Encapsulation of DHA oil improves the DHA bioaccessibility in vitro and affects the DHA metabolism to oxylipins in vivo

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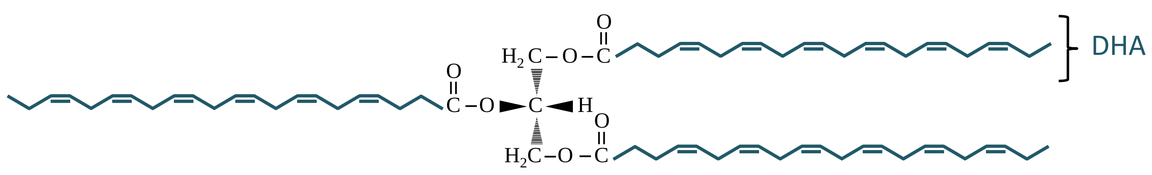
Context of the study

- Docosahexaenoic acid (DHA, 22:6n-3) is a polyunsaturated fatty acid (PUFA) belonging to the omega 3 familly, which is essential for brain and heart health.
- In western diet, the consumption of omega 3 PUFAs is too low, as compared to the intake of omega 6 PUFAs, which is currently too high. This situation leads to the metabolic unbalance between omega 3 and omega 6 PUFAs in cells.
- In this study, the strategy consists of the enrichment of food with DHA (here omelet with ~ 9% DHA) while avoiding oxidation in encapsulating DHA oil.

→ **Digestion of DHA oil was then assessed with a static model of digestion for adult (INFOGEST). The subsequent DHA metabolism was questionned by using a rat model by quantification of DHA derivatives (oxylipins) in tissues.**

DHA oil was composed of triacylglycerols (TAG) mainly esterified by DHA.



- DHA oil was encapsulated with heat-denatured whey protein isolate (WPI) as Pickering emulsion (**Fig 1A**), then incorporated into egg and cooked as omelet (**Fig 1B**).
- Three omelets were prepared : with only WPI (**Control**), with WPI and un-encapsulated DHA oil (**UN-DHA-O**) and with encapsulated DHA oil (**EN-DHA-O**).

for details of methods

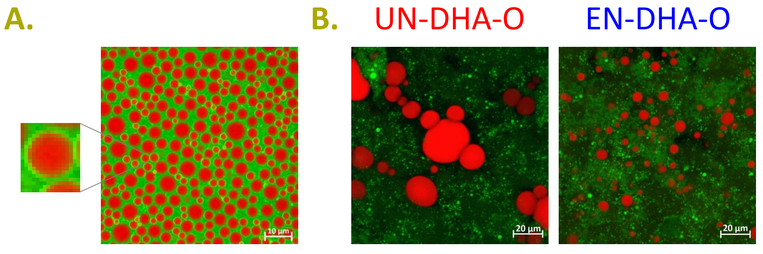


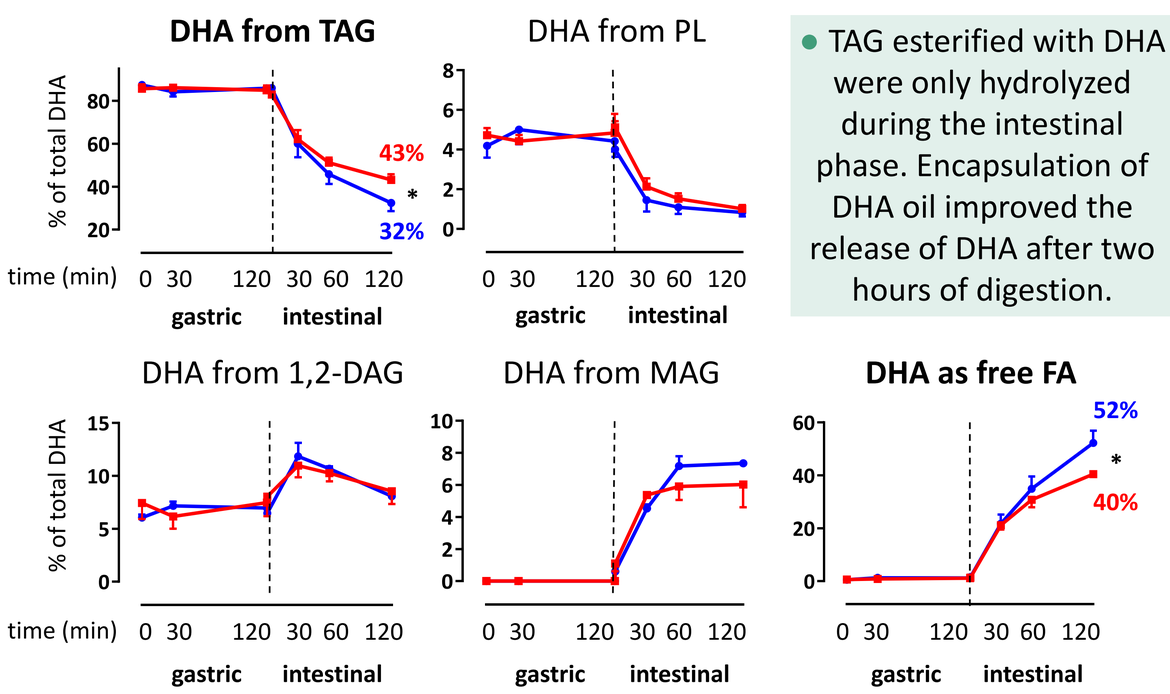
Fig 1. Pickering emulsion with DHA oil (A) and distribution of DHA oil in omelets (B). DHA oil (*red*) was stained by Nile red before encapsulation, whereas proteins (*green*) from WPI and eggs were dyed with Fast Green.

EN-DHA-O droplets, smaller than for UN-DHA-O, were uniformly dispersed in omelets with a regular droplet size distribution.

In vitro digestion of encapsulated DHA oil

Control
UN-DHA-O
EN-DHA-O

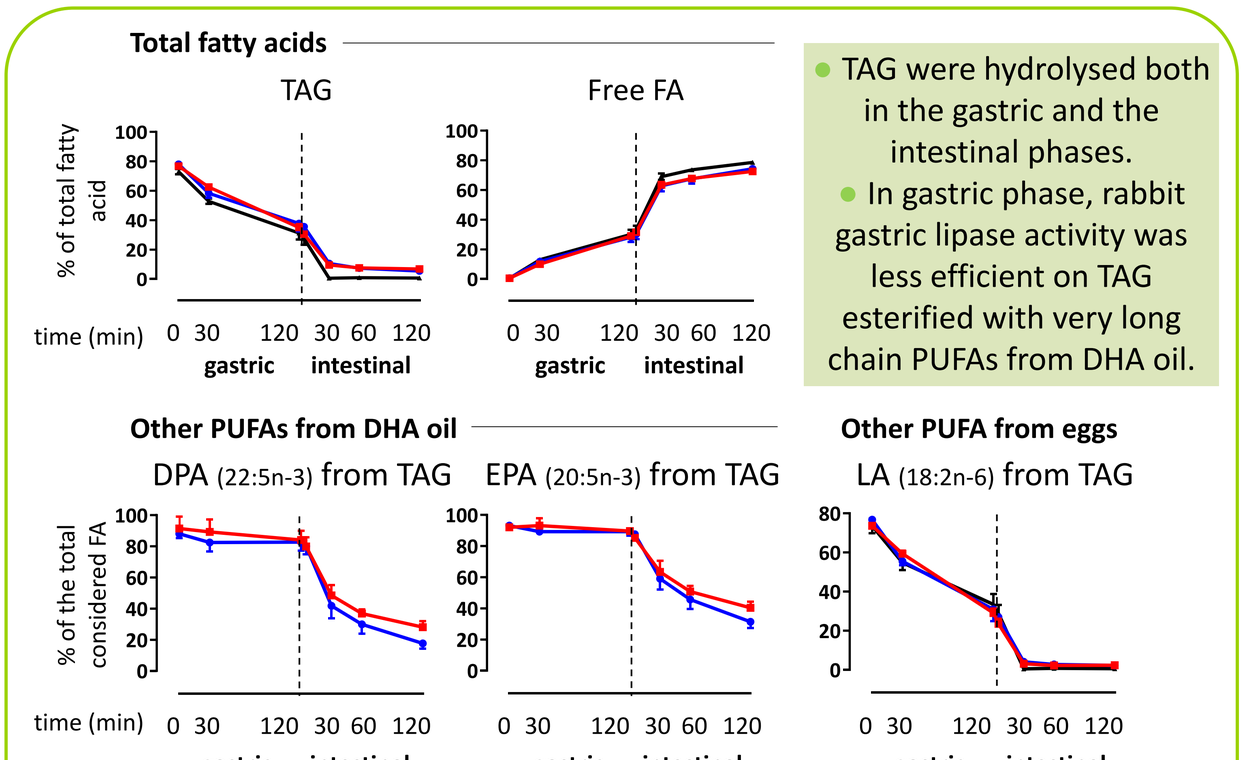
The DHA profile during the digestion



- TAG esterified with DHA were only hydrolyzed during the intestinal phase. Encapsulation of DHA oil improved the release of DHA after two hours of digestion.

Fig 2. The DHA proportions from the different lipid species during digestion.

Profile of the other fatty acids during the digestion



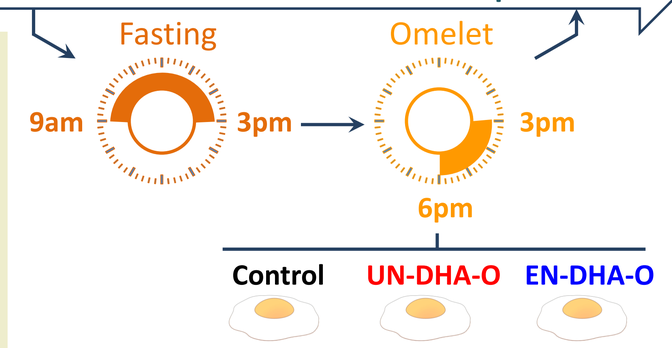
- TAG were hydrolysed both in the gastric and the intestinal phases.
- In gastric phase, rabbit gastric lipase activity was less efficient on TAG esterified with very long chain PUFAs from DHA oil.

Fig 3. The proportions of FA from DHA oil and from eggs.

In vivo metabolism of DHA to oxylipins

The experimental design and oxylipin profile of omelets

4-weeks old male rats — **4 weeks with a rodent diet *ad libitum* from 6pm to 9am**



Oxylipins are oxygenated derivatives of fatty acids synthesised either enzymatically or by non-enzymatic pathways. There were initially present in the DHA oil but also in eggs. They were partially destroyed by cooking omelets.

Table 1. The oxylipin profile of DHA oil and omelets.

		DHA oil	Omelets (ng/3 g omelet)		
	OXYLIPINS	(ng/mL)	**Control**	**UN-DHA-O**	**EN-DHA-O**
from omega 6	Sum of oxylipins	69.3	15.0	8.1	12.5
from omega 3	18-HEPE (EPA)	2.2	0.0	0.0	0.0
	17-HDoHE (DHA)	17.6	0.0	0.0	0.0
	14-HDoHE (DHA)	13.1	0.0	0.0	0.0

Bioavailibility of DHA and the oxylipin profile in tissues

DHA bioavailability

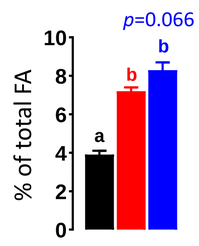


Fig 4. DHA in plasma.

- Bioavailibility of DHA tended to increase with encapsulation of DHA oil.
- The oxylipin profile changed with diets, depending on tissues and oxylipin families. Encapsulation of DHA oil increased oxylipins generated from DHA or EPA (minorly present in DHA oil) in tissues but not in plasma.

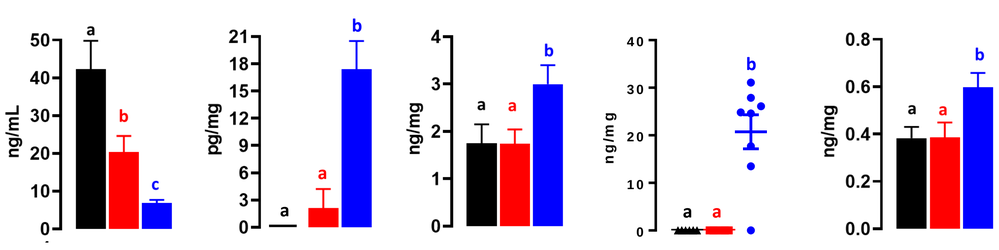


Fig 5. Oxilipins derived from omega 3 PUFAs quantified in tissues.

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