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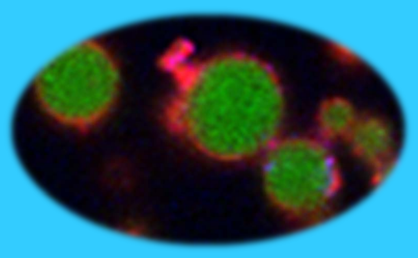
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Storming through plant biodiversity to extract oleosomes for sustainable food applications

ASSOR C.[1], BAROUH N.[2], BERTON-CARABIN C.[3]*, BOURLIEU C.[1]*, CHARDOT T.[4]*, D'ANDREA S.[4], FABRE J.-F.[5], GOHON Y.[4], LACROUX E.[5], LULLIEN-PELLERIN V.[1], MAMERI H.[1], MICARD V.[1], MERAH O.[5], MEYNIER A.[3], VALENTIN R.[5]*, VIÉ V.[6], VILLENEUVE P.[2]

*claire.bourlieu-lacanal@inrae.fr, *claire.berton-carabin@inrae.fr, *romain.valentin@ensiacet.fr, *thierry.chardot@inrae.fr

Context

Oilseeds and cereal seeds enclose a wide range of nutriments 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 oleosomes (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

o 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

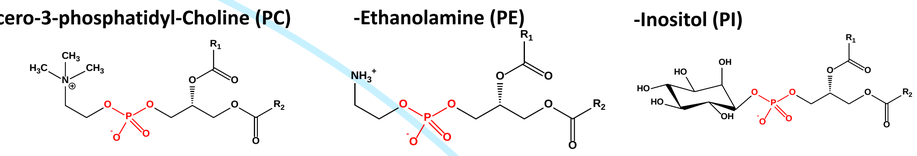
**HO : high oleic; References: [1-5]*

- ✓ 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

o Phospholipid composition

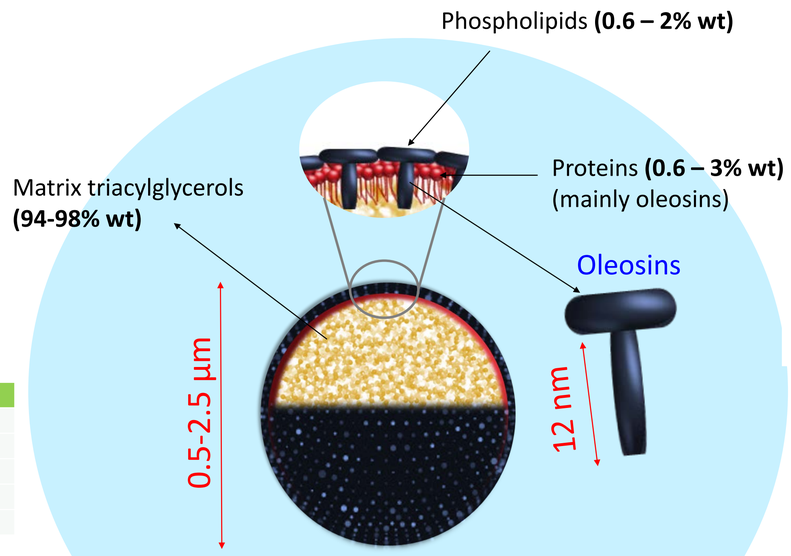
Monolayer of proteins associated to « classical » phospholipids

1,2-acyl-*sn*-glycero-3-phosphatidyl-Choline (PC) -Ethanolamine (PE) -Inositol (PI)



-Glycerol (PG) -Serine (PS)

	Sunflower	Soy	Rapeseed	Linseed	Mustard	Cotonseed	Maize	Peanut	Sesame
PC	79	57.1	59.9	57.2	53.1	58.9	64.1	61.6	41.2
PE	13	13.5	5.9	2.8	15.5	4.6	8.1	5.0	15.8
PI	8	15.6	14.0	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



Oleosome / Oil Body (OB)

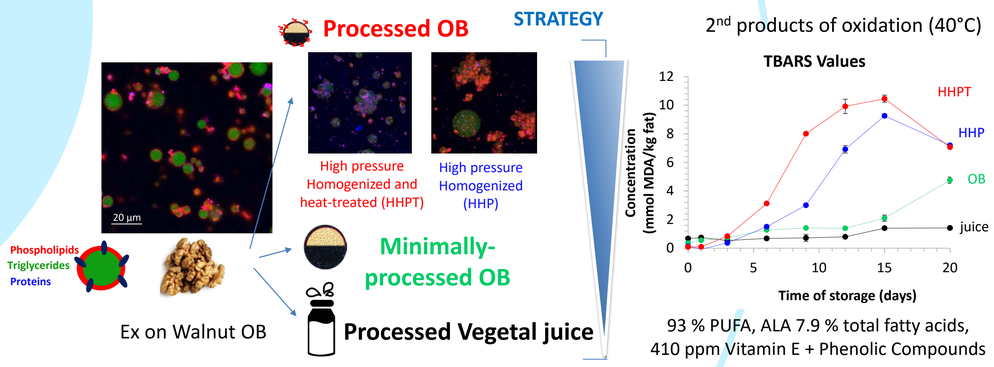
References: [1; 10]

o Micronic sizes and composition

Seeds	Rapeseed	Linseed	Mustard	Cotonseed	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 (%)	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)

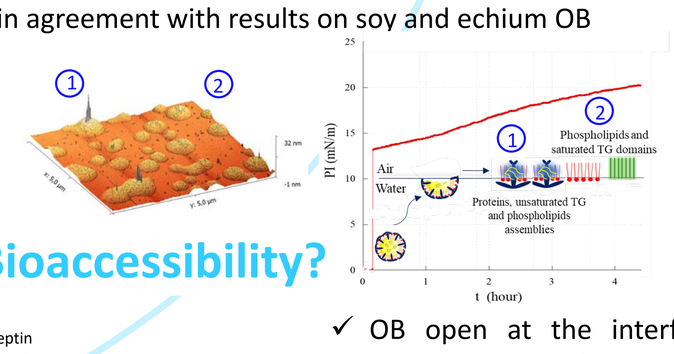
References: [1; 6-7]

o Resistance to oxidation / surface activity

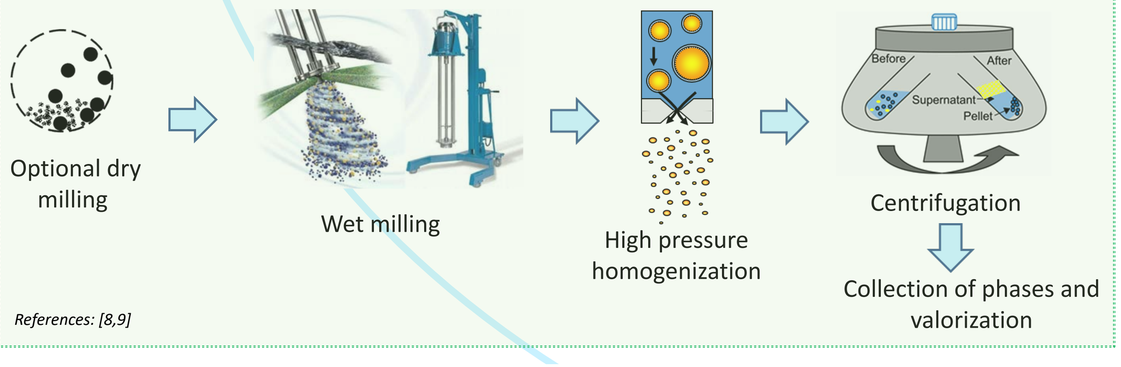


- ✓ Minimally-processed walnut OB extracted by wet milling present good oxidative stability in agreement with results on soy and echium OB

References: [5; 11-12]



o 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*



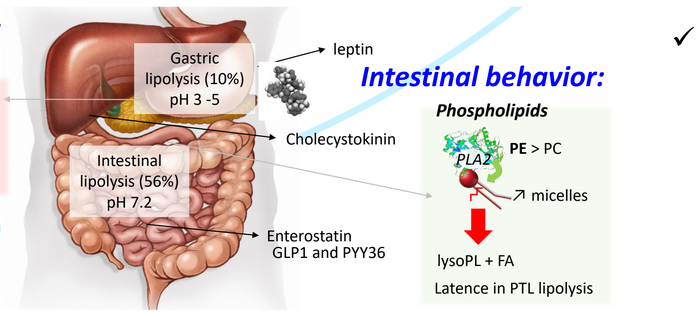
- Limited physico-chemical stability of OB emulsion
- Microbial stability << oil
- Allergenicity of oleosins?
- Removal of antinutritional compounds?

o Specificity of digestion /Bioaccessibility?

Gastric behavior:

Aggregation but stability

Isoelectric point 5.5-6.7



References: [13-15]

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

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

Reference: [5]

Conclusions

Oleosomes can thus constitute new dietary carriers of ω3 and other bioactive molecules. Moreover, the combination of oleosomes 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 oleosomes can be a strategic route in the development of sustainable food systems.

** **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/) and Rennes Institute of Physics (Rennes, https://ipr.univ-rennes1.fr/en/ipr-institute-physics-rennes).

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1 UMR IATE, INRAE/Univ Montpellier/Institut Agro, Montpellier, France;
2 UMR QUALISUD, CIRAD/Univ Montpellier/Institut Agro/IRD/Univ Réunion, Montpellier, France;
3 UR BIA, INRAE, Nantes, France;
4 UMR 1318 IJBP, INRAE/AgroParisTech/ Univ Paris-Saclay, Versailles, France;
5 UMR 1010 LCA, INRAE/Université de Toulouse/INPT/ENSIACET, Toulouse, France;
6 IPR Institute of Physics, UMR UR1 CNRS 5261, Rennes 1 Univ, Rennes, France;