Encapsulating DHA oil promotes the digestion process in vitro and profoundly modifies the metabolism of DHA in vivo

Jun Wang, Jordane Ossemond, Yann Le Gouar, Françoise Boissel, Didier Dupont, Frédérique F. Pédrono

ICFD 2024
9-11 April 2024
Porto, Portugal
P159

Encapsulating DHA oil promotes the digestion process *in vitro* and profoundly modifies the metabolism of DHA *in vivo*

Jun Wang, Jordane Ossemond, Yann Le Gouar, Françoise Boissel, **Didier Dupont**, Frédérique Pédrono

INRAE, L'Institut Agro Rennes-Angers, STLO, 35042 Rennes, France

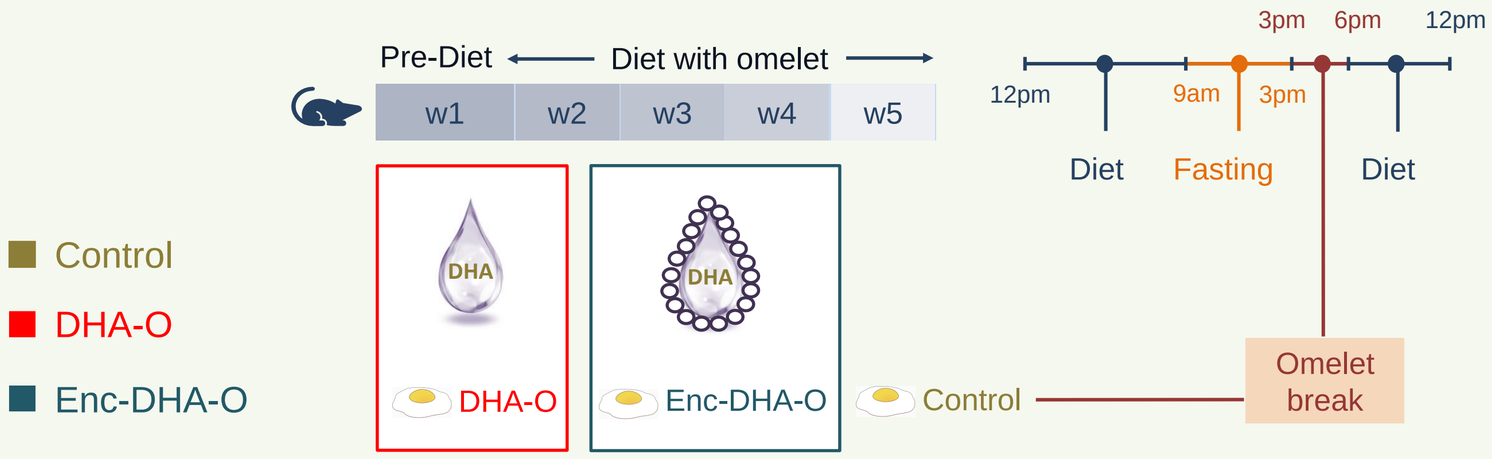
Introduction

Modifying the structure of a food determines its metabolic fate. Indeed, a nutrient delivered by encapsulation will have a different digestion dynamic, which may result in early or delayed release, and can then modulate nutrient metabolism and physiological effects.

The project is based on the encapsulation of docosahexaenoic acid (DHA) oil with milk proteins. DHA is a valuable fatty acid, important for the development and maintenance of brain, heart and visual functions. When DHA oil is encapsulated, *in vitro* digestion shows that the bioaccessibility of DHA has been considerably enhanced, inducing a greater release of DHA (1). Based on this observation, the model was tested *in vivo* to see the impact of encapsulation on DHA metabolism.

Methods

An oil consisting of triglycerides highly enriched in DHA (Polaris, France), was encapsulated with whey proteins to form Pickering emulsions (2). The emulsion or crude DHA oil was then cooked in an omelette. Omelettes containing encapsulated or non-encapsulated DHA oil (25 mg of DHA per day) were administered to young rats of 4-weeks old (n=8) for 4 weeks to observe the metabolic effects. Particularly oxylipins and endocannabinoids were measured by liquid chromatography combined with tandem mass spectrometry (MetaToul-Lipidomic platform, Toulouse, France).

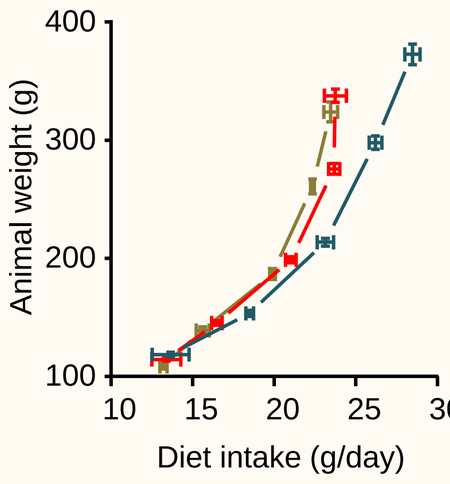


Results

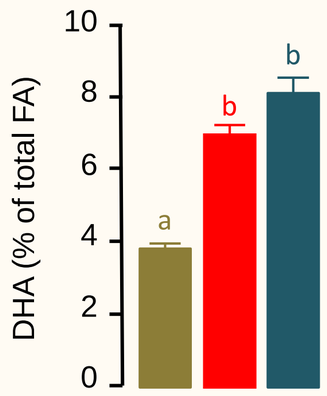
DHA AND ANIMAL BEHAVIOUR

① Food intake and water consumption

② Growth of animals



③ DHA in plasma

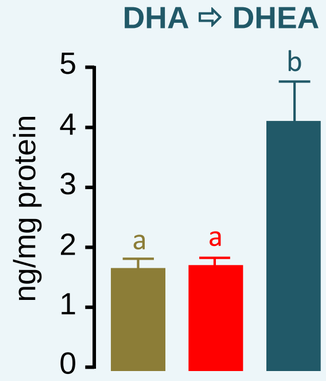


DHA oil encapsulation increased animal feed intake and consequently growth. During the omelet break, DHA, encapsulated or not, reduced water consumption.

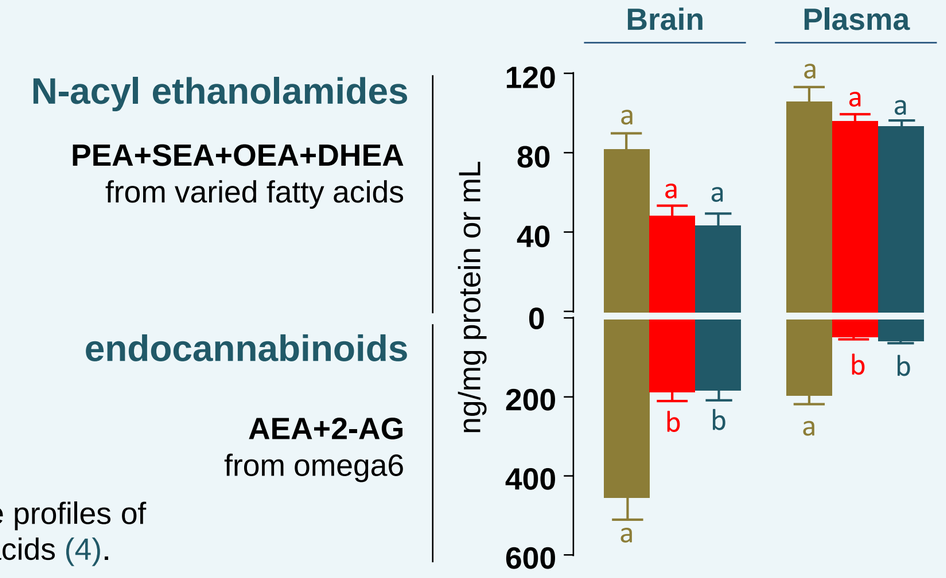
At the same time, the bioavailability of DHA tended to increase with the encapsulation of DHA oil.

ENDOCANNABINOIDS DERIVED FROM FATTY ACIDS

④ DHEA in Heart



⑤ Brain and Plasma Endocannabinoidome



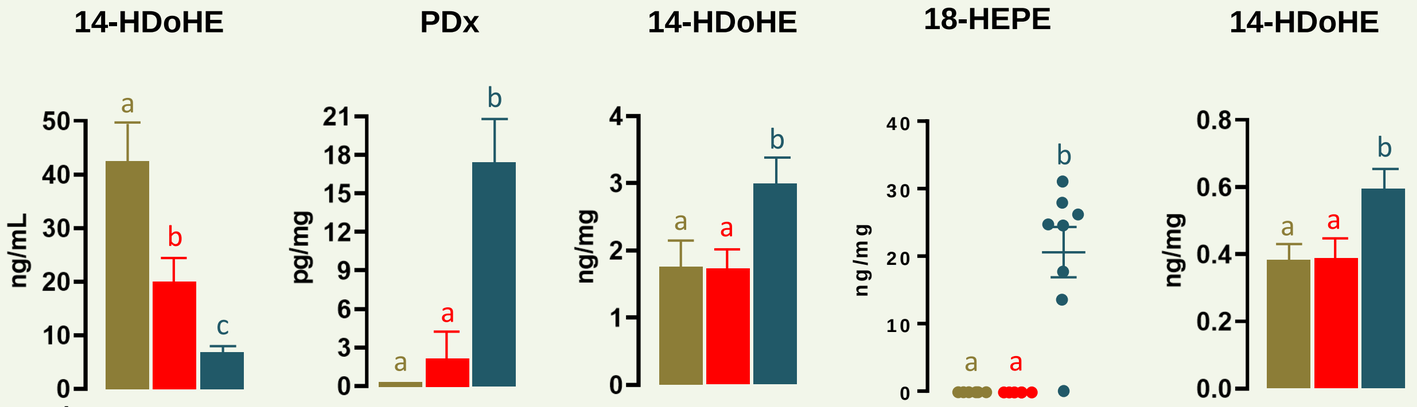
Administration of DHA oil modified the profiles of endocannabinoid derivatives of fatty acids (4).

Endocannabinoids and N-acylethanolamides were greatly reduced in plasma and brain, but without the impact of DHA encapsulation. The heart showed a different pattern, with an increase in DHEA from DHA, specifically when DHA oil was encapsulated.

OXYLIPINS DERIVED FROM FATTY ACIDS

⑥

plasma	heart			brain
from DHA	from DHA		from EPA	from DHA
14-HDoHE	PDx	14-HDoHE	18-HEPE	14-HDoHE



Administration of DHA oil significantly altered the profiles of oxygenated fatty acid derivatives, drastically reducing the overall levels of omega-6-derived oxylipins in the plasma and the heart, but not in the brain (3). This effect was greatly accentuated when the DHA oil was encapsulated. On the other hand, DHA-derived oxylipins were increased overall in the heart and brain, even more so when the DHA oil was encapsulated.

Conclusion

In conclusion, these results show that modifying the food structure allows a nutrient to be delivered differently, and thus to modify not only its digestion process but also its subsequent metabolism.

They also highlight the fact that the impact of the food structure may not really influence the levels of the target nutrient in the body, but may completely affect its metabolism into lipid derivatives, which must be investigated and quantified.

(1) Wang J et al. Food Res. Int. 162 (Pt B):112112, 2022. (2) Wang J. et al. Int. Dairy J., 110, 104815-104824, 2020. (3) Wang J. et al. Nutrients, 15(21), 4622, 2023. (4) Wang J. et al. Front. Nutr. Jan 2022 13;8:812119. doi: 10.3389/fnut.2021.812119.