Supplementary Materials

Postprandial variability in plasma long-chain omega-3 is independent of supplement lipid structure

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Supplementary Table 1. Study details of the LC omega-3 postprandial studies grouped by the type of lipid supplement

Supplement type	Dose & subject details	Study details	Postprandial CV for the AUC/iAUC	Comments	Reference
TAG oils					
TAG (fish oil)	1700 mg EPA+DHA, n=15 (8F, 7M) healthy adults from northern Finland.	72-h study, with breakfast (29g fat), standardised lunch, dinner and supper.	CV for iAUC Plasma PL EPA+DHA 59.2±22.2 (SD), CV= 38% Plasma TAG EPA+DHA 35.0±26.5 (SD) CV= 76% (iAUC % x h).	Nine adverse events: 1 after fish oil, 5 after krill meal and 3 after the fish oil (note double entries for fish oil which might be an error). Most events were classified as mild and included loose stools.	Kohler et al[12]
Re-esterified fish oil, (rTAG)	1680mg EPA+DHA, n= 12 (M) healthy adult from Germany.	72-h study, capsules with breakfast (30.1g fat). Standardized meals consumed throughout study.	CV for AUC Plasma PL EPA+DHA, 59.8±36.8 (SD), CV= 62%. (AUC - % x h).	Adverse events not mentioned	Schuchardt et al[15]
TAG (blended fish oil)	452 mg EPA+DHA, n=20 (10F, 10M) healthy young adults from the UK.	8-h study with breakfast (49.5g fat).	CV for iAUC F: Plasma TAG EPA+DHA 63.1±10.8 (SEM) (SD 48.2), CV= 76% M: Plasma TAG EPA+DHA 84.4±7.4 (SEM) (SD 31.7), CV= 38% F: Plasma PC EPA+DHA 159.9±25.1 (SEM) (SD 112.2), CV= 70% M: Plasma PC EPA+DHA 167.7±30.3 (SEM) (SD 135.4) CV= 81% (iAUC umol/L x h).	No reported adverse effects were reported during trial	West et al [16]
TAG (fish oil)	4.5g fish oil (19.8% EPA, 7.9% DHA, 1247mg EPA+DHA), n=7 healthy subjects from the UK.	24-h study, no breakfast.	CV for AUC Plasma EPA 25.3±11.2 (SD), CV= 44% (no units provided for AUC)	Did not report any adverse effects	Wakil et al [17]
PL-rich oils					
PL-rich (Krill oil)	1700 mg EPA+DHA as krill oil, n=15 (8F, 7M) healthy adults from northern Finland.	72-h study, with breakfast (29g fat), standardized lunch, dinner and supper	CV for iAUC Plasma PL EPA+DHA 89.1±33.4 (SD), CV= 38% Plasma TAG EPA+DHA 24.5±17.6 (SD), CV= 76% (iAUC % x h).	Adverse events mild. One subject reported increased defecation.	Kohler et al [12]

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Supplement type	Dose & subject details	Study details	Postprandial CV for the AUC/iAUC	Comments	Reference
PL-rich oils					
PL-rich (Krill oil)	1680mg EPA+DHA, n= 12 M healthy. from Germany.	A 72-h study, capsules with breakfast (30.1g fat). standardized meals consumed throughout study.	CV for AUC Plasma PL EPA+DHA 80.0±34.7 (SD), CV= 43% (AUC % x h).	KO had high FFA levels containing EPA and DHA (22%, 19% of total content, respectively). Adverse events not mentioned	Schuchardt et al [15]
PL-rich (Krill oil)	206mg EPA+DHA, n=24 (14F, 10M), healthy subjects from USA (48% non-Hispanic/Other, 52% Hispanic/Latino).	A 24-h study, no breakfast just water. Low fat lunch/dinner	CV for iAUC Plasma EPA+DHA 448±248 (SD) CV = 55% (iAUC nmol/ml x hr)	One adverse event - upper resp tract inf. – judged to be unrelated to treatment.	Guarneiri et al [18]
PL-enhanced Fish oil	337mg EPA+DHA, n=24 (14F, 10M), healthy subjects from USA (48% non-Hispanic/Other, 52% Hispanic/Latino).	A 24-h study, no breakfast just water. Low fat lunch/dinner	CV for iAUC Plasma EPA+DHA 440±286 (SD) – CV = 65% (iAUC nmol/ml x hr)	One adverse event - upper resp tract inf. – judged to be unrelated to treatment.	Guarneiri et al [18]
PL-rich (Krill oil)	1.02g EPA, 0.54g DHA, n=10 (10M), healthy subjects from Germany.	A 10-hr study, 55g breakfast	CV for iAUC Plasma EPA 137±39 (SD), CV= 28% Plasma DHA 70±39 (SD), CV= 56% (iAUC ug/ml/hr)	Adverse events not mentioned	Kagan et al [19]
Polar rich algal oil (incl. glycolipids & PC)	1.5g EPA, n=10 (M), healthy subjects from Germany.	A 10-hr study, 55g breakfast	CV for iAUC Plasma EPA 277±135 (SD), CV= 49% Plasma DHA 65±45 (SD) CV= 69% (iAUC ug/ml/hr)	Adverse events not mentioned	Kagan et al [19]

Supplementary Table 1. Study details of the LC omega-3 postprandial studies grouped by the type of lipid supplement (cont.)

Supplement type	Dose & subject details	Study details	Postprandial CV for the AUC/iAUC	Comments	Reference
FFA					
FFA (Epanova)	4 x 1g cap of each type. FFA contained 0.55g EPA, 0.22g DHA/g. Dose = 2200mg EPA, 880 mg DHA, n=26 healthy subjects from USA (3 non-Hispanic/Other, 23 Hispanic/Latino).	24-h study, low fat breakfast (<10%en fat). The study was conducted at the end of 2-week trial taking 4g FFA/day.	CV for iAUC Plasma EPA + DHA geom mean 19.1, CV= 34% (iAUC nmol x hr/ml)	Adverse events not mentioned.	Offman et al [20]
FFA (OM3-FFA)	1748mg EPA + 1516mg DHA as FFA, n=24, (15F/9M) normal healthy adults (but finished with n=21-23/group) from Switzerland.	A 24-h study. No breakfast but fat-free lunch & dinner.	CV for AUC Plasma EPA 1496±734 (SD), CV= 49% Plasma DHA 1356±676 (SD), CV= 50% (AUC nmol-h/ml).	There were 22 adverse events (mild) reported by 11 subjects including nausea, diarrhoea, headache.	Cuenoud et al [21]
FFA (OM3-CA) probably EPANOVA	4g EPA+DHA as FFA, n=14 (7F/7M), healthy Chinese subjects.	A 24-h study; supplements consumed with low fat (<10%) breakfast.	CV for iAUC Plasma EPA 975.6±517.3 (SD), CV= 53% Plasma DHA 273.6±144 (SD), CV= 53% (iAUC h x ug/mL)	In a continuation of the postprandial study, subjects were provided supplement for 14 days, and 6/14 subjects reported at least one mild adverse event (diarrhoea).	Jing et al [22]
MAG					
MAG (Maxsimil 3020)	3000 mg EPA+DHA (1800 mg EPA, 1200mg DHA), n=20 (10F, 10M), healthy subjects from Canada	A 24h study, with breakfast 20% fat	CV for AUC Plasma EPA+DHA 89.6±17.0 (SD), CV= 19%. (AUC mg/dl x h)	Did not mention of adverse events. Did not mention positional distribution of MAG.	Chevalier and Plourde [23]

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Supplement type	Dose & subject details	Study details	Postprandial CV for the AUC/iAUC	Comments	Reference
MAG					
MAG Enzymatically produced oil followed by distillation, with EPA main FA.	4.5g MAG oil (19.8% EPA, 7.9% DHA; 1247mg EPA+DHA), n=7 healthy subjects from the UK.	A 24hr study, no breakfast	CV for AUC Plasma EPA 13.4±12.5 (SD), CV= 93%. (no units provided)	Did not report any adverse effects	Wakil et al [17]
1(3)-MAG	1655mg EPA + 1275mg DHA, n=24, (15F/9M) normal healthy adults (but finished with n=21-23/group) from Switzerland.	A 24-h study. No breakfast but fat-free lunch & dinner.	CV for AUC Plasma EPA 1486±626 (SD), CV= 42% Plasma DHA 1206±600 (SD), CV= 50% (AUC nmol-h/ml).	There were 22 adverse events (mild) reported by 11 subjects including nausea, diarrhoea, headache.	Cuenoud et al [21]
Ethyl esters (EE)					
Ethyl esters (Lovanza)	1860mg EPA, 1500mg DHA. n=26/arm (10F, 16M), healthy subjects from USA (4 non-Hispanic/Other, 22 Hispanic/Latino).	A 24-h study, low fat breakfast (<10%en fat) postprandial study treatment conducted at the end of 2-week trial.	CV for iAUC Plasma EPA + DHA 3.32, SD not provided, but CV was reported as 76%. (iAUC nmol x hr/ml)	Adverse events not mentioned	Offman et al [20]
Ethyl esters (fish oil origin)	680mg EPA+DHA, n=30 (20F,10M) from Australia.	A 24hr study, with breakfast (2g fat)	CV for iAUC Plasma EPA+DHA 150.2±40.5 (SEM) (221 SD), CV = 147%. (units not supplied)	Adverse events not mentioned	Bremmell et al [24]
Ethyl esters (GmbH)	1680mg EPA+DHA, n= 12 healthy M . from Germany.	A 72-h study, capsules with breakfast (30.1g fat). standardized meals consumed throughout study.	CV for AUC Plasma PL EPA+DHA: 47.5±38.4 (SD), CV= 81% (AUC % x h).	Adverse events not mentioned.	Schuchardt et al [15]
Ethyl esters (Omacor)	Ethyl esters 3080mg (1700mg EPA, 1380mg DHA), n=24, F15/M9 normal healthy adults (but finished with n=21-23/group) from Switzerland.	A 24-h postprandial study. No breakfast but fat-free lunch & dinner.	CV for AUC Plasma EPA: 163±252 (SD), CV= 154% Plasma DHA: 562±695 (SD), CV= 124% (AUC nmol-h/ml).	There were 22 adverse events (mild) reported by 11 subjects including nausea, diarrhoea, headache.	Cuenoud et al [21]

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Supplement type	Dose & subject details	Study details	Postprandial CV for the AUC/iAUC	Comments	Reference
Ethyl esters (EE)					
Ethyl esters (Omacor)	1000mg ethyl esters omega-3, n=12 (M) healthy adults from Republic of Korea.	A 72-h study, breakfast, 15-20% fat 20 min before single dose of capsules with 200mL water.	CV for AUC Plasma EPA 914±464 (SD), CV= 41% Plasma DHA 404±216, CV= 53% (AUC ug/ml x h).	No adverse events were reported	Kang et al [25]
Ethyl esters	3360mg EPA+DHA, n=40 (20F/20M) healthy adults from Switzerland and the UK.	A 48-h study, no breakfast, capsules consumed with water, but low-fat lunch (<15g) and standard meals thereafter.	CV for iAUC Plasma EPA+DHA 46.96±31.05 (SD), CV= 66%. (iAUC ug x h/mL/g).	No adverse events were reported.	Qin et al [26]
Ethyl esters (Lovaza)	840mg EPA+DHA as EE, n= 18 (9F, 9M) from USA.	A 72-h study, breakfast with 23g fat	CV for iAUC Plasma EPA+DHA 764±93 (SEM) (395 SD), CV= 52%. (iAUC ug x h/mL)	No significant changes in GI symptoms over study period	Cook et al [27]
Ethyl esters (no brand mentioned)	3g EPA+DHA 1800 mg EPA, 1200mg DHA, n=20 (10F, 10M), healthy subjects from Canada.	A 24h study, with breakfast 20% fat	CV for AUC Plasma EPA+DHA 38.4±12.4 (SD), CV = 32%. (AUC mg/dl x h)	Did not mention of adverse events.	Chevalier and Plourde [23]
EPA and DHA ethyl esters (KD Pharma)	2024mg EPA, 1921 mg DHA (oil form), n=10 (M) healthy subjects from Germany.	A 72-h cross-over study, with breakfast (36.6g fat)	CV for iAUC EPA: Plasma EPA 2461±279 (SEM), 882 SD, CV= 36% DHA: Plasma DHA 1021±170 (SEM), 538 SD, CV= 53% (iAUC ug/ml)	No adverse effects were reported.	Smieta et al [28]
Wax ester					
Wax ester (Calanus finmarchicus oil)	4g oil containing 260mg EPA and 156 mg DHA, n= 18 (9F, 9M) from USA.	A 72-h study, breakfast with 23g fat	CV for iAUC Plasma EPA+DHA 931±92 (SEM) (391 SD), CV= 42%. (iAUC ug x h/mL)	No significant changes in GI symptoms over study period	Cook et al [27]

Supplementary Table 1. Study details of the LC omega-3 postprandial studies grouped by the type of lipid supplement (cont.)

Supplement type	Dose & subject details	Study details	Postprandial CV for the AUC/iAUC	Comments	Reference
EE or TAG with enhanced emulsification properties					
Self-emulsifying drug delivery system, Aquacelle ethyl esters	680mg EPA+DHA Aquacelle EE n=30 (18F, 12M), healthy subjects from Australia.	A 24-hr study, with breakfast (2g fat)	CV for AUC Plasma EPA+DHA 460.3±69.8 (SEM) (381 SD), CV = 83% (units were not supplied)	Adverse events not mentioned	Bremmell et al [24]
Ethyl esters of omega-3 with enhanced solubility	580mg novel liquid microcrystalline nanoparticle ethyl esters of omega-3, n=12 (M) healthy adults from Republic of Korea.	A 72-h study, breakfast, 15-20% fat 20 min before single dose of capsules with 200mL water.	CV for AUC Plasma EPA 929±285 (SD), CV= 31% Plasma DHA 541±287, CV= 53% (AUC ug/ml x h).	No adverse events were reported.	Kang et al [25]
Ethyl esters with self microemulsifying delivery system (SMEDS) containing ethyl esters	1680mg EPA+DHA, n=40 (20F/20M) healthy adults from Switzerland and the UK.	A 48-h study, no breakfast, capsules consumed with water, but low-fat lunch (<15g) and standard meals thereafter.	CV for iAUC Plasma EPA+DHA 358±141 (SD), CV= 39% (iAUC ug x h/mL/g).	No adverse events were reported	Qin et al [26]
TAG either enteric coated or as microencapsulated emulsified form (LipoMicel, LMF)	Single meal, cross-over study. The standard and enteric-coated capsules contained 600mg omega-3 (400mg EPA + 200mg DHA); the microencapsulated form contained 374mg omega-3 (200mg EPA; 133 mg DHA; 41 mg DPA)., n=12 healthy adults (gender not specified) from Canada.	A 24-h study with breakfast (bagel, cream cheese, jam); lunch and dinner provided (no details)	CV for iAUC Blood total LC omega-3 Standard capsule 1498.9±443 (SEM), 1534 SD, CV=102% Enteric-coated capsule 2057.2±813.7 (SEM), 2819 SD, CV= 137% Microencapsulated capsule 16150±5454 (SEM), 18892 SD, CV= 117%. (iAUC ng/mL x h)	No side effects were reported during the study.	Ibi et al [29]

Supplementary Table 1. Study details of the LC omega-3 postprandial studies grouped by the type of lipid supplement (cont.)

Supplement type	Dose & subject details	Study details	Postprandial CV for the AUC/iAUC	Comments	Reference
Whole Foods					
Whole food (herring) rich in omega-3 TAG	Single meal, cross-over study. The meals contained 3.2g omega-3 (baked herring) and 2.7g omega-3, (pickled herring). n=17 (M) overweight subjects from Sweden.	A 7-h study, meal of baked or pickled herring (29g fat, EPA+DHA 22% in baked herring and 18% in pickled herring).	Baked herring -CV for iAUC Plasma EPA 108.3± 14.5 (SEM) (59.8 SD), CV= 56% Plasma DHA 120.0± 20.0 (SEM) (82.5 SD), CV= 68% Pickled herring – CV for iAUC Plasma EPA 93.9±10.8 (SEM) (44.5 SD), CV= 48% Plasma DHA 101.1±13.3 (SEM) (54.8 SD), CV= 54% (iAUC mg/L x h).	Did not report side effects.	Svelander et al [30]
Butter or sunflower oil supplemented with fish oil TAG	Single meal, cross-over study. The meals contain 1.9g omega-3 plus either 38g butter or 32g sunflower oil. n=26 (18F, 8M) from Australia.	A 6-h study, meal of mashed potato plus butter or sunflower oil plus omega-3 (1.9g EPA+DHA).	Butter + omega-3 - CV for iAUC Plasma total omega-3 161.55±34.2 (SD), CV= 21% Sunflower oil + omega-3 - CV for iAUC Plasma total omega-3 164.89±42.02 (SD), CV= 26% (no units provided)	Did not report adverse events.	Dias et al [31]
Standard meal or standard meal enriched with fish oil	Single meal, cross-over study. The standard meal contained 0.4g EPA+DHA, and enriched meal contained 2.3g EPA+DHA (1.2g EPA, 1.1g DHA), n=20 (10F, 10M) from UK.	A 6-h study, meals were a liquid emulsion together with toast and jam/marmalade (55-56g fat).	Standard meal CV for iAUC Plasma TG EPA 0.5±0.1 (SEM), 0.45 SD, CV= 89% Plasma TG DHA -0.5±0.2 (SEM), 0.9 SD, CV= 180% Enriched meal CV for iAUC Plasma TG EPA 3.2±0.4 (SEM), 1.79 SD, CV= 56% Plasma TG DHA 1.3±0.4 (SEM), 1.79 SD, CV= 138% (units not mentioned)	Did not report adverse events.	Burdge et al [32]
Soup or rice crackers with encapsulated algal DHA (HighDHA) or capsules of DHA (HighDHA)	Single breakfast, cross-over study. Each treatment contained 400mg DHA and 14-15mg EPA, n=27 (M) from Australia and Singapore.	A 24-h cross-over study, all treatments included standard breakfast (7.3g fat) and low-fat snacks, lunch and dinner.	CV for iAUC Soup: Plasma DHA 8069±5500 (SD), CV= 68% Rice Crackers : Plasma DHA 7367±5599 (SD), CV= 76% DHA capsule: Plasma DHA 9864±8603 (SD), CV= 87%. (iAUC ug/ml x hr)	No adverse events were reported during the study	Stonehouse et [14]