

Lipids and proteins bioaccessibility in DHA-enriched fortified infant flours and formulas using a static in vitro 6-month-old infant digestion model

Mathilde Cancalon, Marine Tournaux, Youna Hemery, Pauline Pinel, Mélina Robert, Valérie Micard, Erwann Durand, Bruno Baréa, Nathalie Barouh, Pierre Villeneuve, et al.

▶ To cite this version:

Mathilde Cancalon, Marine Tournaux, Youna Hemery, Pauline Pinel, Mélina Robert, et al.. Lipids and proteins bioaccessibility in DHA-enriched fortified infant flours and formulas using a static in vitro 6-month-old infant digestion model. 8th International Conference on Food Digestion, Apr 2024, Porto, Portugal. 10.15454/1.5572338990609338E12). hal-04548227

HAL Id: hal-04548227

https://hal.science/hal-04548227

Submitted on 16 Apr 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers. L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Mathilde Cancalon, Marine Tournaux, Youna Hemery, Pauline Pinel, Mélina Robert, Valérie Micard, Erwann Durand, Bruno Baréa, Nathalie Barouh, Pierre Villeneuve and Claire Bourlieu Lacanal*

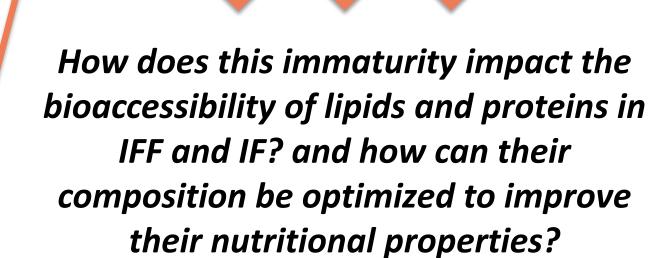
mathilde.cancalon@inrae.fr; claire.bourlieu-lacanal@inrae.fr

CONTEXT

WHO recommandations Infant follow-on formulas (IFF) Exclusive breastfeeding for the first six months of life, followed by Used as breast complementary breastfeeding up to milk substitute the age of two years (human milk is the most suitable nutrient WHO, 2021 source for infants) Infant flours (IF) Used as a complementary of infant food to start diversification breastfed at from 6 months onwards 6-months WHO, 2022

Digestive immaturity of 6-months infants

Characterized by limited secretory capacity and enzymatic activity affecting nutrients bioaccessibility



AIM OF THE STUDY

Assess the bioaccessibility of lipids and proteins in optimized IF and IFF (IF_REF and IFF_REF) in terms of oxidative stability and nutritional composition in comparison with commercial products using a static in vitro 6-month-old infant digestion model



EXPERIMENTAL STRATEGY



parameters that improve both oxidative stability and nutritional properties

Cancalon et al., Food Chem, 2023 Cancalon et al., EJLST, 2023

In vitro digestion of optimized IF and IFF _____

Evaluation of the nutrients bioaccessibility using an in vitro digestion model mimicking the digestive conditions of a 6-month-old infant

Overview of the nutritional values IF and IFF Dataset of the nutritional values of 96 IF and 91 IFF

Cancalon et al., Data gouv, 2023 Cancalon et al., Data in brief, 2023

Selection of optimized IF and IFF

IF and IFF with improved nutritional and stability properties

Teff



Cowpea

% of FFA released (w/w)

Soy





* ARA: Arachidonic acid C20:4 ω6,

DHA: Docosahexaenoic acid C22:6 ω3

IFF_OP composition

Oil phase:

Dairy fat, rapeseed, sunflower, oleic

sunflower oils and rich in ARA* & DHA*

Emulsifier:

Dairy phospholipid

Aqueous phase:

Lactose/Maltodextrine (50:50)

Whey protein/Casein (40:60)

Static in vitro model adapted to the digestive conditions of a 6-month-old infant

No Oral phase: short residence time of food in mouth

GASTRIC PHASE

60 min, 37°C, pH = 3 Meal/Digestive fluid ratio of 50:50 Pepsin: 295 U/mL, Lipase: 22 U/mL

INTESTINAL PHASE

120 min, 37°C, pH = 7 Meal/Digestive fluid ratio of 25:75 Lipase: 90 U/mL, Bovine bile: 3.1 mM

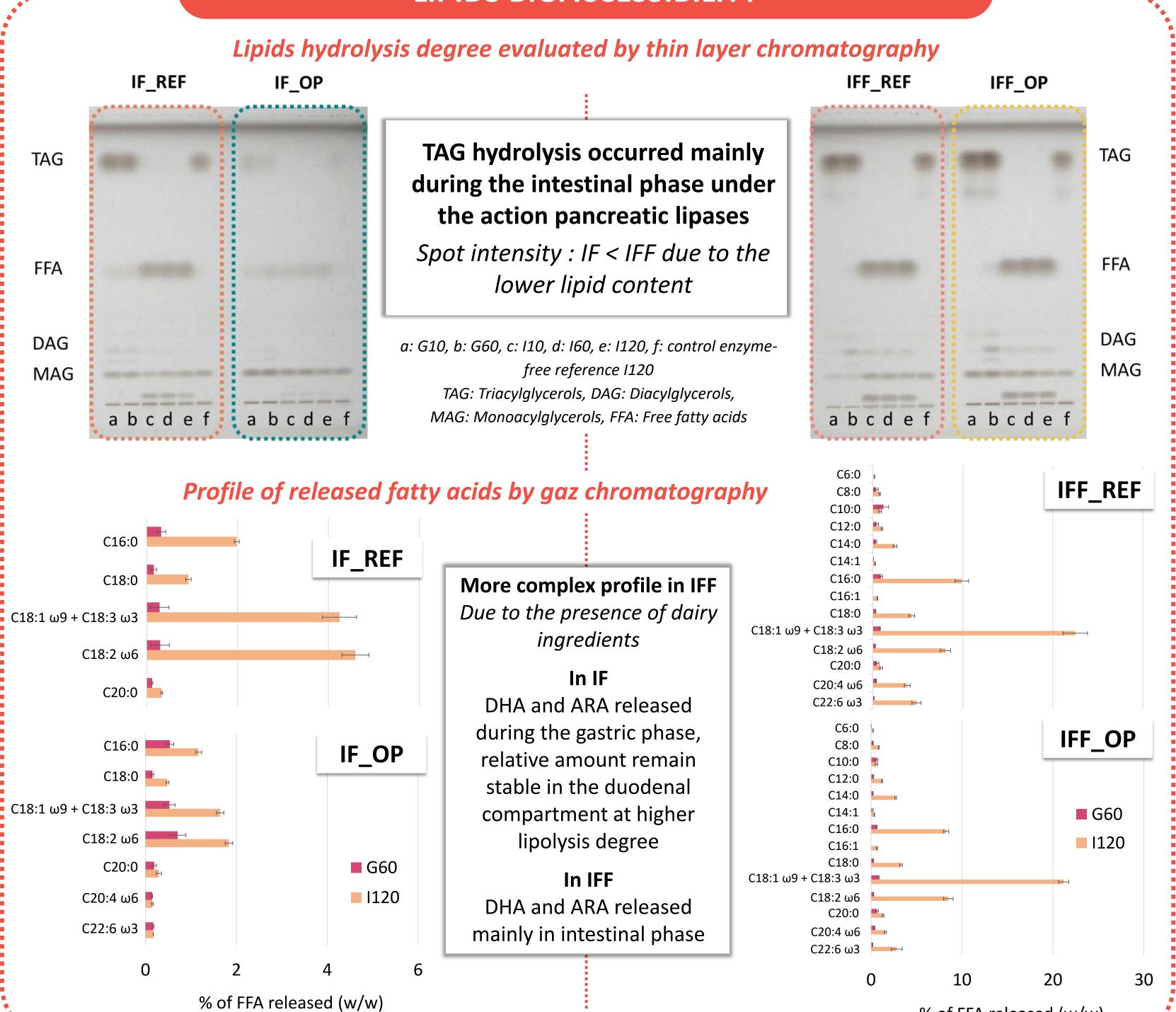
Bourlieu et al., Crit. Rev. Food Sci. Nutr., 2014 Minekus et al., Food Funct., 2014 Ménard et al., Food Chem., 2018

RESULTS

.

		IF_REF	IF_OP	IFF_REF	IFF_OP
Fatty acid profile (g/100 mL of IFF or IF)	Total lipids	1.0	0.4	3.1	3.4
	SFA	$\boldsymbol{0.40 \pm 0.05}$	0.13 ± 0.00	0.98 ± 0.05	$\textbf{0.92} \pm \textbf{0.05}$
	MUFA	$\textbf{0.23} \pm \textbf{0.01}$	$\boldsymbol{0.07 \pm 0.00}$	$\textbf{1.24} \pm \textbf{0.07}$	$\boldsymbol{1.32 \pm 0.07}$
	PUFA	$\textbf{0.32} \pm \textbf{0.01}$	$\boldsymbol{0.18 \pm 0.01}$	0.56 ± 0.03	$\boldsymbol{0.58 \pm 0.03}$
	LA C18:2 ω6	$\boldsymbol{0.30 \pm 0.01}$	$\textbf{0.11} \pm \textbf{0.00}$	0.46 ± 0.03	$\boldsymbol{0.49 \pm 0.03}$
	ALA C18:3 ω3	0.03 ± 0.00	0.02 ± 0.00	0.06 ± 0.00	0.05 ± 0.00
	ARA C20:4 ω6	-	0.02 ± 0.00	0.01 ± 0.00	$\textbf{0.02} \pm \textbf{0.00}$
/ 8)	DHA C22:6 ω3	-	0.03 ± 0.00	0.02 ± 0.00	0.02 ± 0.00
	ω6/ω3 ratio	10.9	2.5	5.7	8.1
Total tocopherols (ppm)		1105.8 ± 13.9	$\textbf{1033.6} \pm \textbf{17.2}$	595.5 ± 18.8	366.3 ± 10.8
Droplet mode (µm)		-	-	0.47 ± 0.00	$\boldsymbol{0.86 \pm 0.08}$
Viscosity (mm/30 s)		$\textbf{112.7} \pm \textbf{5.0}$	93.7 ± 10.0	-	_

LIPIDS BIOACCESSIBILITY



Trypsin inhibitory activity in infant flours (mg/g of IF dry base)

	Before cooking	After cooking
IF_REF	$\boldsymbol{9.0 \pm 0.1}$	N.D.*
IF_OP	$\textbf{55.2} \pm \textbf{1.2}$	N.D.

of antitrypsin factors during cooking

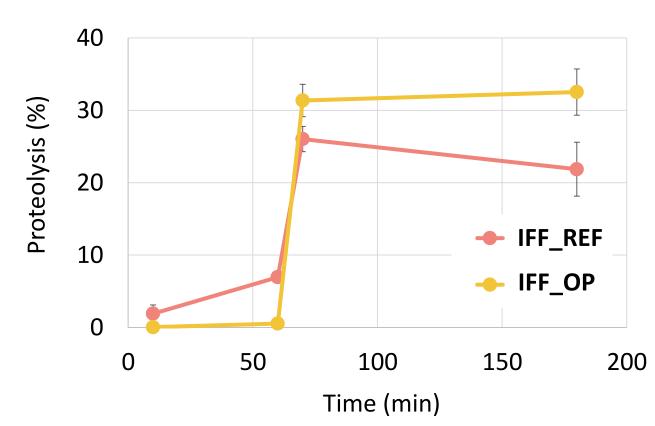
.............

PROTEINS BIOACCESSIBILITY

Protein hydrolysis degree evaluated by released NH₂ out of total using ninhydrin assay IF_REF → IF_OP

150 200 Time (min)

*N.D.: not detected



Moderate levels of intestinal proteolysis (less than 40% released NH₂ out of total) Influenced by large droplet mode in IFF_OP and the presence of anti-nutritional factors in IF_OP

TOCOPHEROLS BIOACCESSIBILITY

Percentage of bioaccessible tocopherols after 120 minutes digestion

IF_OP IFF_REF IFF_OP IF_OP Low tocopherols bioaccessibility Low in comparison with the study of 20.7 ± 0.7 N.D. 15.4 ± 3.6 7.1 ± 3.1 Reboul, Richelle et al. (JAFC, 2006)





The optimized IFF and IF subjected to in vitro digestion present overall good FA and LC-PUFA (including DHA) bioaccessibility. However a limited proteolysis was observed (NH₂ released < 40% out of total) and 7-20 % tocopherols bioaccessibility. This approach should be investigated further but has to be bear in mind to have global multicriteria optimization approaches when optimizing infant foods.









