Does encapsulation of DHA with heat-denatured whey proteins in Pickering emulsions improve its bioaccessibility?

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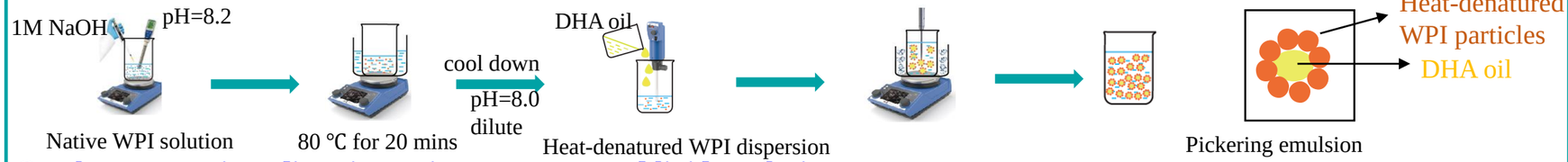
1. INRAE, UMR 1253 STLO, 65 rue de Saint-Brieuc, F-35000 Rennes, France 2. Agrocampus Ouest, 65 rue de Saint-Brieuc, F-35000 Rennes, France 3. Norwegian University of Science and Technolygy, 39000, Norway

Background

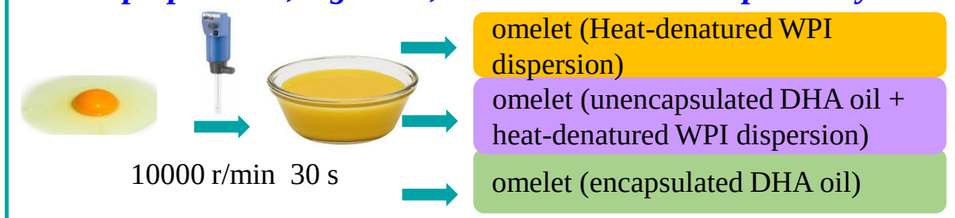
- Docosahexaenoic acid (DHA) is the most important n-3 polyunsaturated fatty acid (PUFA), mainly known for its health benefits on cognitive development and cardiovascular function.
- The current intake of DHA and EPA in the Western diet averages 150 mg per day, less than the recommended daily consumption from The French Food Safety Authority for adults, which is 500 mg.
- Oxidation limits the enrichment of n-3 PUFAs in foods.
- Encapsulation is an effective strategy to strengthen food with n-3 PUFAs, and can also improve the oxidative status.
- Pickering emulsion has garnered exponentially increasing interest in recent years due to its excellent stability.
- Previous research showed that omelets have the highest DHA bioavailability in various forms of DHA-rich foods (milkshake, custard dessert, pancake and omelet).
- In this study, our goal was to study the DHA evolution during the digestion and to compare the DHA bioaccessibility between encapsulation (Pickering emulsion) and unencapsulation based on INFOGEST Adult model.

Materials & Methods

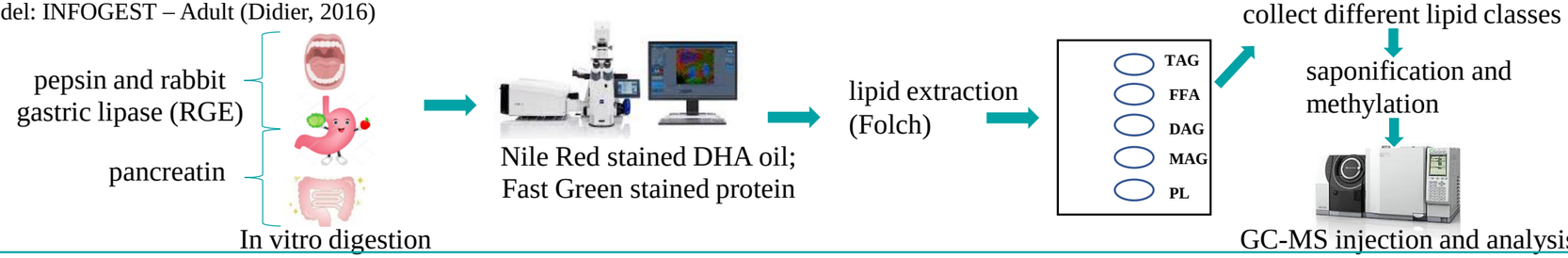
Pickering emulsion preparation *(raw material: whey protein isolate, WPI)*



Omelet preparation, digestion, microstructure and lipid analysis



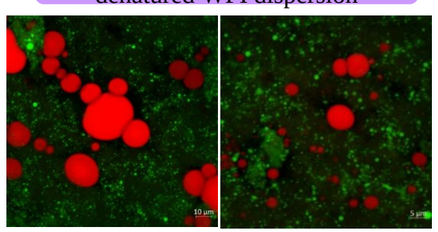
Model: INFOGEST – Adult (Didier, 2016)



Results and discussion

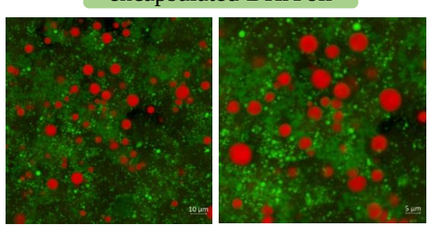
1. DHA oil distribution in omelets

unencapsulated DHA oil + heat-denatured WPI dispersion



DHA oil droplet size and distribution were not uniform

encapsulated DHA oil



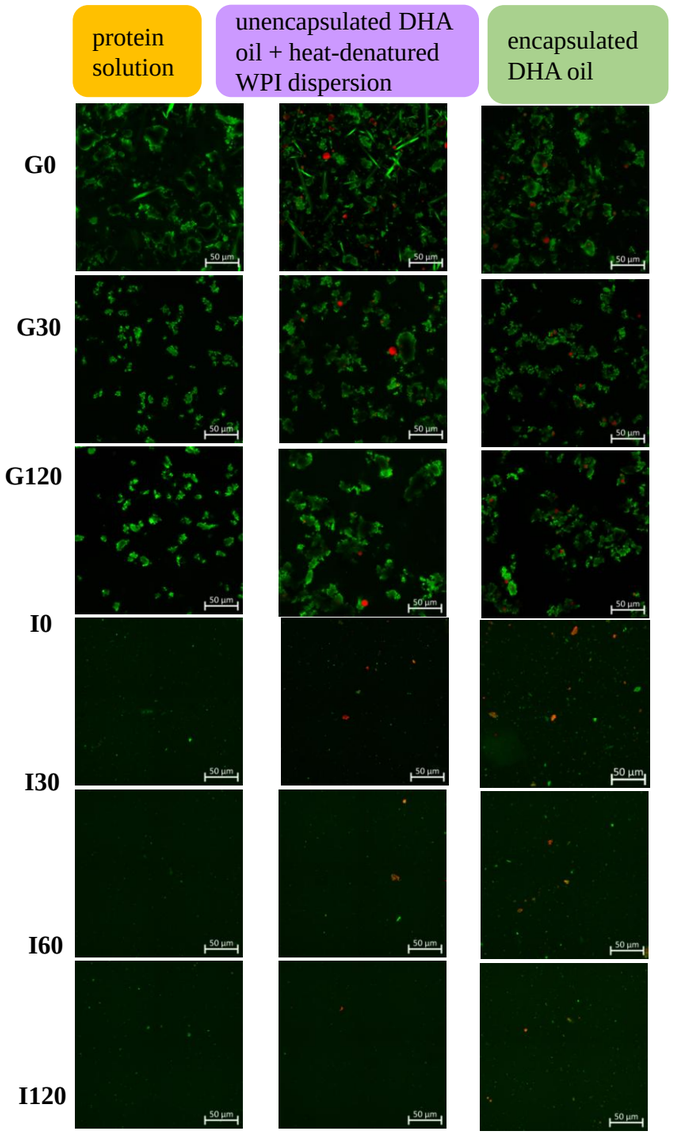
emulsion droplet size and distribution were uniforms

2. DHA oil profile in omelets

		[DHA] µg of FA/mg of sample	DHA % (of total FAs)	DHA from different lipid classes of total DHA (%)						
				TAG	1.2-DAG	1.3-DAG	MAG	FFA	PL	CE
omelet	heat-denatured WPI dispersion	0.5 ^{b} ± 0.0	0.6 ^{b} ± 0.1	Nd ^{b}	Nd ^{b}	Nd ^{b}	Nd	Nd	100.0 ± 0.0 ^{a}	Nd
	unencapsulated DHA oil + heat-denatured WPI dispersion	7.7 ^{a} ± 0.7	9.0 ^{a} ± 0.8	85.8 ± 1.2 ^{a}	7.5 ± 0.8 ^{a}	1.4 ± 0.2 ^{a}	Nd	Nd	5.4 ± 0.6 ^{b}	Nd
	encapsulated DHA oil	9.1 ^{a} ± 1.1	10.3 ^{a} ± 0.7	86.1 ± 2.1 ^{a}	8.3 ± 1.5 ^{a}	1.1 ± 0.1 ^{a}	Nd	Nd	4.5 ± 0.6 ^{b}	Nd

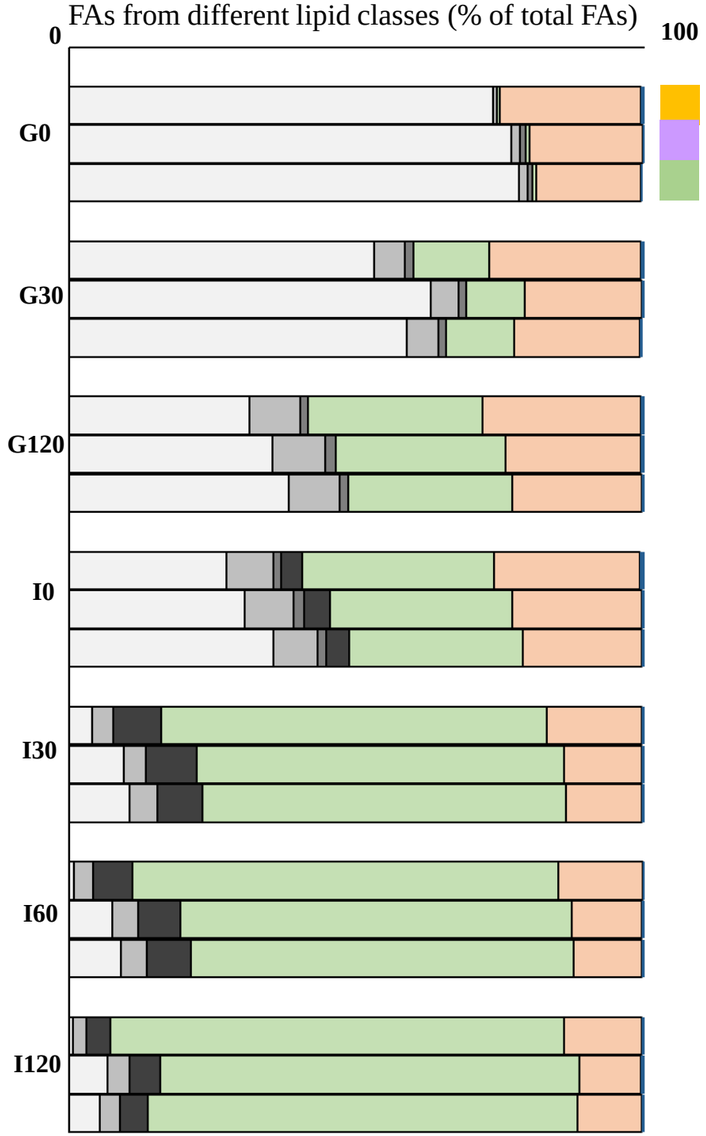
- DHA mainly existed in TAG, less DHA existed in 1.2-DAG, 1.3-TAG.
- Around 5% of DHA from egg, they existed in PL.
- Between unencapsulated DHA oil group and encapsulated DHA oil group, there was no significant difference in the percentage of DHA from different lipid classes of total DHA.

3. Distribution of DHA oil in omelets during the gastricintestinal phase



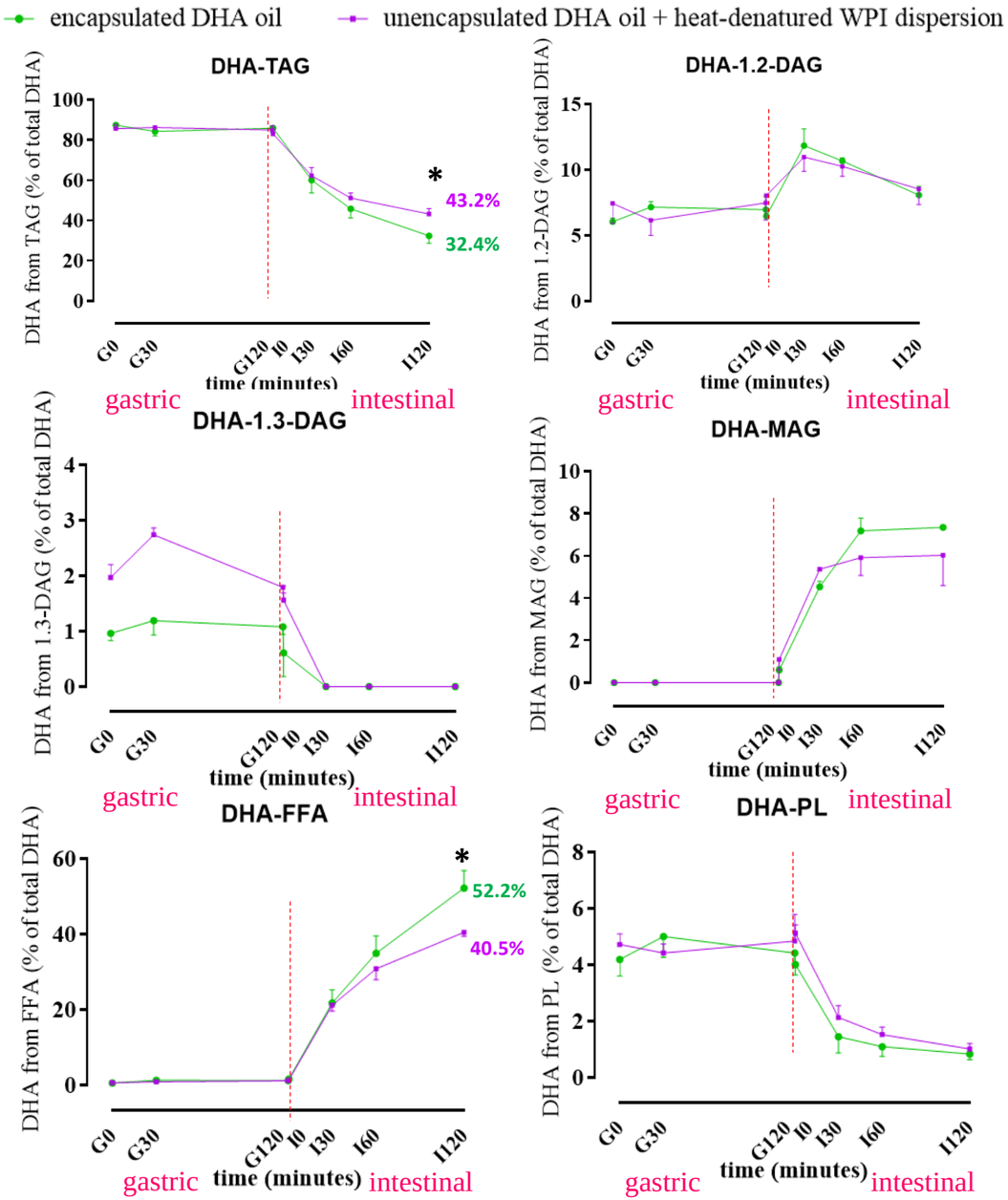
- Size and distribution of DHA oil droplets were uniform in encapsulated group, which is totally different from unencapsulated group.
- DHA oil hydrolysis happened in intestinal phase.

4. The evolution of different lipid classes in the gastrointestinal phase



- Hydrolysis of TAG around 56% in gastric phase; 41% in intestinal phase.
- In no DHA oil group, TAG were almost completely hydrolyzed; In DHA oil rich group, around 5% of TAG were not digested.

5. The evolution and bioaccessibility of DHA in the gastrointestinal phase



- Encapsulation group has a higher level of DHA-FFA.
- Smaller emulsion droplets have a relatively higher oil-water interfacial area available for the pancreatic lipase activity and facilitate lipolysis.

Conclusions

- The addition of DHA oil to the omelets did not affect the evolution of different lipid species during digestion.
- FFA release was no difference in both DHA enriched omelets.
- TAG contains DHA only can be hydrolyzed in intestinal phase because RGE cannot hydrolysis long chain FAs.
- Encapsulation improves the bioaccessibility of DHA.