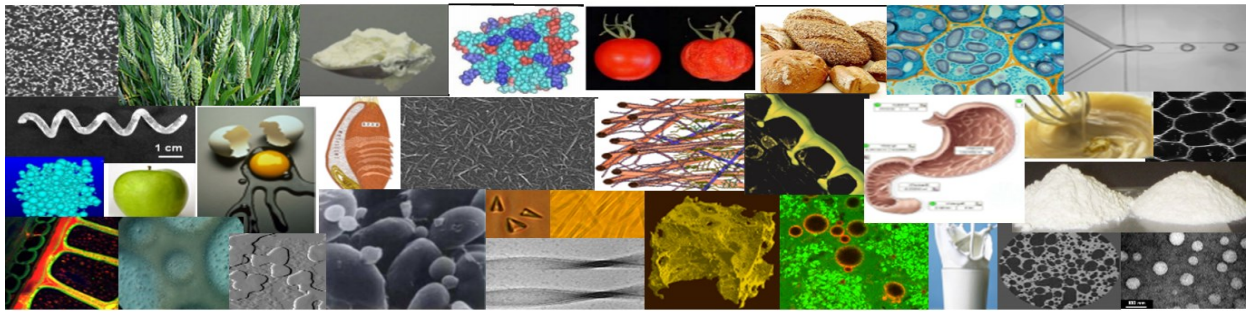

Lipid oxidation in egg products: impact of process, storage and lipid composition

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Context

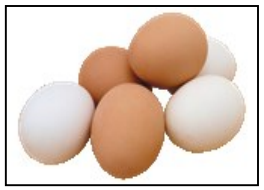
- egg products: functional ingredients (liquid or powder) for food industry
  - bakery, sauces, pastas, ready to eat food, …
  - technofunctionality, sensory and nutritional properties

- strong interest in increasing nutritional properties of eggs by enriching hen diet by ω3 fatty acids
  → ω3 enriched shell eggs

- with the aim to make ω3 enriched egg products, thermo-mechanical treatments of conservation (pasteurization & spray-drying) can alter these properties → risks of oxidation

Goal of the study

- Hen's diet (standard vs ω3 supplemented)



- Egg's production

- Breaking

- Cooling

- Pasteurisation

Effect of ω3 supplementation on lipid oxidation combined with egg processing conditions (pasteurisation, spray-drying and storage)

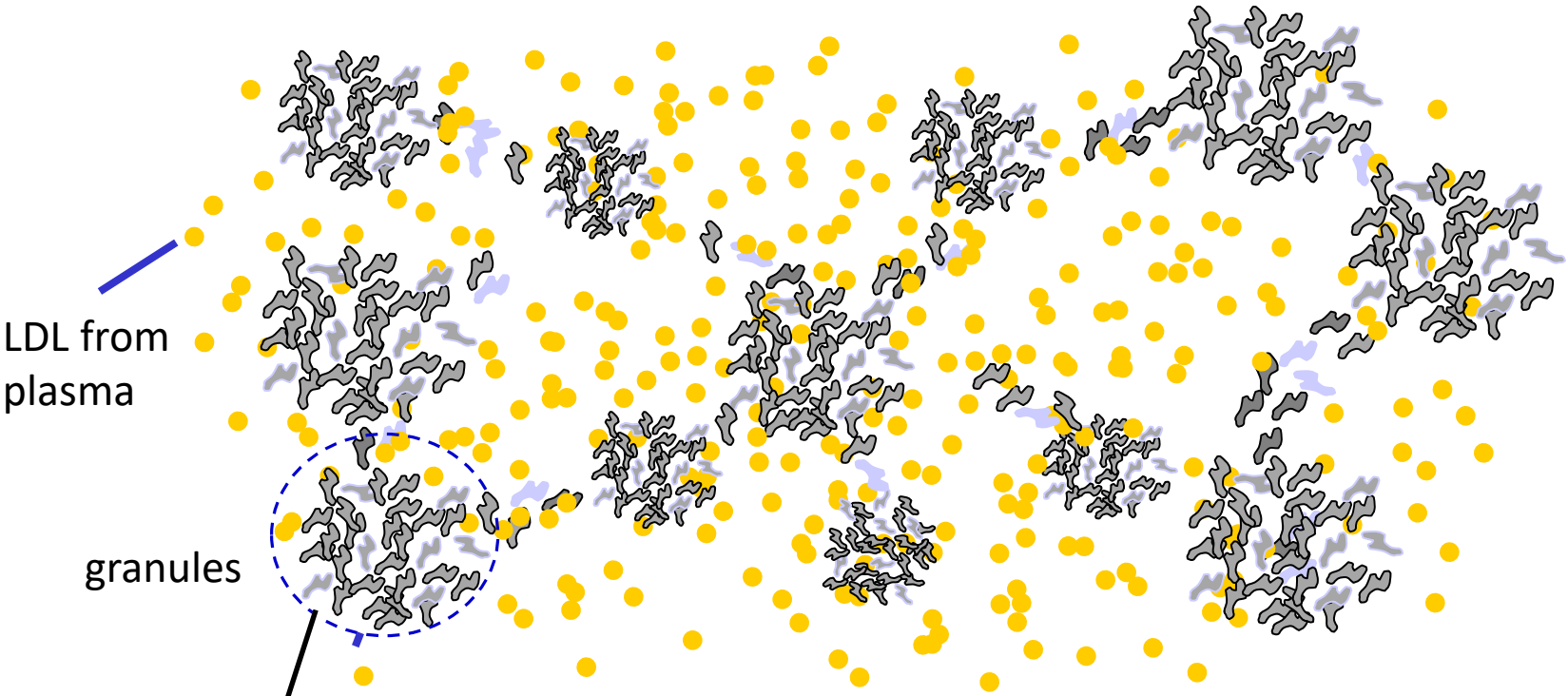
liquids

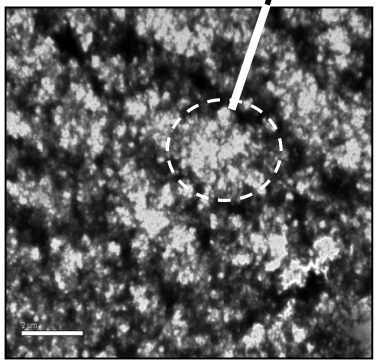
powders

3 ! • Storage

1 ! 2 ! • Spray-drying

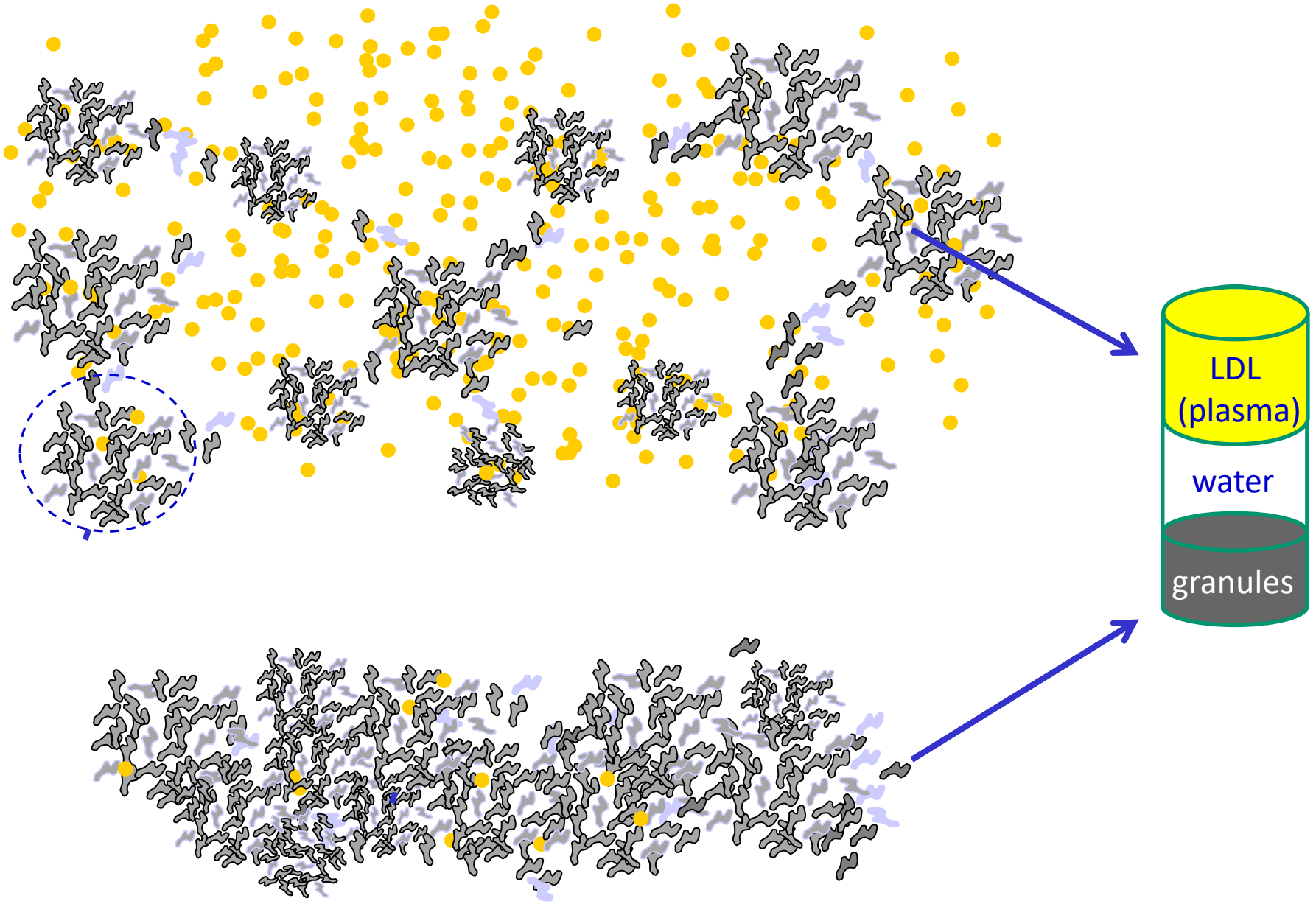
Yolk: a multi-scale structure



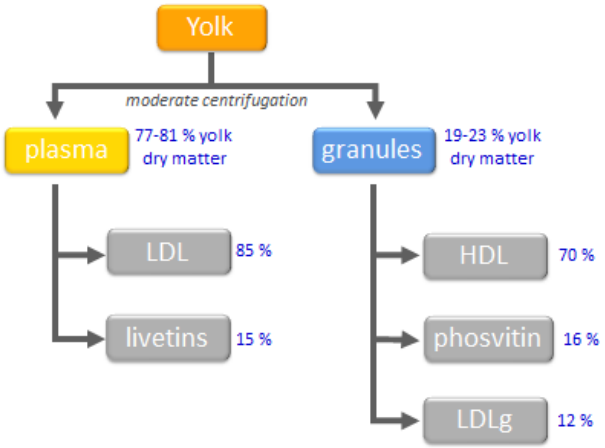


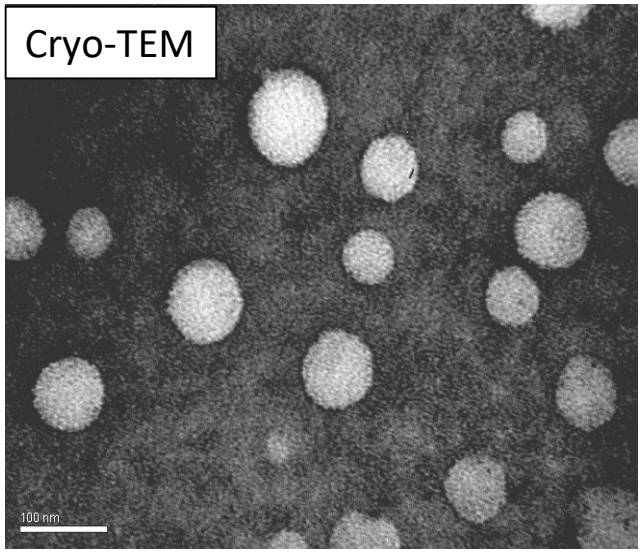
- a new point of view: yolk is a nanoemulsion of LDL structured by granules (network)
- natural nano- and micro- assemblies

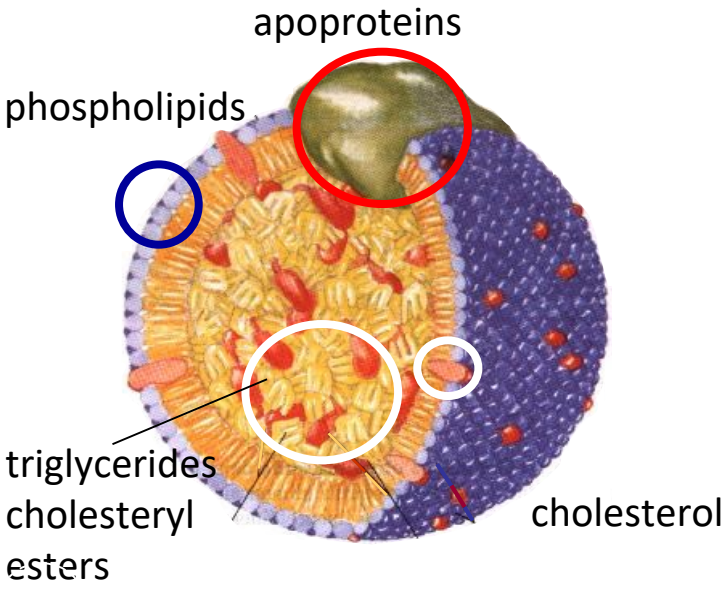
Plasma/granules separation



Lipids in egg yolk



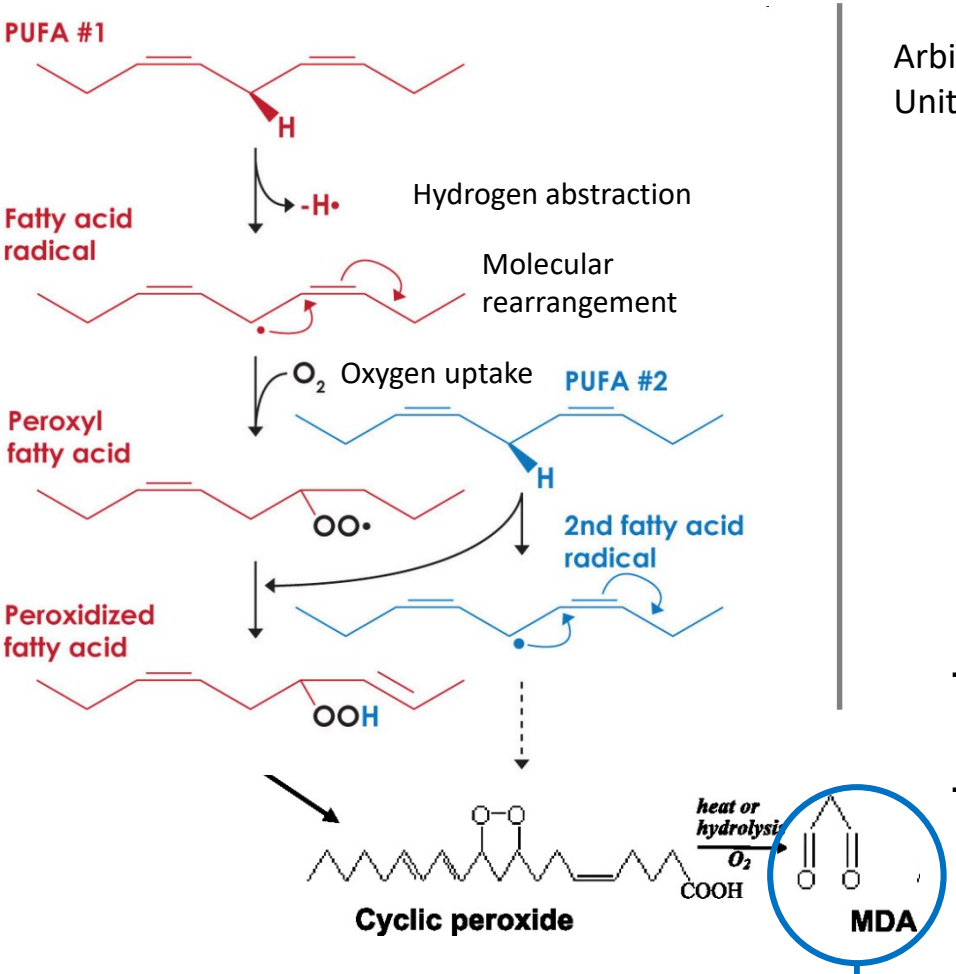


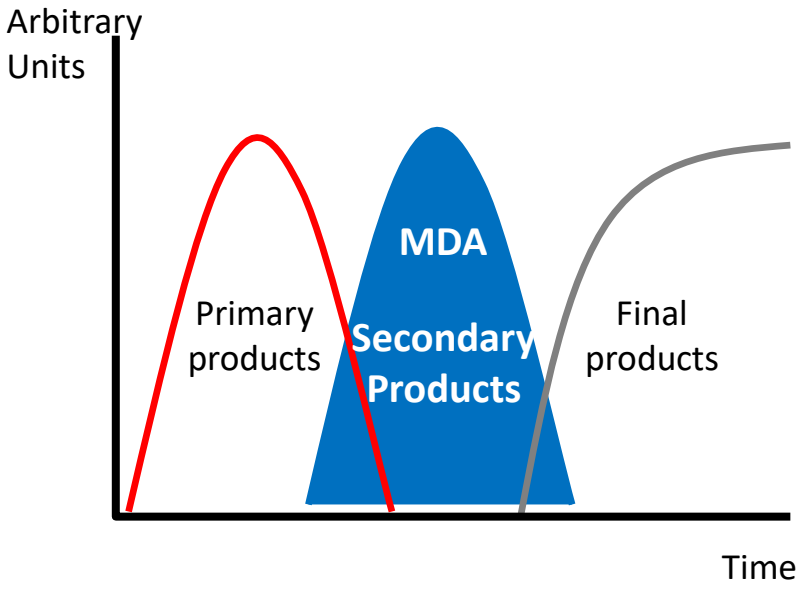


- 66% yolk DM
- Ø 17-60 nm
- 90% lipids →
- 10% proteins
- d = 0.98 g/cm^3

- 70% TG → neutral
- 26% phospholipides
- 3.5% cholestérol
- 0.5% others …

Lipid oxidation chain … and products





→ difficulty to assess all the process

→ a poor quantity of primary products not necessary means an absence of oxidation

malondialdehyde (MDA)

→ secondary products

→ PUFA very sensible

Liquid
egg products

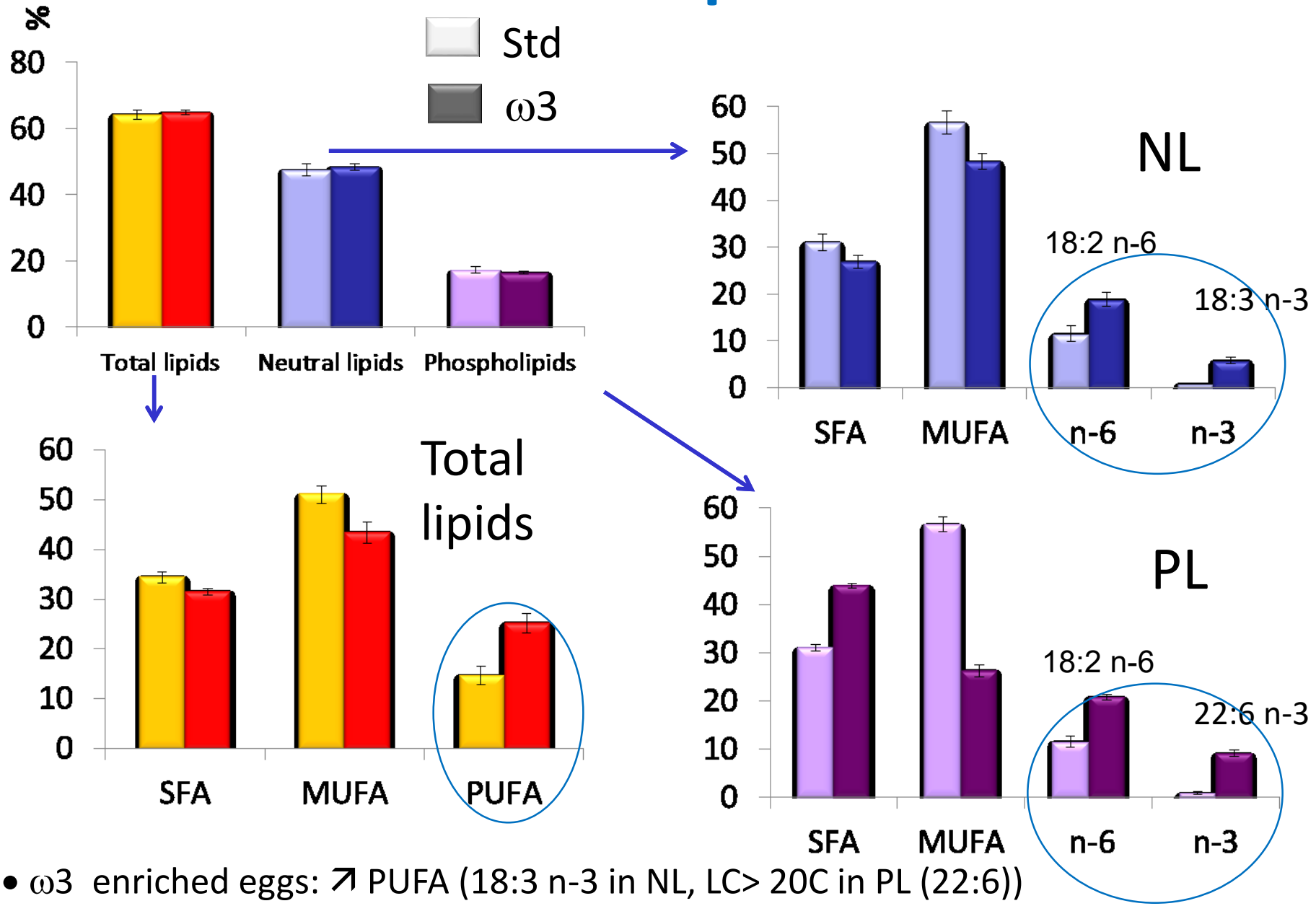
Liquid egg products

- **Diet**
  - Standard diet
  - ω3 enriched diet*
  - * *Extruded linseeds*
- **Treatment**
  - Shell eggs
  - Pasteurized
  - Shell eggs
  - Pasteurized
- **Samples**
  - Std-shell
  - Std-past.
  - ω3-shell
  - ω3-past.
- **Measures**
  1- Lipid composition

  2- Lipid oxidation and antioxidant levels

  3- Physical properties

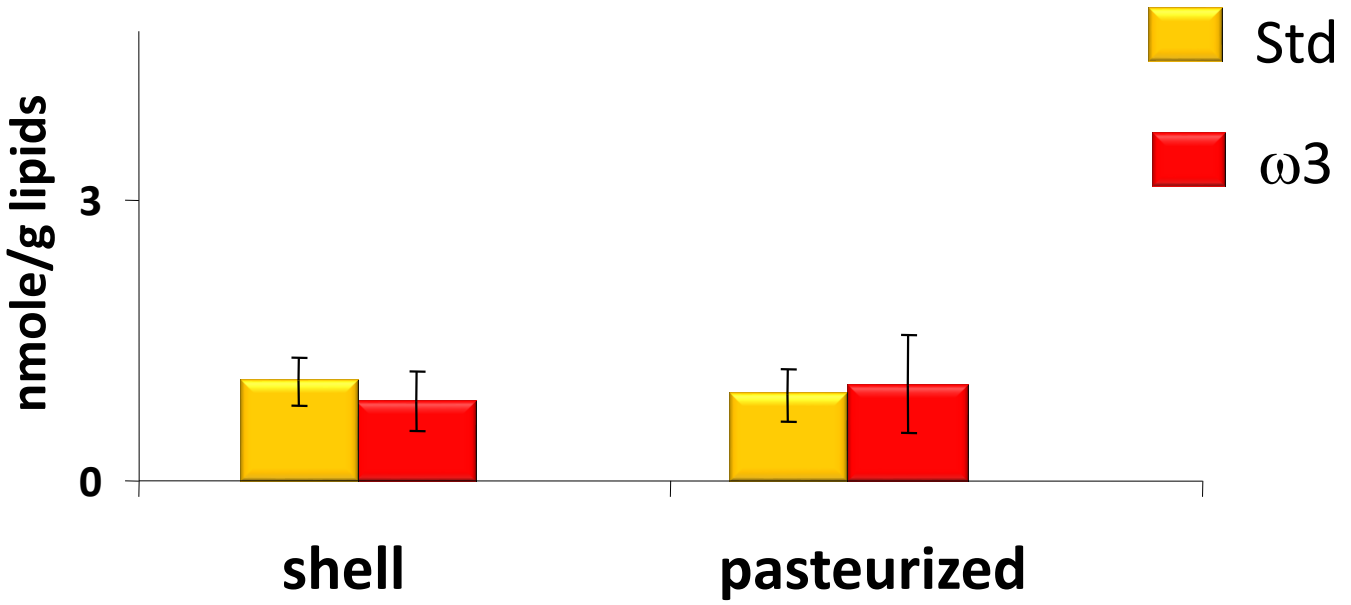
Lipid composition



- ω3 enriched eggs: ↗ PUFA (18:3 n-3 in NL, LC> 20C in PL (22:6))

Lipid oxidation

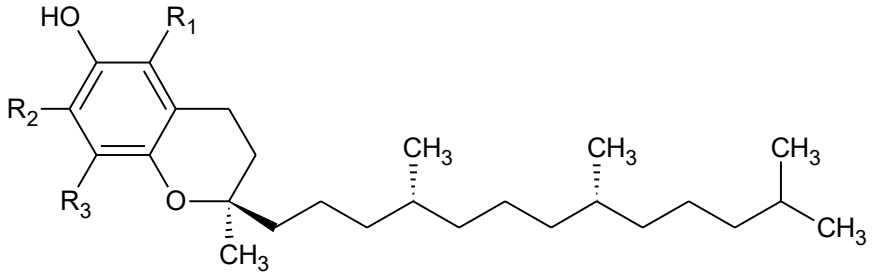
Secondary products:
malondialdehydes (MDA)

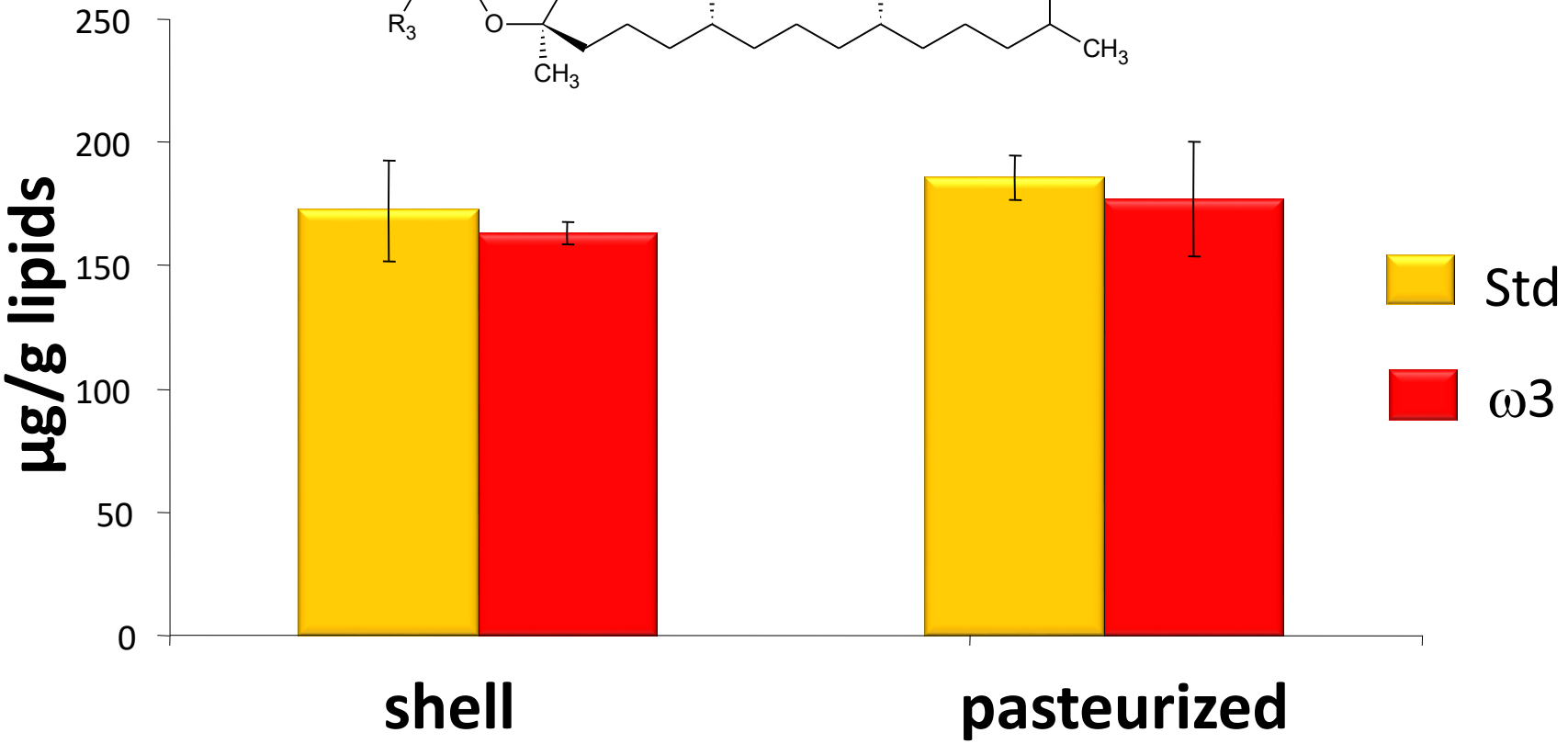


- diet or pasteurization: slight effect on MDA

→ no oxidation

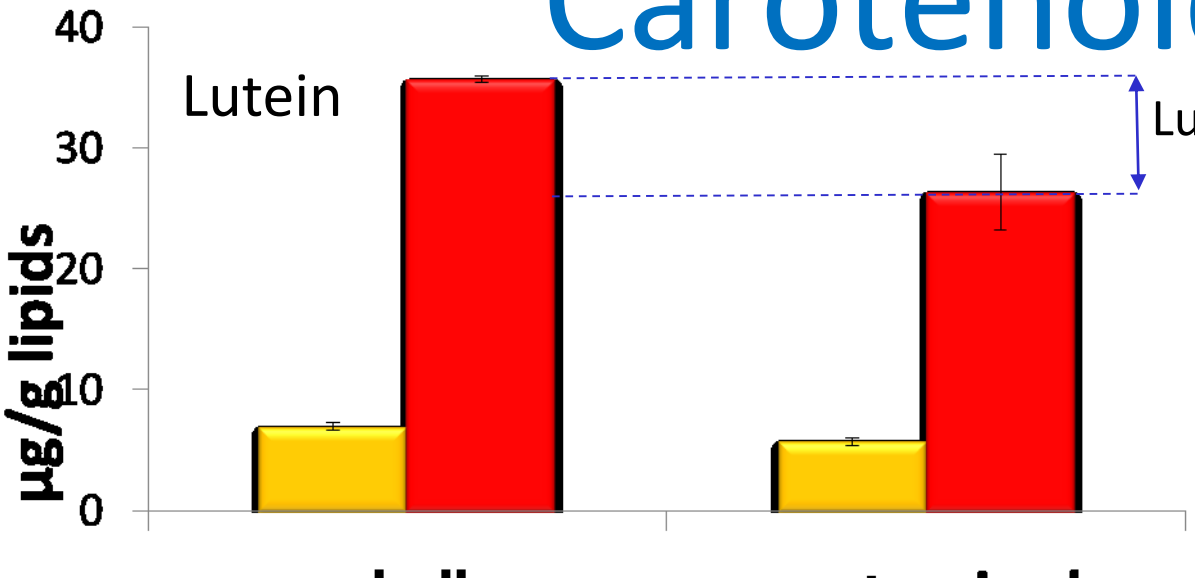
Tocopherols

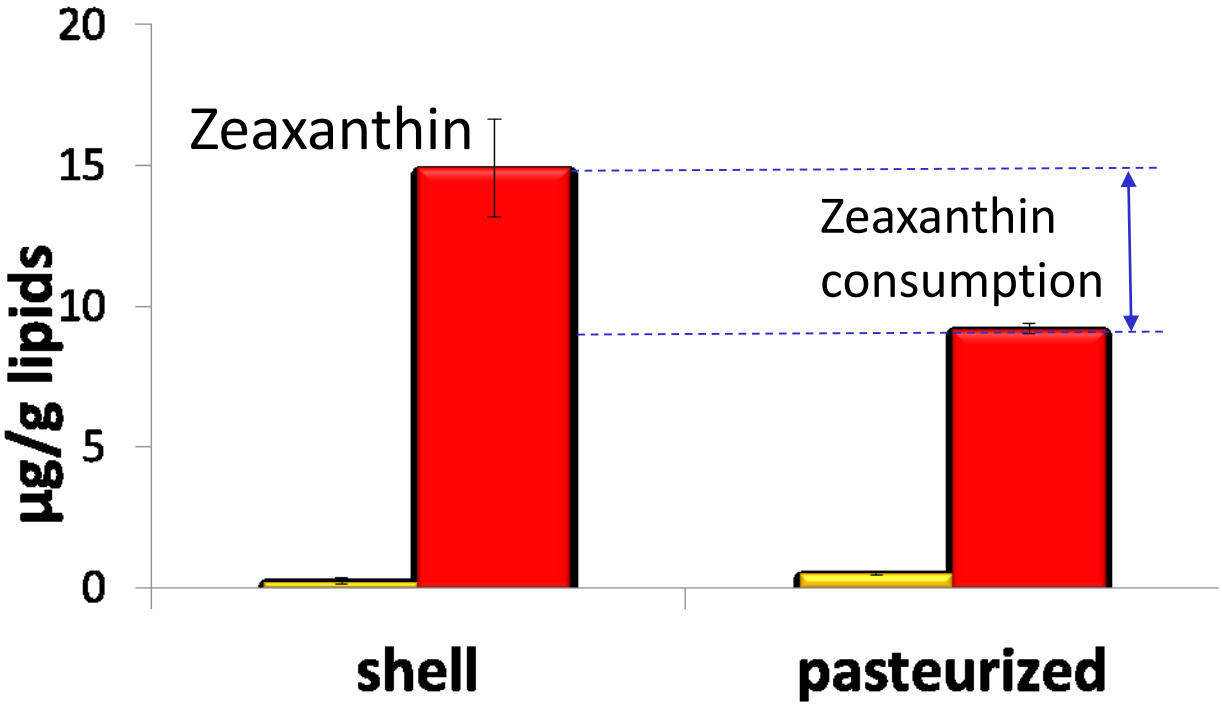




- diet: no global difference, same levels of tocopherol
- pasteurization: no effect

Carotenoids





- diet: supplementation in carotenoids
- pasteurization: ↘ carotenoids

→ protective effect to limit oxidation

Conclusion (1)

ω3 diet effect

- ω3 enriched eggs contain higher proportion and amount of 18:3 n-3 (LNA) in NL and 22-6 n-3 (DHA) in PL
- ω3 enriched diet brings important quantities of carotenoids

Pasteurization effect

- carotenoids are consumed during pasteurization

→ protective effect against oxidation

- no enhancement of MDA: no oxidation due to this effect

Whatever the sample

- very low level of HPX and MDA

→ no detectable oxidation, no effect on sensorial properties on liquid products

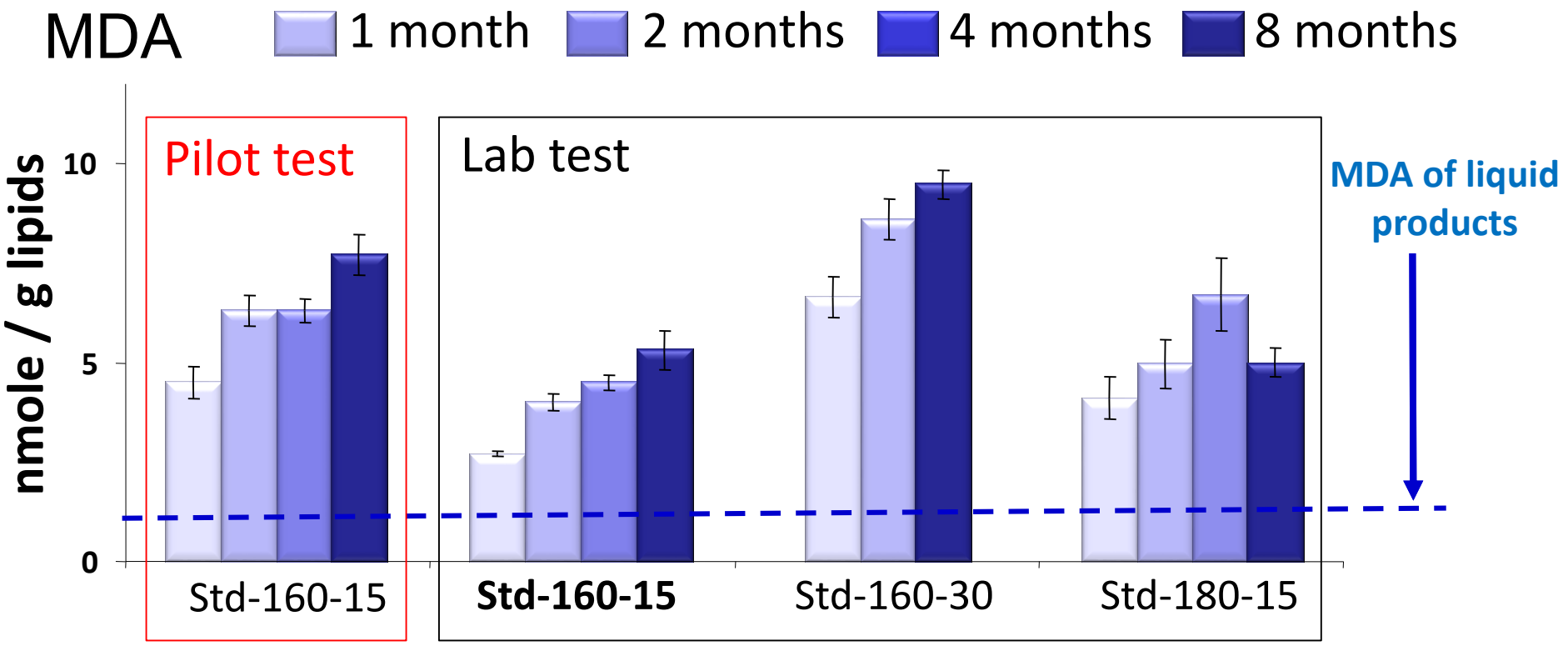
Spray-dried egg products

Egg products: powders

- **Pasteurized eggs**: Standard | ω3
- **Drying process**: T°= 160°C | T° = 180°C
- **T° powder storage**: 15°C | 30°C | 15°C
- **Samples**:
  - Std-160-15
  - Std-180-15
  - ω3-160-15
  - ω3 -180-15
  - Std-160-30
  - Std-180-30
- **Storage time** → 1, 2, 4, 8 months

- **Measures**
  1- Oxidation and antioxidants
  2- Functional properties

Standard diet products



- ↗ MDA / liquid
  ↗ MDA with T° spray-drying important ↗ MDA with storage T° and storage time

➡ ↗ of oxidation due to spray-drying

- differences between pilot and industrial processes

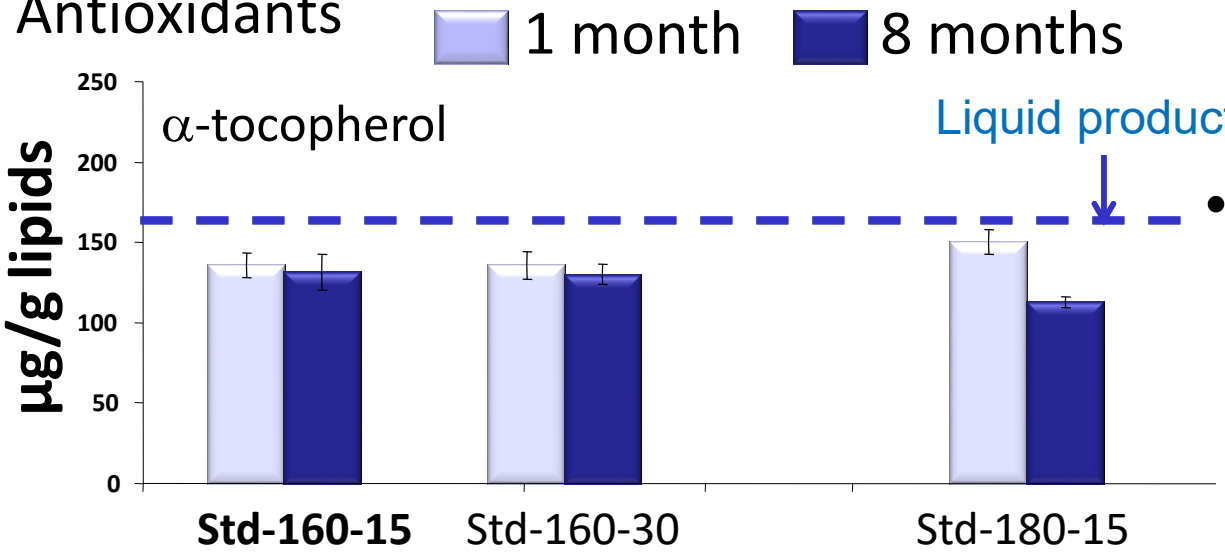
➡ more detrimental

- levels “reasonable” !

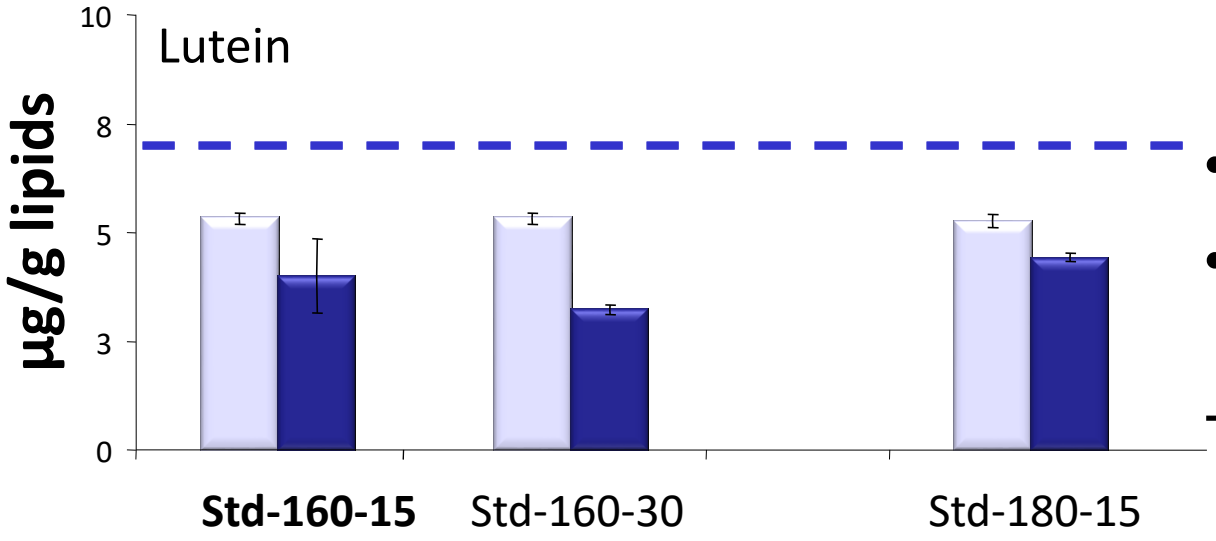
➡ no sensorial degradation

Standard diet products

Antioxidants



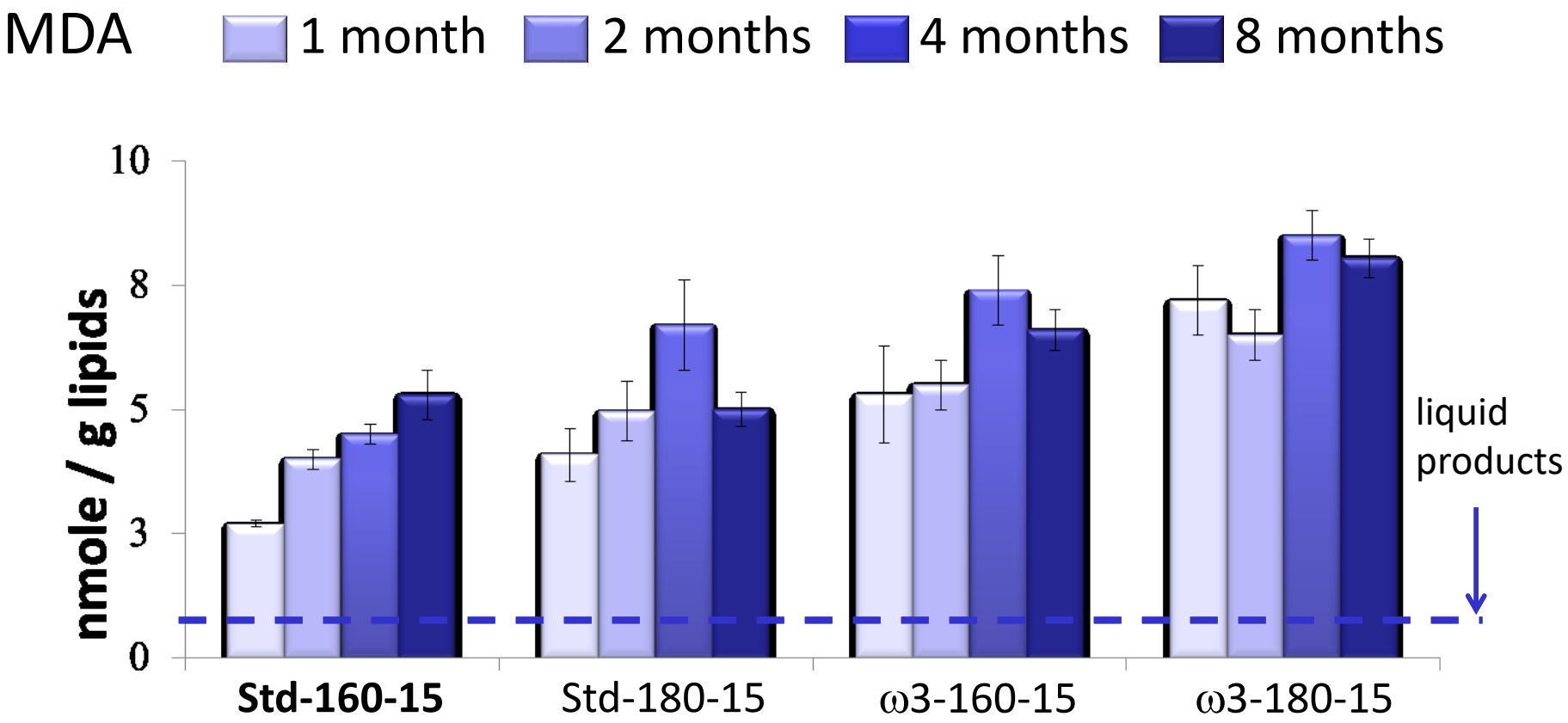
- slight effect of spray-drying: T°, storage T° and time on tocopherol content (excepted at high T°)



- ↘ lutein due to spray-drying
- important effect of storage time

→ reserves are consumed to protect against oxidation

Comparison standards and ω3

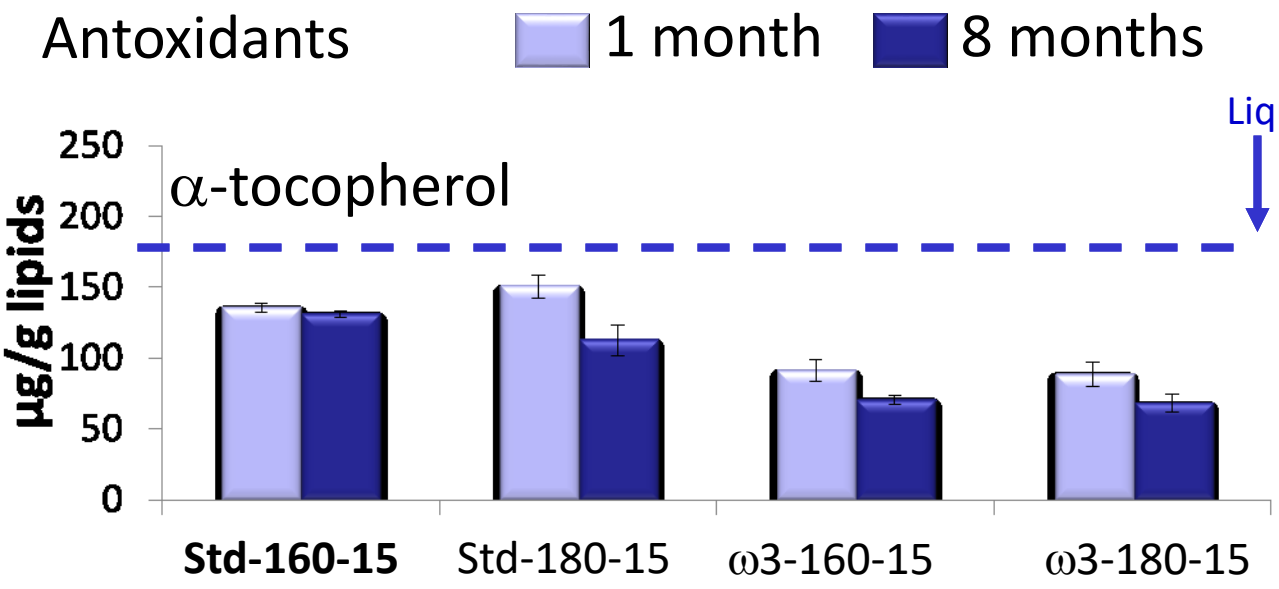


- general ↗ MDA between Std and ω3

  ➡ important ↗ oxidation due to enrichment in ω3

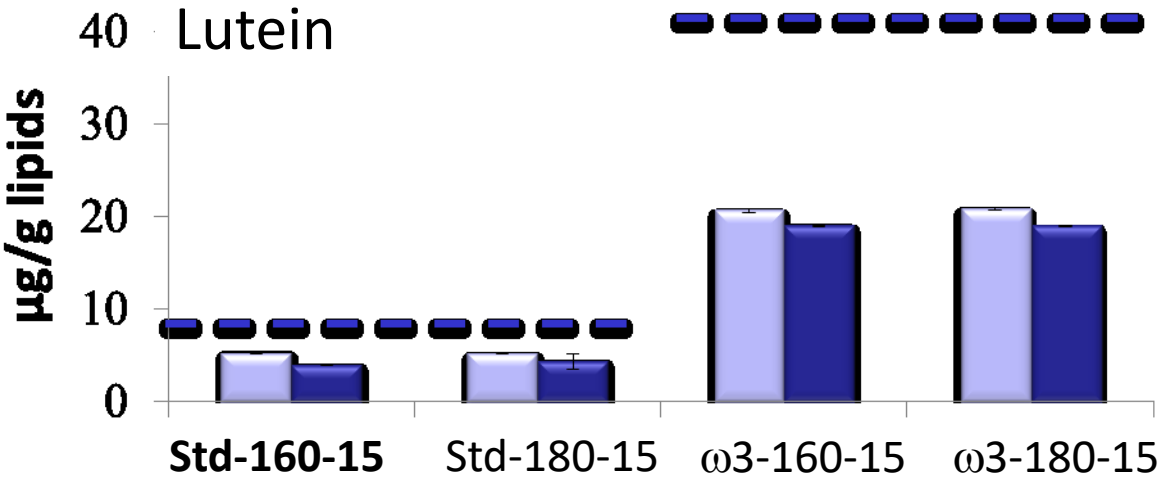
- others effects (drying T°, storage T° and time already observed)

Comparison standards and ω3



- less tocopherol in ω3 samples

→ more consumed during spray-drying



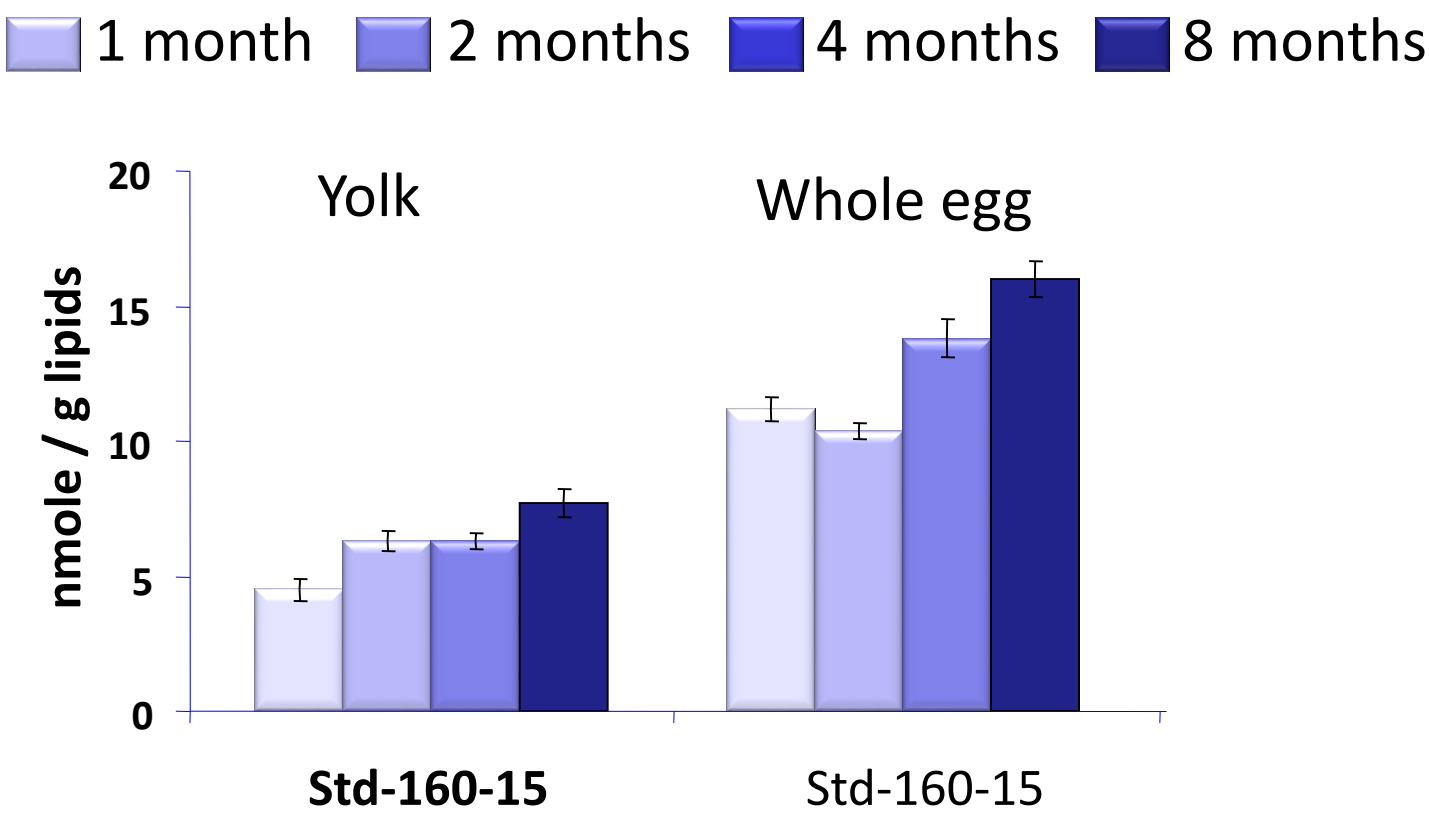
- more important reserves of lutein for ω3 samples

→ being consumed also

- tocopherol and lutein remains in sufficient levels to act against oxidation

Comparison of whole and standard egg powders

MDA



- effect of albumen proteins ? (metals, degradation, …)

Conclusion (2)

Spray-drying effect

↗ MDA as compared to liquid products

→ enhancement of oxidation

highly accentuated by spray-drying T°, and storage time and T°

antioxidants are consumed to protect against oxidation

ω3 diet effect

↗ MDA with w3

→ presence of ω3 PUFA enhances oxidation

but ω3 enriched diets are supplemented in carotenoids

Practical point of view

low levels of oxidation in this study

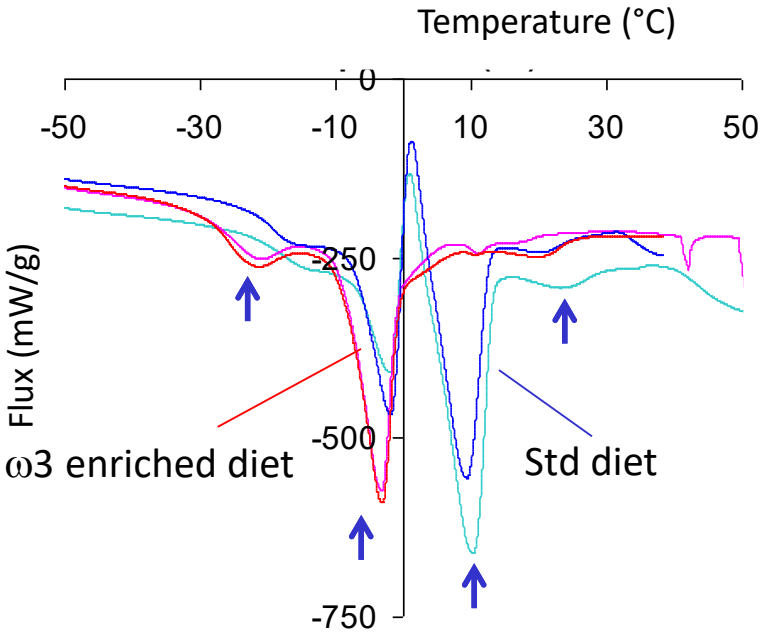
sensorial and nutritional characteristics conserved after 8 months of storage

Functional properties

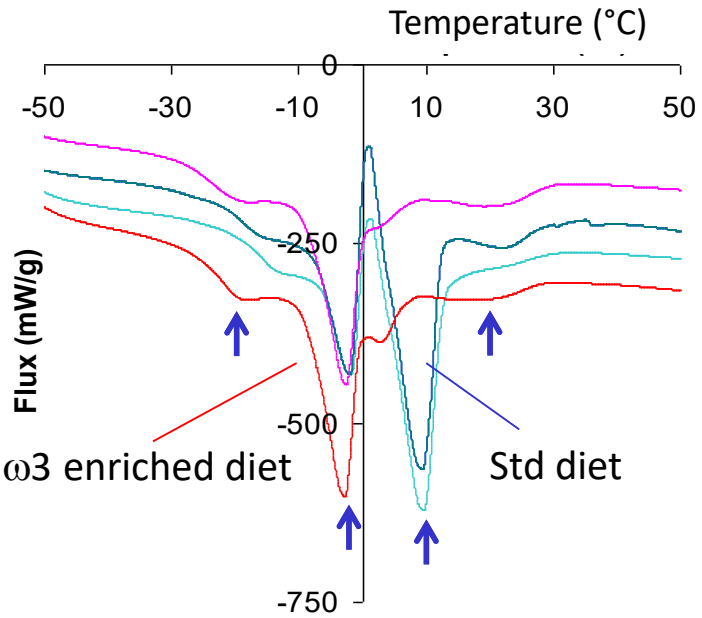
Thermal properties

Fusion profils of lipids

Liquid products

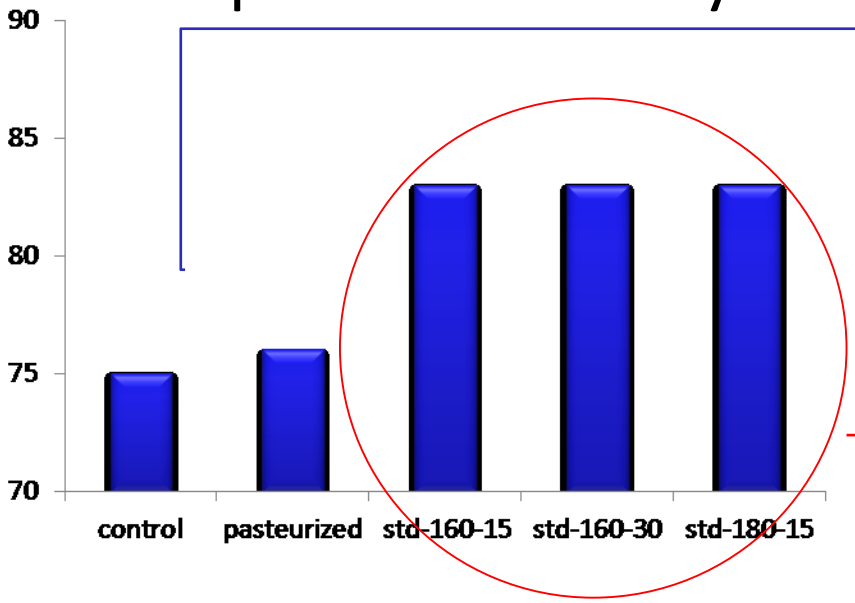


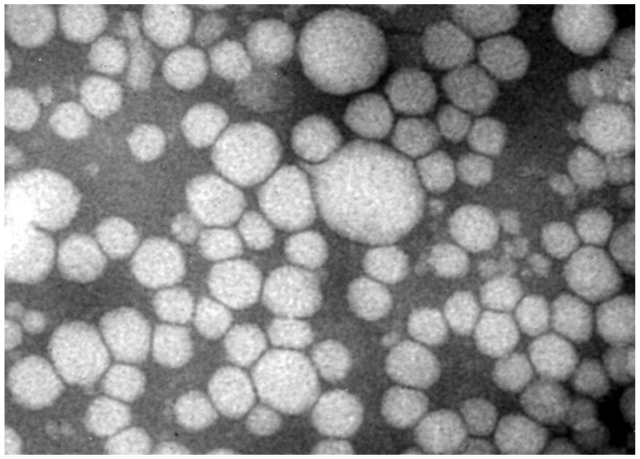
Powders

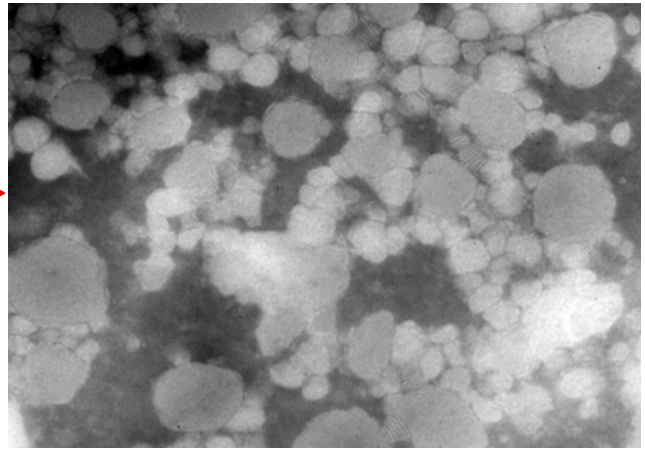


- Melting T° of lipids is diminished for ω3 enriched eggs
- No difference between processing parameters

Physical properties

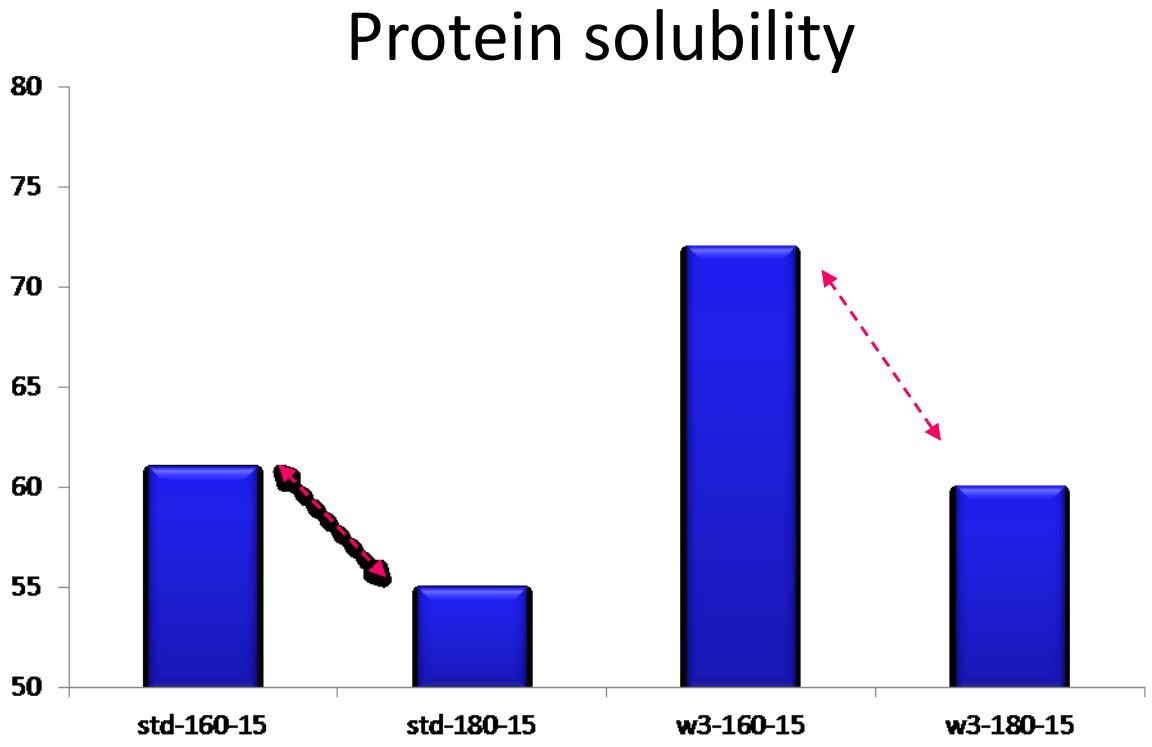






- Spray-drying disrupts yolk structures (easier lipid extractability) …

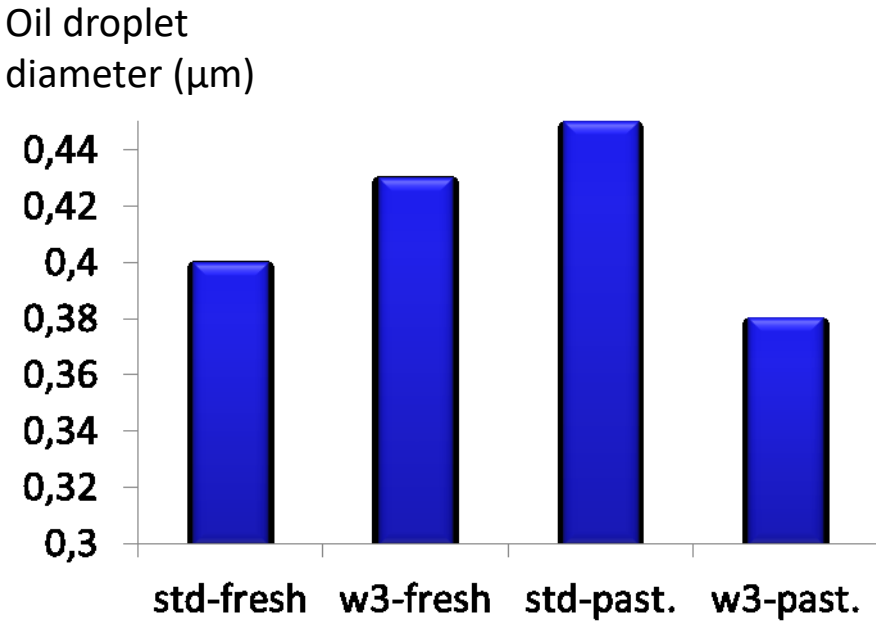
Physical properties



… and affects protein aggregation (lower solubility under higher spray-drying T°)

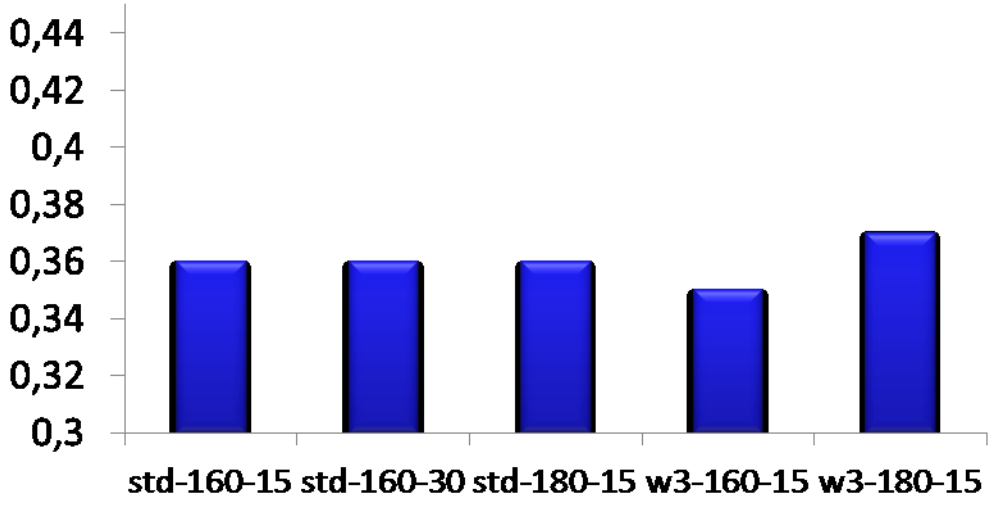
Emulsifying properties

Liquid products



Mean: 0,42 µm

Powders



0,36 µm

- Spray-drying allows smaller oil droplets (but slight difference)
- No effect of diet or process parameters

General conclusions

- pasteurization/spray-drying processes combined with enriched ω3 diets affect physical properties of egg yolk products but the impact on emulsifying properties is poor

- pasteurization and spray-drying, as they are generally conducted, affect oxidation of lipids and this alteration is enhanced by the enrichment in ω3 PUFA

- the levels of oxidation and the modifications of functional properties remain reasonable and allows to propose egg products enriched in ω3 fatty acids **without changing standard processes**