 MM	-4%	+5%
⋮					
TOTAL	\$8.1 B	-4%	1.8 B	-5%	1%

SPINS gfi / Good Food Institute

The Good Food Institute: “In [UK and Germany] countries, consumers scored plant-based foods lower than animal meat and dairy on factors such as taste, availability, confidence in cooking.”

“Long-term outlook: The plant-based industry still has a long road to parity with conventional meat when it comes to price, taste, and convenience.”

Protein ingredient sensibility to oxidation



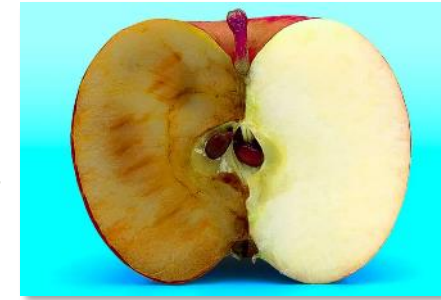
Defining oxidation

The oxidation reaction is a process occurring when **one substance**, called the “**reducing agent**”, gives up **electrons** to another substance, called the “**oxidizing agent**”, usually oxygen.

Rust is the result of iron oxidation



Browning is the result polyphenols oxidation



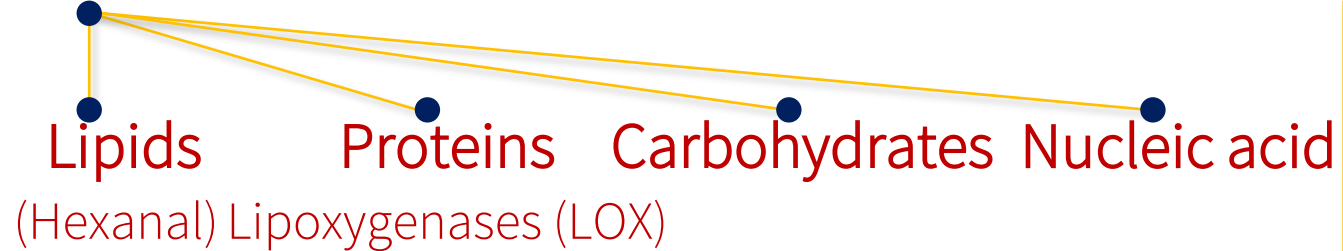
Influencing oxidation

An alkaline pH, the presence of transition metals (Fe, Cu...), O₂, light, heat or enzymes can **amplify the formation of oxidants** and **accelerate oxidation reactions**.

Protein ingredient sensibility to oxidation



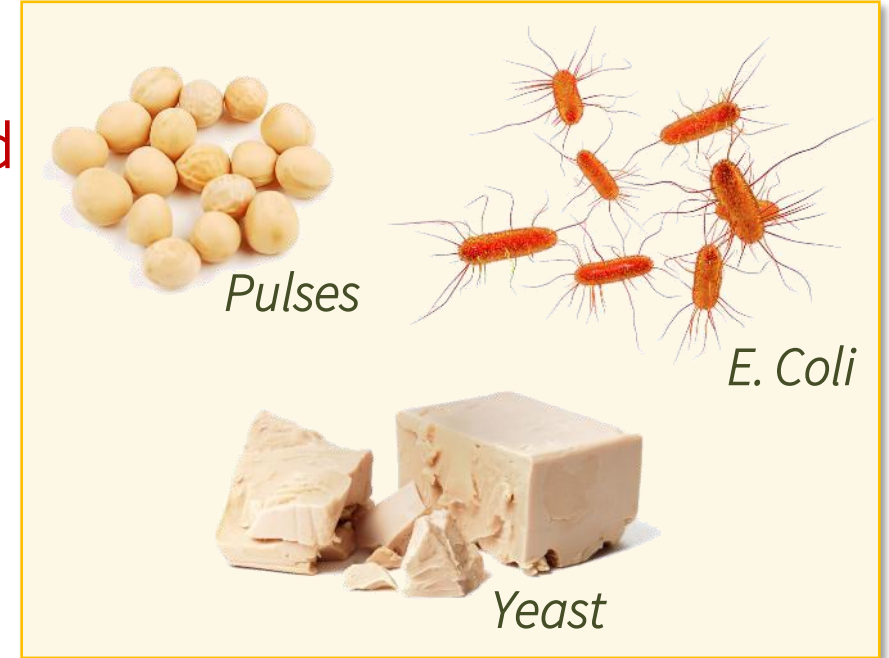
Macromolecules



Secondary metabolite



Other molecules



Protein ingredient sensibility to oxidation



1 Storage

2 Dehulling / milling
Oil extraction

3 (Air classification)

4 Alkaline extraction

5 IEP / UF

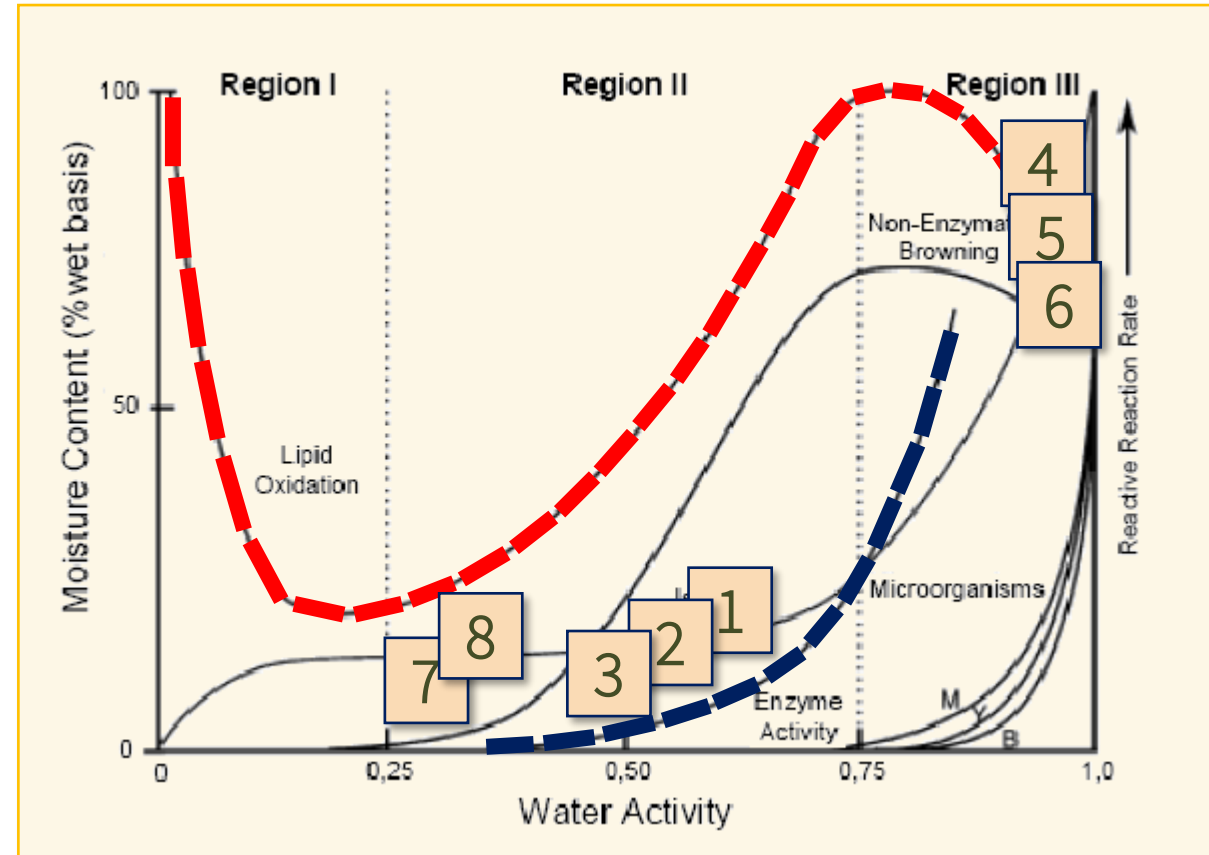
6 Pasteurization

7 Drying

8 Storage

Dry process

Wet process



Stability map of food as a function of water activity
(from Theodore P Labuza)

Influence factors

Oxygen

Light

T°C

LOX

Moisture

Basic pH

Compo.

Protein ingredient sensibility to oxidation



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Dry processing

- Important air (oxygen) flow
- Low purification: presence of sensible compounds
- Size, shape, moisture
- Impact of the variety

Antioxidant,
Modified
atmosphere

Wet processing

- High moisture and presence of oxygen
- Presence of LOX and reactive compounds
- Alkaline pH, high temperature and mixing

Reactive
compounds
removal,
Antioxidant,
Modified
atmosphere

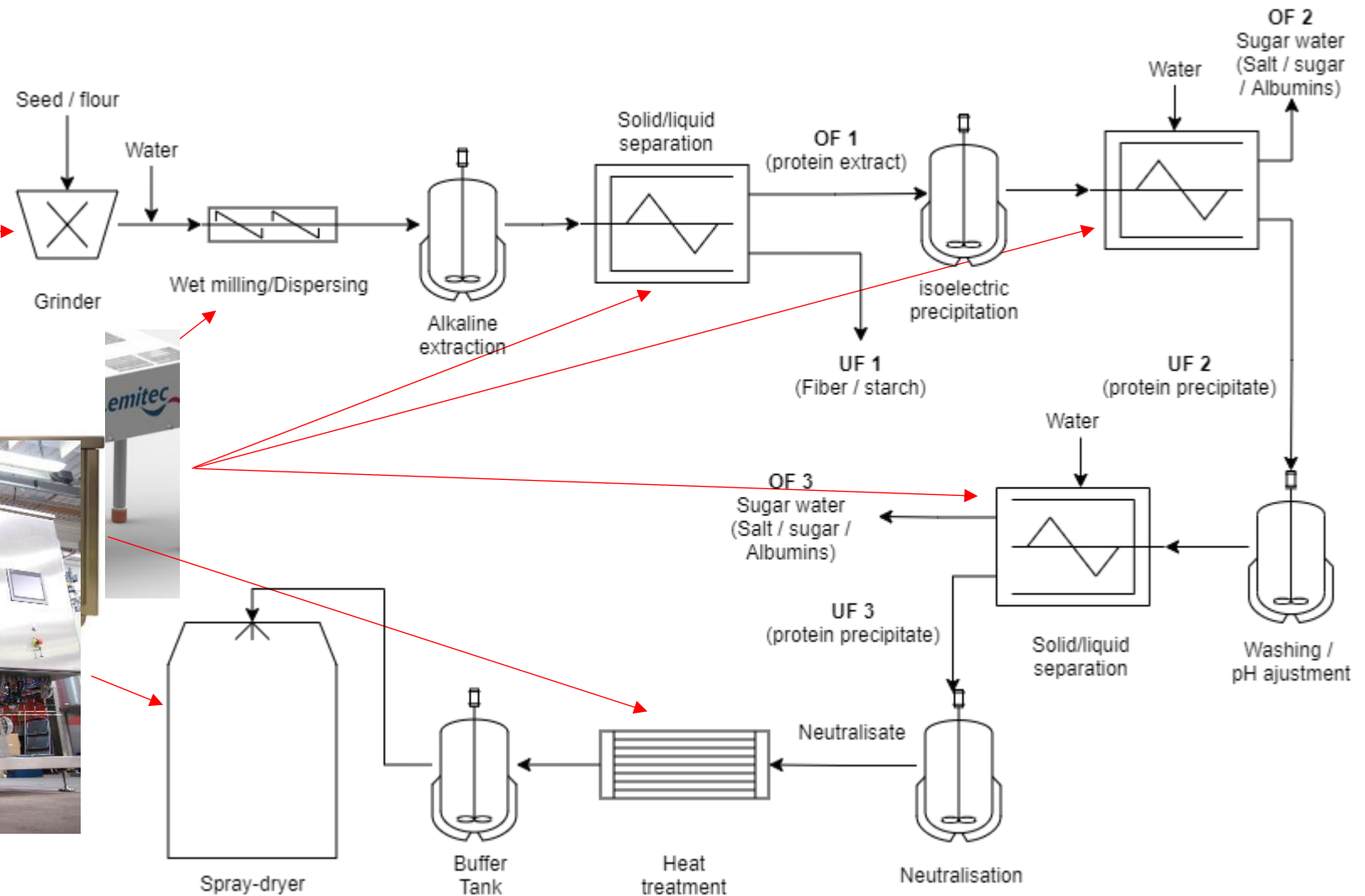
Stabilization & storage

- Presence of oxygen
- Moisture, remaining reactive compounds
- Long storage period

Antioxidant,
Coating agent,
Modified
atmosphere
packaging
(MAP)

Study case 1

Avoiding oxidation in wet processing



Proprietary information of IMPROVE SAS

Study case 1

Avoiding oxidation in wet processing

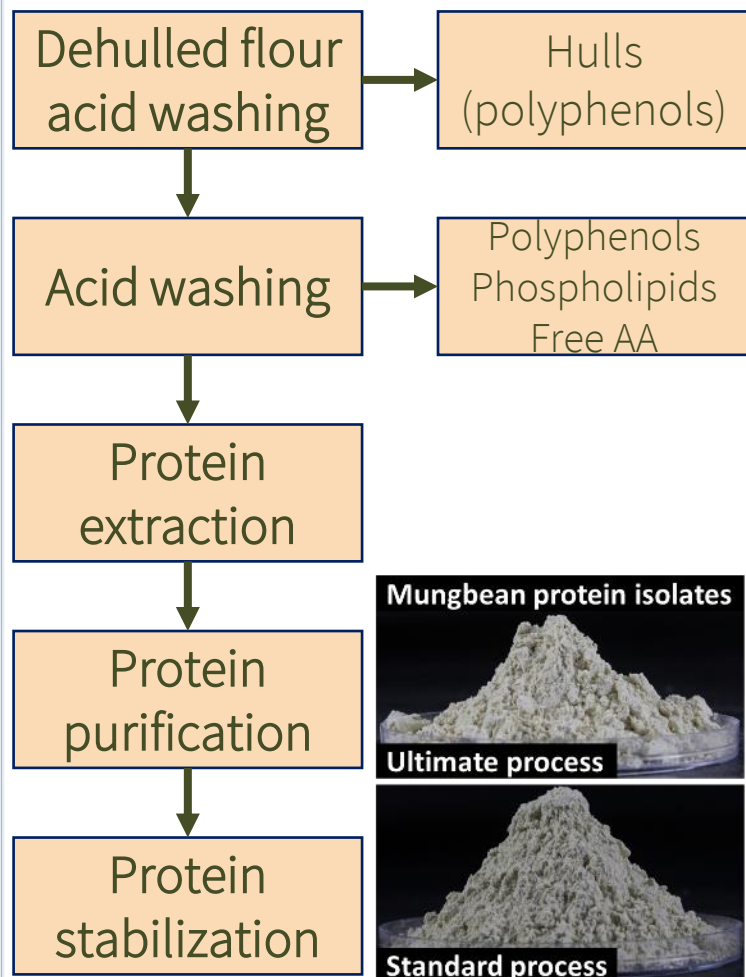


IMPROVE's Continuous processing line

- Chain of Operations
- No Waiting Time
- No stop or intermediate storage
- Shorter time = lower oxidation
- Oxidative compounds not removed
- Risk during storage and use
- Applicable to alternative protein processing

Study case 2

Removing unwished molecules before protein



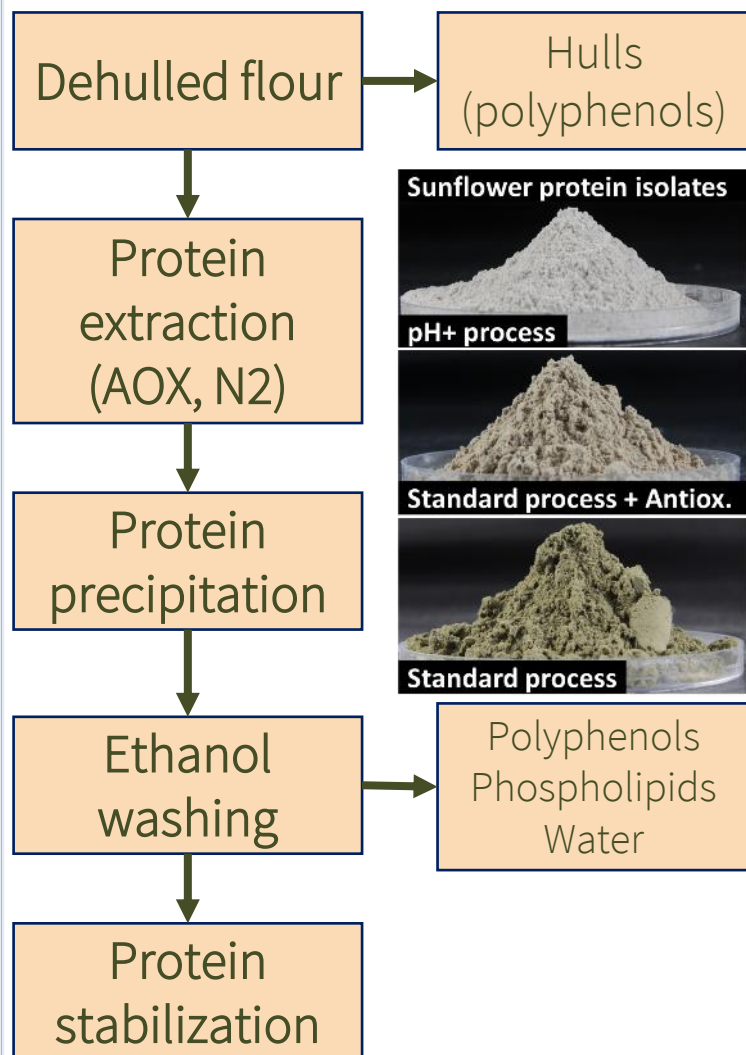
IMPROVE pulse processing method

- Pulse compounds subject to oxidation:
 - Polyphenols
 - Phospholipids
 - Free AA

Interaction with proteins
- Pretreatment before protein extraction and purification
 - **Extraction of LOX** (water soluble protein) and free AA
 - Partial extraction of phospholipids
 - Extraction of Oligosaccharides, sugars and **pigments** including Carotenoids
- Lighter color (less yellowish)
- Improved taste, neutral odor without beany smell

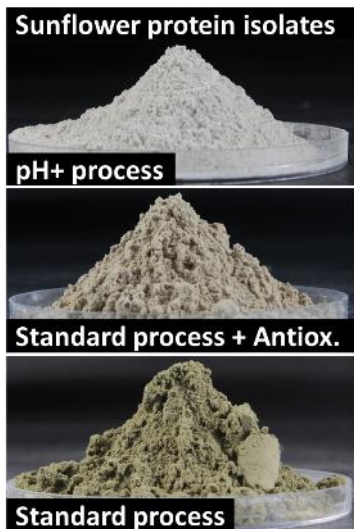
Study case 3

Removing unwished molecules from the protein isolate



IMPROVE soy & sunflower processing method

- Soy & Sunflower compounds subject to oxidation:
 - Polyphenols (chlorogenic acid) $\rightarrow$ Interaction with proteins
 - Lipids
- Treatment before protein isolate drying
 - **Extraction of polyphenols** (ethanol soluble) of products of oxidation
 - **Extraction of phospholipids** (ethanol soluble) of products of oxidation
 - Extraction of sugars and **pigment**
- White color & neutral flavor
- High Protein purity >95% $\rightarrow$ Lower risk during storage



Key Takeaways

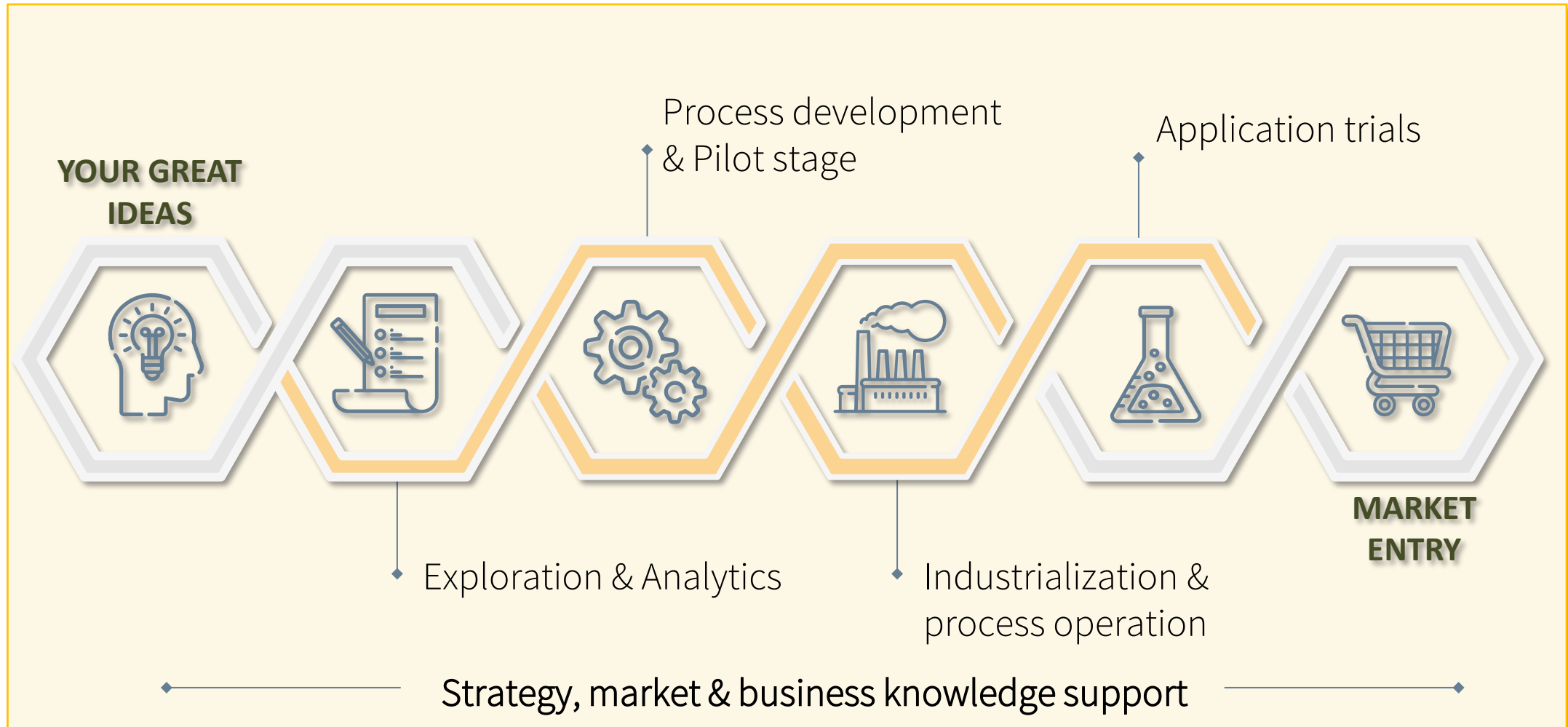


- Oxidation is coming from **diverse compounds** → Full raw matter characterization
- **Several factors** influence the oxidation
- **Partial purification** of protein ingredients → All steps sensitive to oxidation
- Oxidation issues need to be part of **process definition in the early stages**
- Consider process from the very beginning → Raw material to the end-product
- Options:
 - **Avoiding oxidation** during the process using processing aids or process adaptation
 - **Preventing oxidation** around the process by redefining the process steps
- And also responsible of the flavors: Maillard reaction, saponins, isoflavones...

IMPROVE a part of an innovative Group



Comprehensive Support for Industrials: From Research to Commercialization



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We innovate for our clients in understanding and enhancing alternative proteins.

Thank you
For your attention!