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# Exploring plant biodiversity to extract oil bodies for sustainable food applications

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**CONTEXT.** Oilseeds and cereal seeds enclose a wide range of nutrients such as lipids, proteins, polysaccharides and various mineral and organic micronutrients. *In planta*, these nutrients are found under the form of natural assemblies such as oil bodies (OB), protein bodies or starch granules, that have interesting properties (micronic sizes, surface activity, high physicochemical stability, etc.). Up to now, these assemblies are extracted by various processes using energy, organic solvents, steam, alone or in combination. Thus, their natural structures are often strongly damaged, and thereby some of their functionalities are lost. Storming through natural assemblies' biodiversity to address the societal demand for more natural and minimally-processed food, seems promising. Indeed, the soft extraction of such assemblies could be an alternative to traditional intensive fractionation methods of plant raw materials to isolate target ingredients (sucrose, starch, refined oils, etc.). This would allow for energy savings and avoid solvent use, but must be balanced with potential challenges of this new green refinery scheme.

## OBJECTIVES

- To highlight the physicochemical properties of various OB in the spotlight of the OBTAIN\*\* consortium
- To present the green refinery scheme proposed for their extraction

## FATTY ACID COMPOSITION



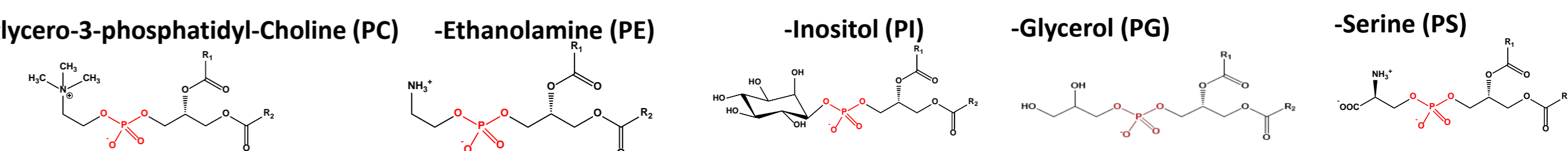
Main Fatty acids (%)	Rapeseed	Sunflower	HO* Sunflower	Soybean	Linseed	Chia	Rice	Walnut
Palmitic acid (C16:0)	4	7	4	10	7	7	20	7
Stearic acid (C18:0)	2	5	6	4	4	3	2	0.3-1.0
Oleic acid (C18:1-ω9)	56	24	85	21	20	7-10	48	15
Linoleic acid (C18:2-ω6)	21	63	5	56	17	19-20	27	70
α-linolenic acid (C18:3-ω3)	10	0	0	8	52	60-64	2	17

\*HO : high oleic  
References: [1-5]

- ✓ Omega-3 rich sources (linseed, chia, hemp, walnut) are of special interest to correct the low dietary intake of French and European population as well as the ω6/ω3 balance
- ✓ Specific blends of OB extracted from different seeds can help meeting the needs of specific nutritional target

## PHOSPHOLIPID COMPOSITION

Monolayer of proteins associated to « classical » phospholipids

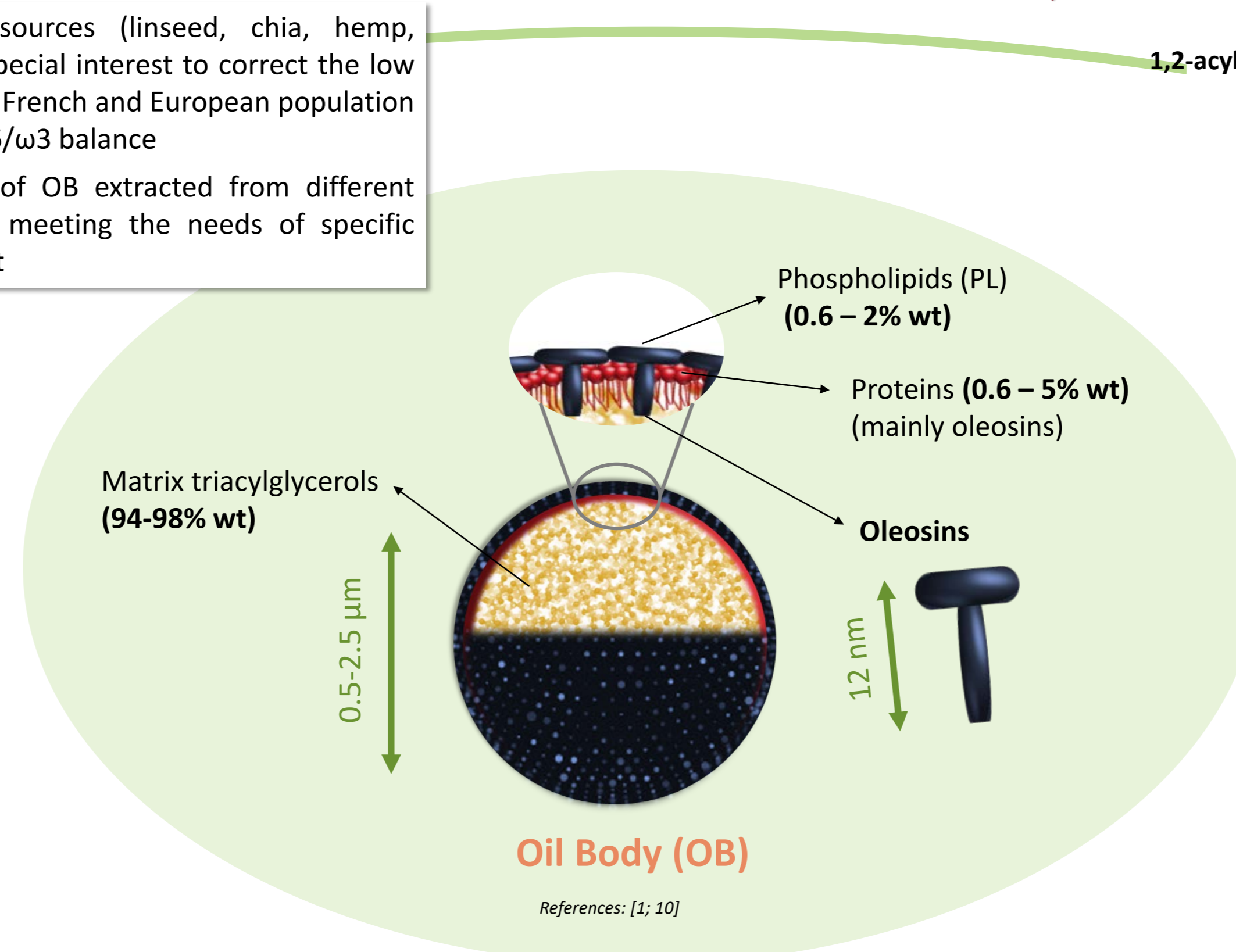


%	Rapeseed	Sunflower	Soybean	Linseed	Mustard	Cotoneed	Maize	Peanut	Sesame
PC	59.9	79	57.1	57.2	53.1	58.9	64.1	61.6	41.2
PE	5.9	13	13.5	2.8	15.5	4.6	8.1	5.0	15.8
PI	14.0	8	15.6	6.9	13.1	18.1	7.6	8.4	20.9
PG	(-)	(-)	3.4	(-)	(-)	(-)	(-)	(-)	(-)
PS	20.2	(-)	(-)	33.1	18.3	18.7	20.2	25.0	22.1

## MICRONIC SIZES AND COMPOSITION

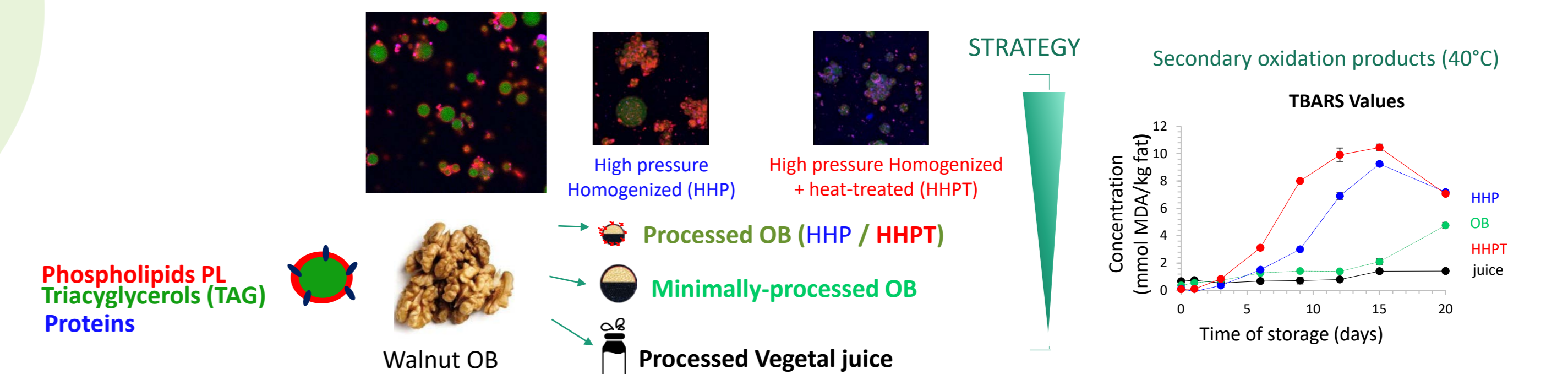
Seeds	Rapeseed	Linseed	Mustard	Cotoneed	Maize	Peanut	Sesame	Oat
Diameter (μm)	0.65	1.34	0.73	0.97	1.45	1.95	2.00	1.07
Triacylglycerols (%)	94.21	97.65	94.64	96.99	97.58	98.17	97.37	89.9
Proteins (mainly oleosin) (%)	3.46	1.34	3.25	1.70	1.43	0.94	0.59	5.4
Phospholipids (%)	1.97	0.90	1.60	1.18	0.91	0.80	0.57	(n.a)
Free fatty acids (%)	0.36	0.11	0.17	0.13	0.09	0.09	0.13	(n.a)

References: [1; 6-7]



Oil Body (OB)  
References: [1; 10]

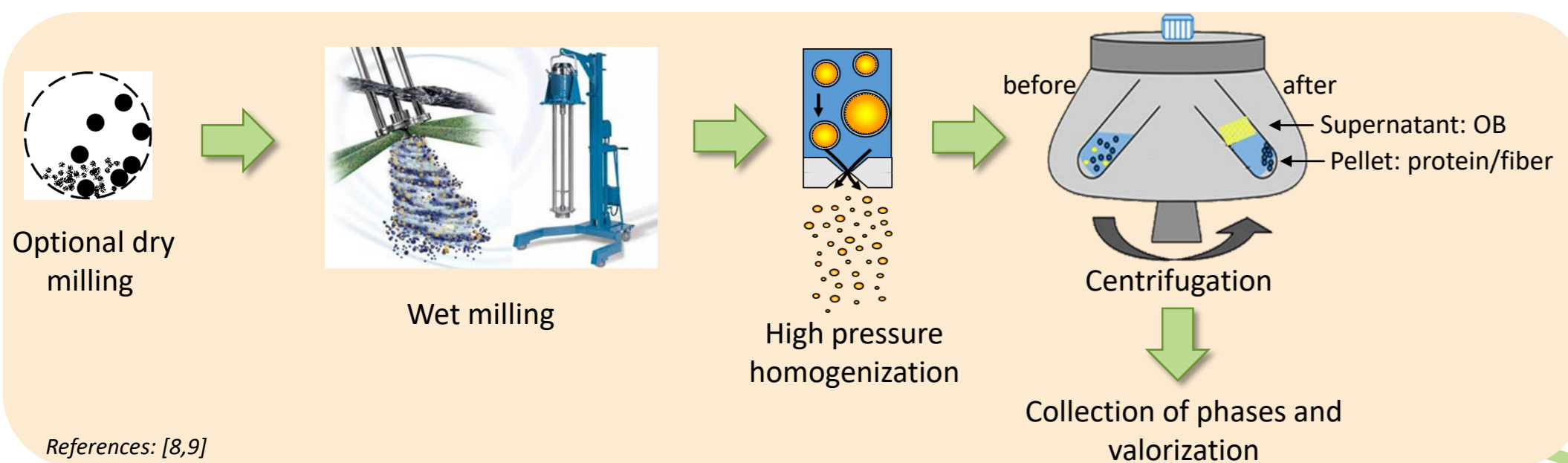
## Resistance to oxidation / surface activity: example on walnut OB



- ✓ Minimally-processed walnut OB extracted by wet milling present good oxidative stability

References: [5; 11-12]

## NEW REFINERY SCHEME FOR LIPIDS ?



References: [8,9]

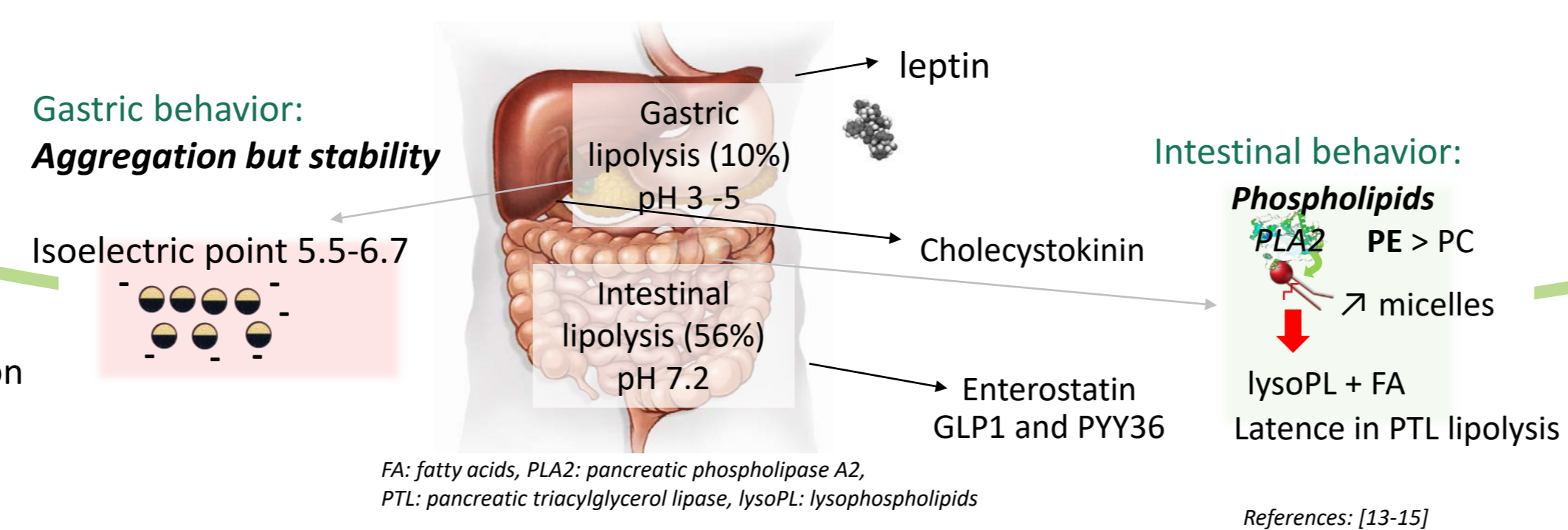
- Avoid solvent extraction (REACH)
- Limit the use of synthetic surfactants / surface activity of oleosins
- Alternative to soy lecithins
- PUFA\* rich membrane / OB
- Relative physical stability of OB
- Assembly extraction / Minimal processing
- High demand for vegetal juices

\*PUFA: polyunsaturated fatty acids



- Limited physico-chemical stability of OB emulsion
- Microbial stability << oil
- Allergenicity of oleosins?
- Removal of antinutritional compounds?

## SPECIFICITY OF DIGESTION – BIOACCESSIBILITY ?



FA: fatty acids, PLA2: pancreatic phospholipase A2, PTL: pancreatic triacylglycerol lipase, lysoPL: lysophospholipids

References: [13-15]

- ✓ OB open at the interface and spread out in domains and assemblies thanks to good cohesiveness between the different molecules

Reference: [5]

**CONCLUSIONS.** Oil bodies can thus constitute new dietary carriers of ω3 and other bioactive molecules. Moreover, the combination of oil bodies with specific features (fatty acid profiles, stabilities, vitamin contents) can help meeting the requirements of specific nutritional targets (infants, children, elderly, athletes, etc.). Altogether, we are convinced that the valorization of these diverse oil bodies can be a strategic route in the development of sustainable food systems.

References: 1. Tzen et al. *Plant Physiol*, 1993; 2. Nantiyakul et al., *JAOCs*, 2012; 3. Nantiyakul et al., *J Cereal Sci*, 2013; 4. Nitrayova et al., *Potravinarstvo Sci J Food Ind*, 2014; 5. Kergomard et al., *Food Chem*, 2021; 6. Huang, *Annual Rev Plant Physiol Plant Mol Biol*, 1992; 7. White et al., *JAFc*, 2009; 8. Fabre et al., *OCL*, 2015; 9. Fabre et al., *Ind Crops Products*, 2015; 10. Jolivet et al., *Ind Crops Products*, 2013; 11. Kapchie et al., *Food Chem*, 2013; 12. Gray et al., *EJLST*, 2010; 13. Gallier et al. *Food Funct*, 2012; 14. Beisson et al., *BBA*, 2001; 15. Carrière et al., *Am J Physiol*, 2001.

\*OBTAIN is a consortium comprising scientists from INRAE (TRANSFORM department, <https://www.inrae.fr/departements/transform>); UMR IATE, Montpellier, <https://umr-iate.cirad.fr/>; UMR IJPB, Versailles, <https://ijpb-versailles.inrae.fr/en/>; UMR LCA, Toulouse, <https://www6.toulouse.inrae.fr/lca/>; UR BIA, Nantes <https://www6.angers-nantes.inrae.fr/bia/>; CIRAD (Montpellier, <https://umr-qualisud.cirad.fr/>); AgroParisTech (IJPB, <https://ijpb-versailles.inrae.fr/en/>); Rennes Institute of Physics (Rennes, <https://ipr.univ-rennes1.fr/en/ipr-institute-physics-rennes>).