Prediction of polyunsaturated fatty acid content in the bovine muscle

Benoît-Pierre MOUROT[1,2]**,** Dominique GRUFFAT [1], Denys DURAND[1], Dominique BAUCHART[1], Guillaume CHESNEAU[2], Guillaume MAIRESSE[2], André LEBERT[3]
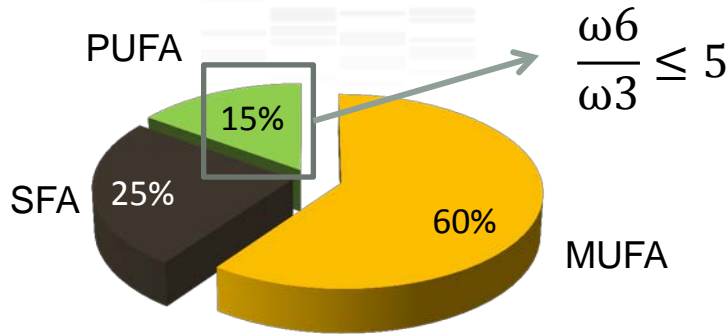
[1]UMR 1213 Herbivores, INRA Theix, 63122 St-Genès-Champanelle, France/VetagroSup, 63370 Lempdes France
[2]Valorex, La Messayais, 35210 Combourtillé, France
[3]Institut Pascal, UMR6602 UBP/CNRS/IFMA, 24 Avenue des Landais, BP80026, 63171 Aubière, France

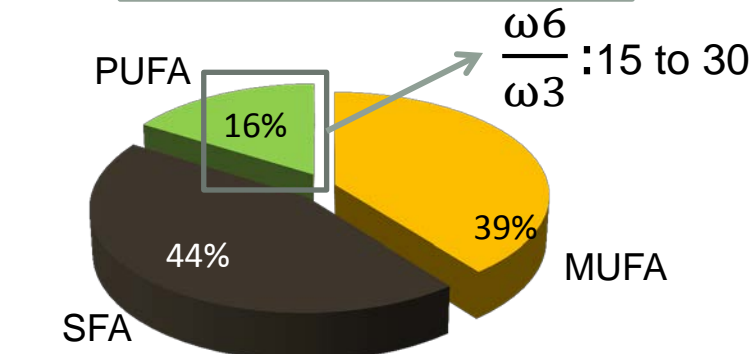# Dietary fatty acids (FA) in human nutrition

FA requirement

PUFA

$$\frac{\omega 6}{\omega 3} \leq 5$$

15%

SFA 25%

60%

MUFA

(Anses, 2010)

Important PUFA needs

PUFA: polyunsaturated fatty acid

Mean FA consumption

PUFA

$$\frac{\omega 6}{\omega 3} : 15 \text{ to } 30$$

16%

39%

SFA 44%

MUFA

(Afssa, INCA2, 2007)
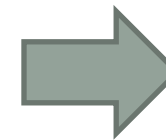
Unbalanced ω6/ ω3 ratio

!

We don't consume enough ω3

Human can't synthetized
ω3 PUFA
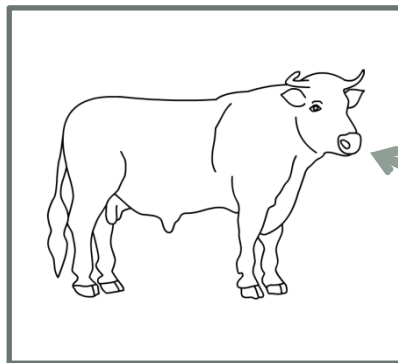
Only in plants → in animals

Food industries issues

Feeding strategy to increase ω3 PUFA content in animal products: fresh grass, linseed,…

We must be able to measure the content of ω3 PUFA in the beef slaughter chain

Results control for labels

Nutritional quality information for consumer

Positive economic impact on beef industry

Glossary of fatty acids (FA)

	DENOMINATION		ABBREVIATION
Major FA	**Saturated FA**		**SFA**
		Palmitic acid	-
		Stearic acid	-
	Mono-unsaturated FA		**MUFA**
		Oleic acid	-
Minor FA	**Poly-unsaturated FA**		**PUFA**
	ω6	Linoleic acid	LA
		Arachidonic acid	ARA
	ω3	α-linolenic acid	ALA
		Eicosapentaenoic acid	EPA
		Decosahexaenoic acid	DHA

Method of fatty acids measurement

Gas-Liquid Chromatography

- Time-consuming
- Costly
- Tissue sampling
- Laboratory material

Not adapted for systematic daily controls

Near-Infra Red Spectroscopy

N I R S

- Short analysis time (1 to 2 min)
- Cheaper (than reference method)
- No depreciation
- Slaughter chain adapted (portable)

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Original work

	GLC	NIRS
Major FA		
SFA		
Palmitic Acid	✓	✓
Stearic Acid		
MUFA		
Oleic Acid		
Minor FA		
PUFA		
(ω6) LA		
(ω6) ARA	✓	✗
(ω3) ALA		
(ω3) EPA		

PUFA are more interesting for beef industry **BUT** NIRS cannot measure them

Is there a link between major FA and PUFA?

NIRS can't measured PUFA. We need to establish an alternative method to measure PUFA

To develop
prediction equations
in order to predict PUFA
indirectly from major FA

Materials and methods

- **Prediction database**:

W3Meat in the data-warehouse Nutriflux^{INRA}) from published beef FA composition (182 references, H 32000 values, >2000)

Muscles
Longissimus Thoracis
Rectus Abdominis
Semimenbranosus
...

Diets
Concentrate
Pasture
Silage
...

Breeds
65 breeds and crossbreeds

Types
Steer
Cull cow
Heifer
...

- **Validation database**:

from industrial individual beef samples

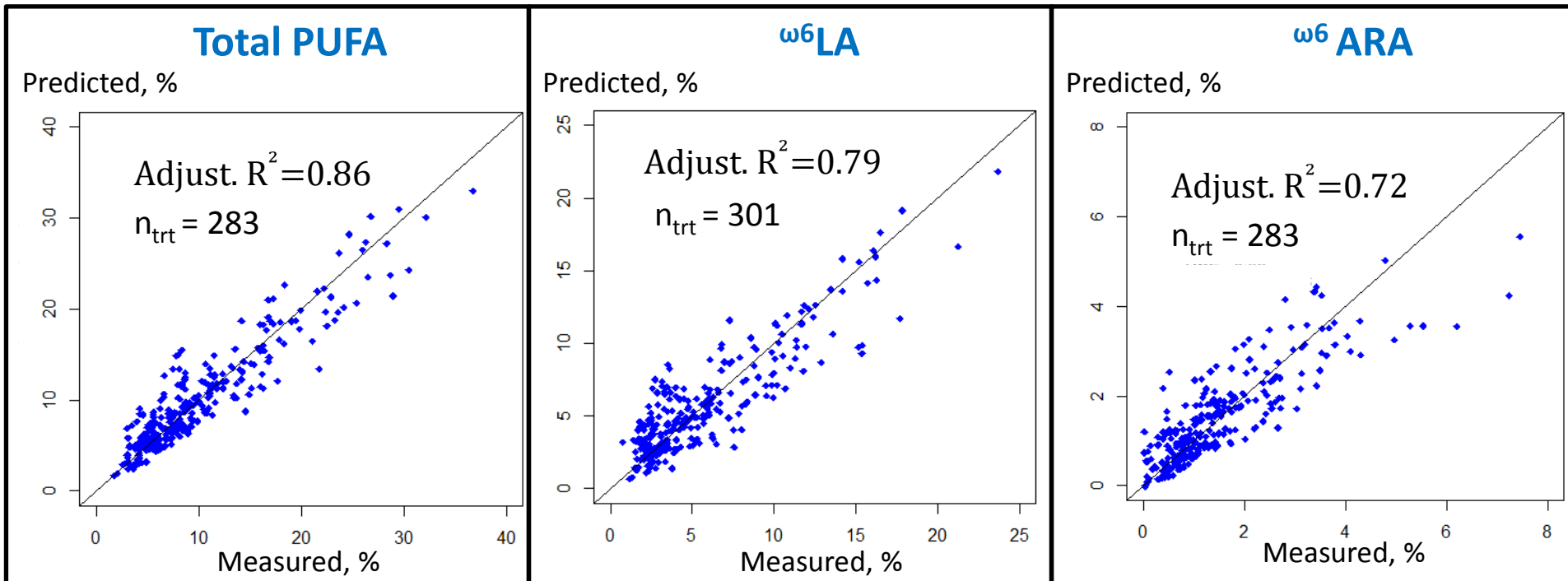(595 animals H 10000 values)

- Selected statistical method:

Multiple linear regression (R software)

Prediction equations were performed by using a bibliographic database and linear regression

Prediction equations of total PUFA and ω6 PUFA

predictors :   <u>SFA</u> ,   <u>Palmitic Acid</u>   , <u>Stearic Acid</u>
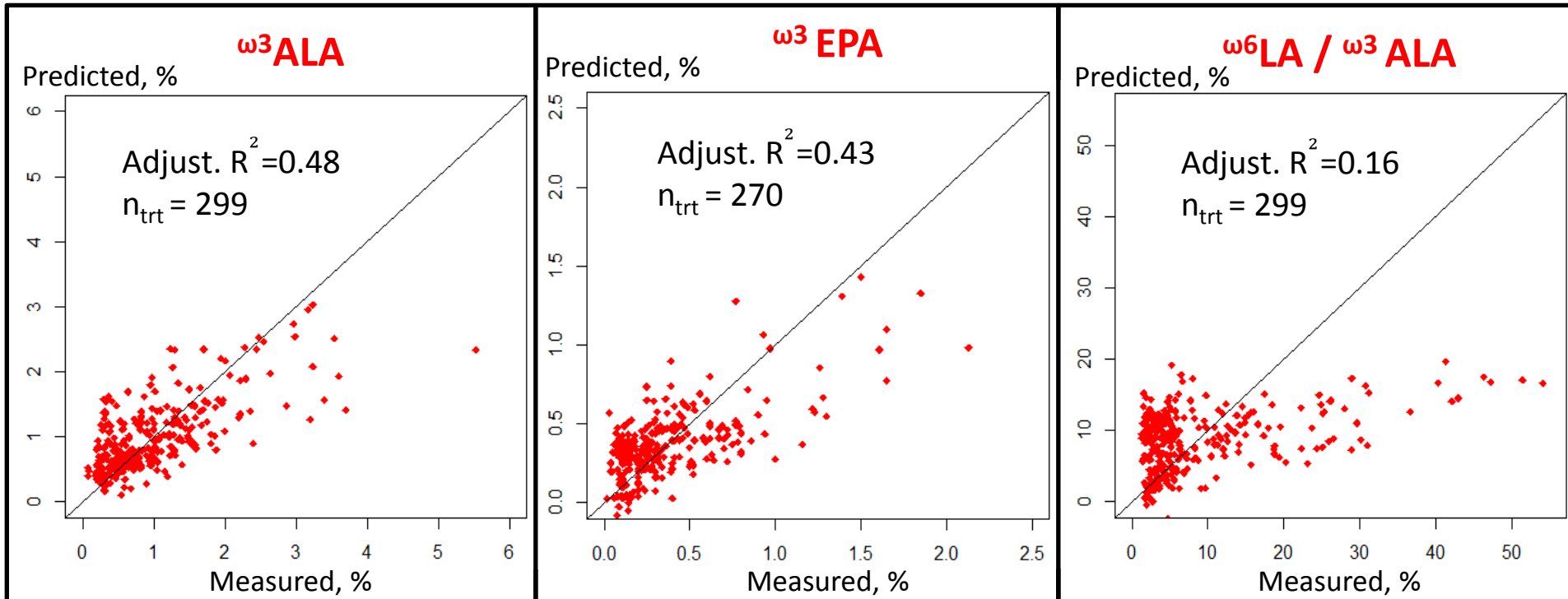<u>MUFA</u> , <u>Oleic acid</u>

Each prediction equation has been tested and validated with the validation dataset

Total PUFA and ω6 PUFA class are correctly predicted

Prediction equations of ω3 PUFA

predictors :   <u>SFA</u> ,   <u>Palmitic Acid</u>   , <u>Stearic Acid</u>
                 <u>MUFA</u> , <u>Oleic acid</u>

ω3 PUFA predictions are not satisfactory

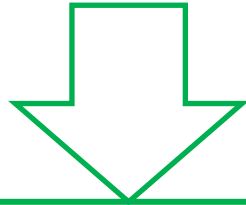# Strategy to improve the prediction of beef ω3 PUFA

prediction equations	NIRS calibrations

prediction equations

- To update the database with recent data (from bibliography and own laboratory data).
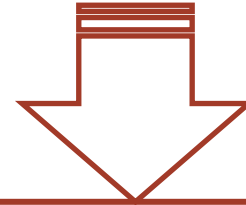
- To incorporate more variable data (extreme data)

NIRS calibrations

- To find new tissue samples more variable in ω3 PUFA
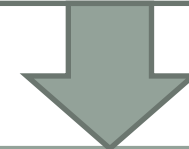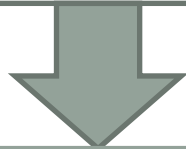
- To refine FA spectra treatments

Conclusion

NIRS data used with prediction equations of PUFA

Well adapted for
Total PUFA and
ω6 PUFA determinations

More studies are in
progress for ω3 PUFA
determinations

Information on nutritional quality of beef

Could have a positive impact for producers, industries, and consumers
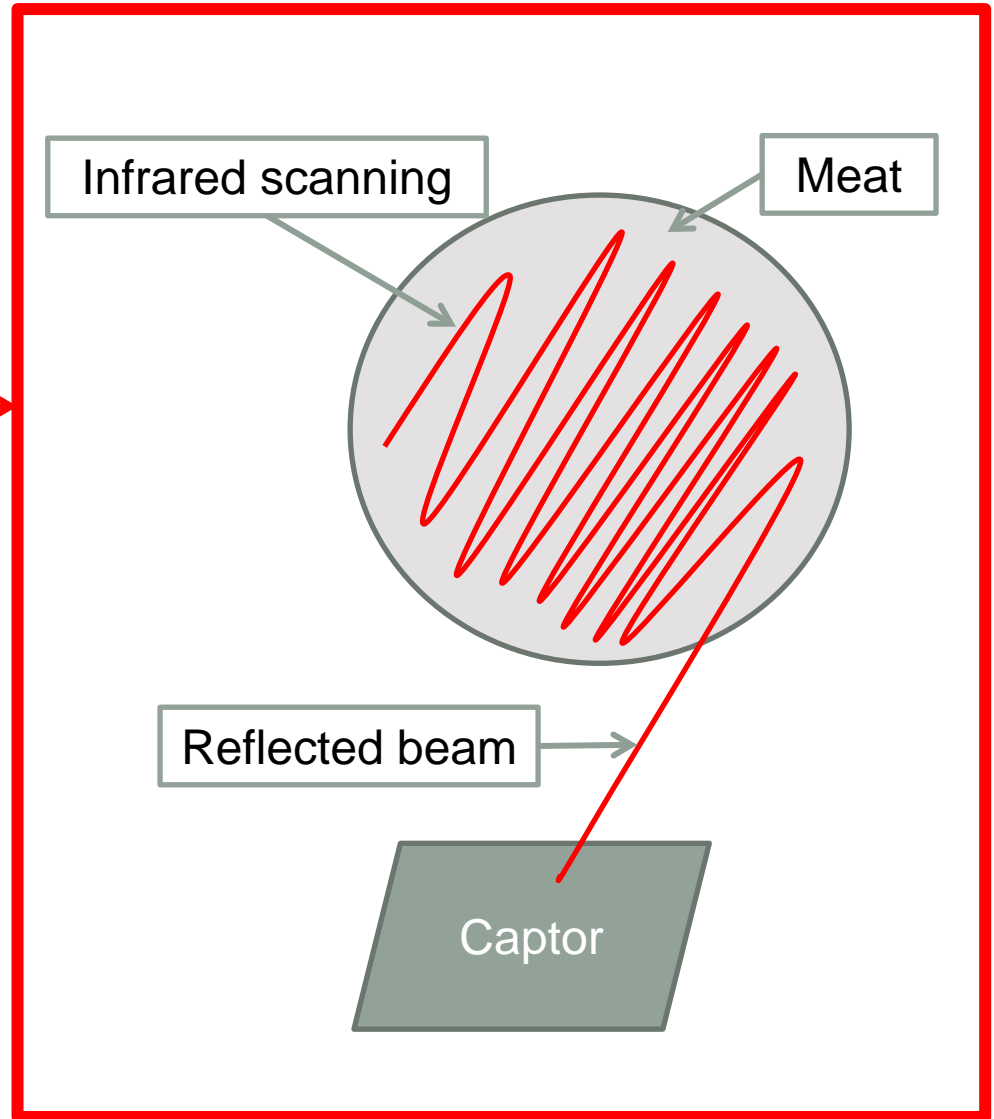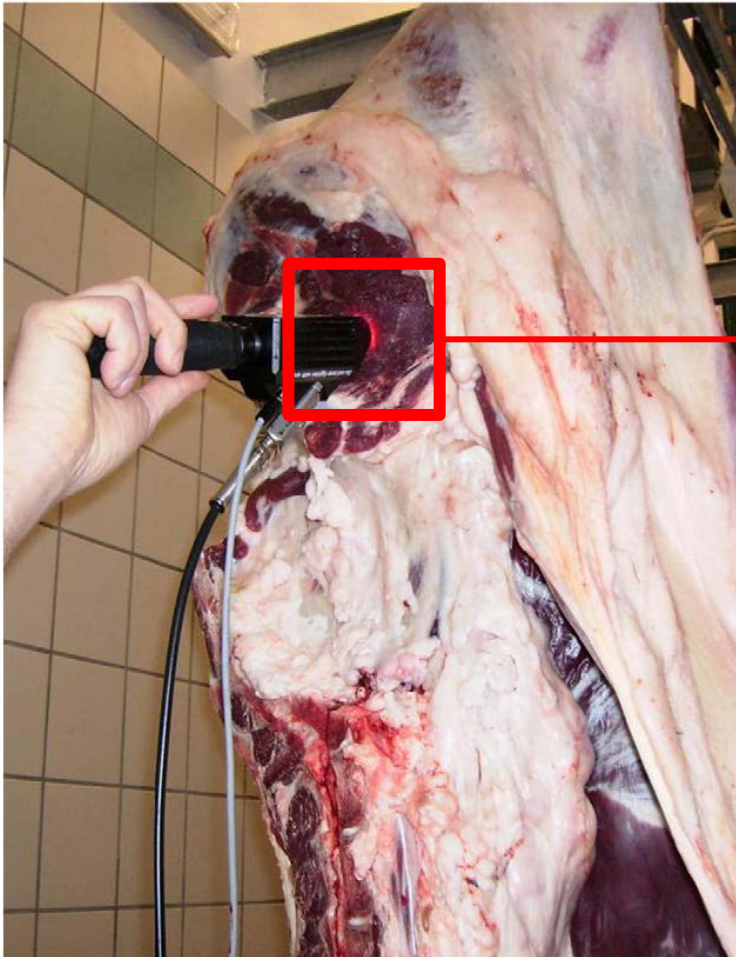
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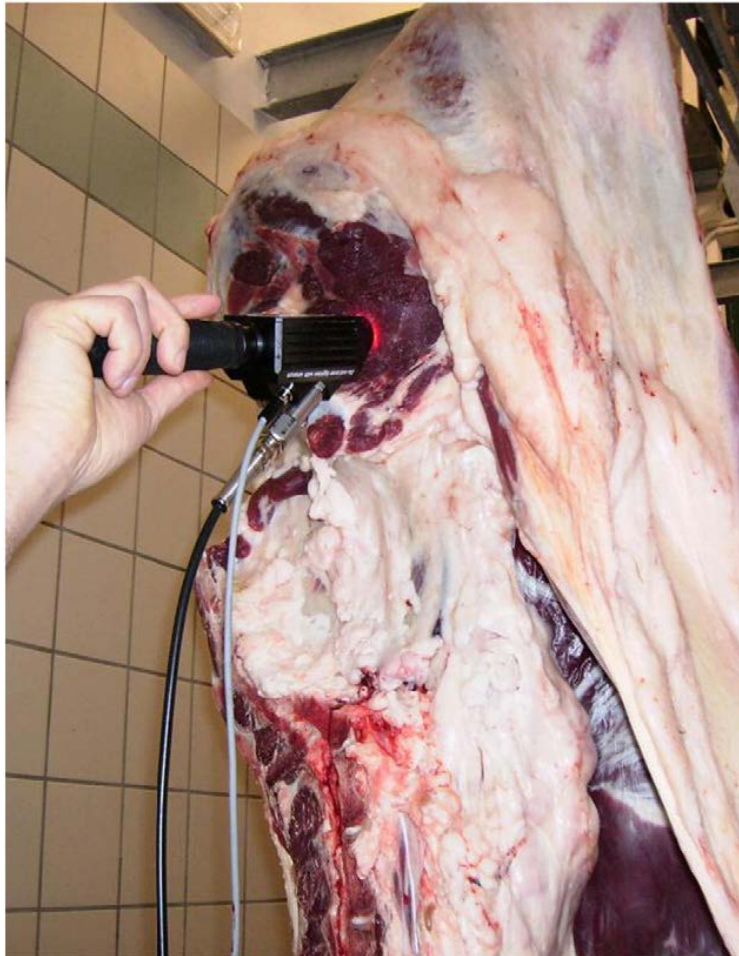Thank you for your attention!

NIRS – method (1)

(De Marchi *et al.*, 2013)

Infrared scanning
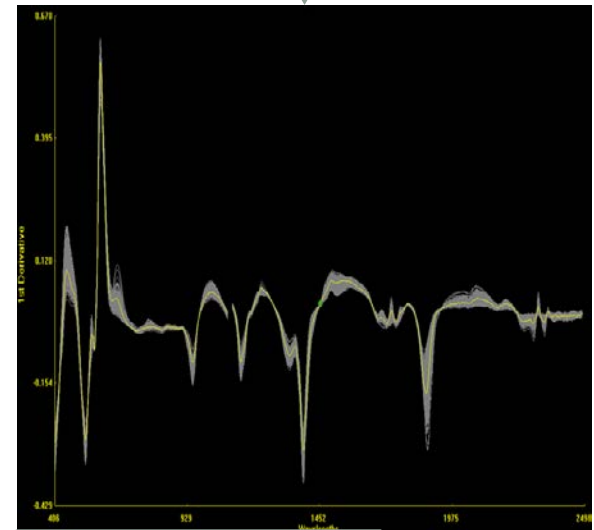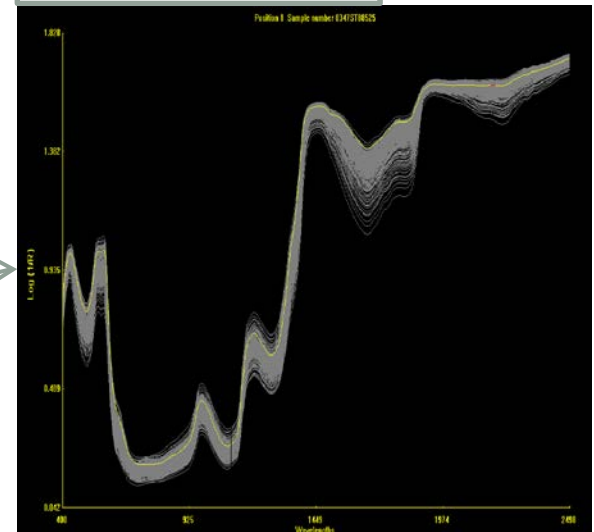
Meat

Reflected beam

Captor

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NIRS – method (2)

(De Marchi *et al.*, 2013)

Captor

Treated spectra

NIRS – calibration

For a component

Method: Partial least square
(PLS) regression

Reference values

Treated spectra

Model with R² > 0.82
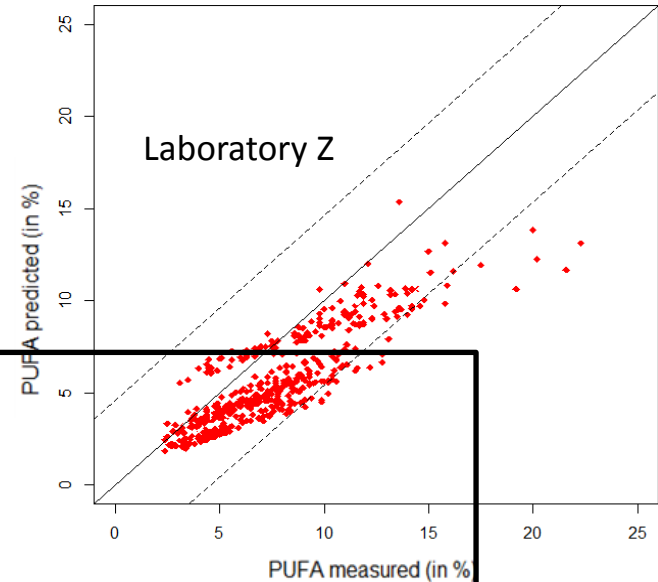
= well calibrate (Guy *et al.*,2011)

Nutriflux Database

Prediction equation – Validation

- New dataset
- ≈ 600 FA composition from industrial animal production
- 3 different laboratories analysis

VALIDATED
But
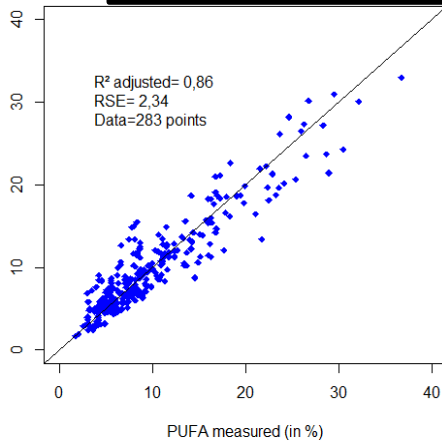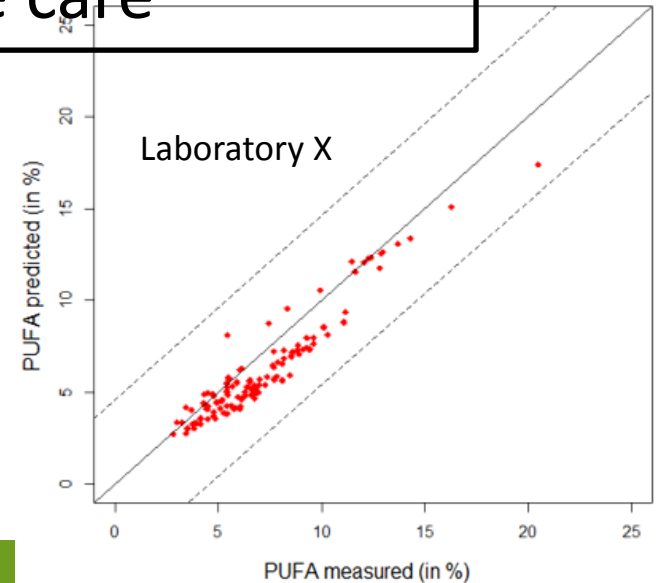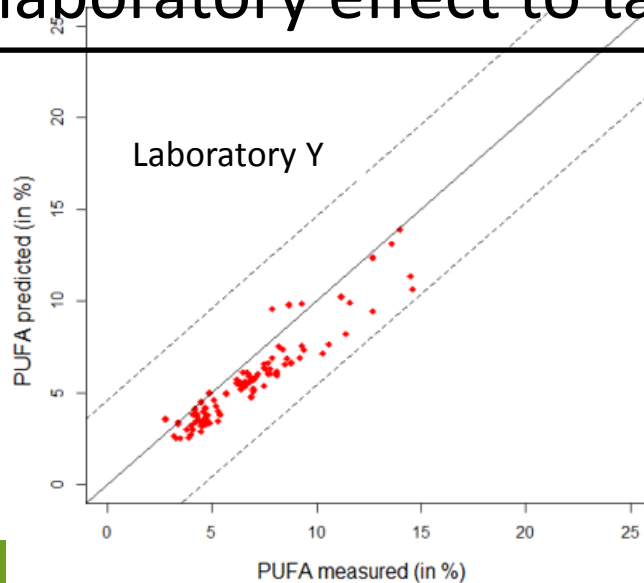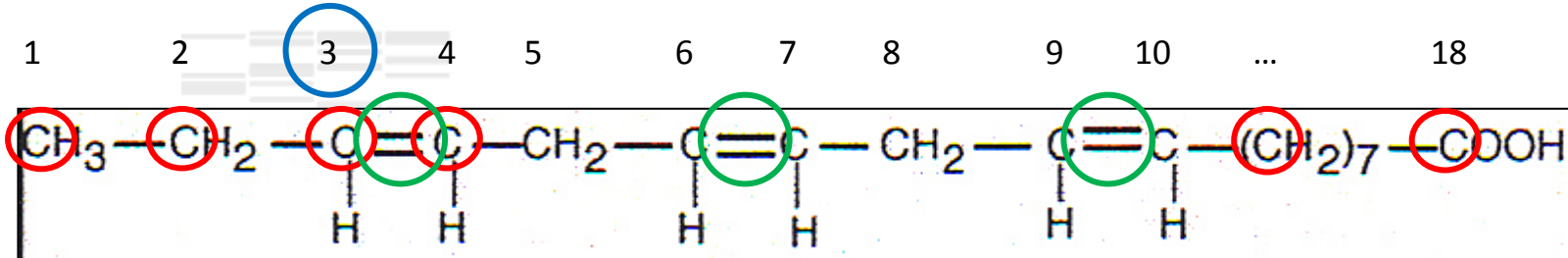laboratory effect to take care

Laboratory Z

Total PUFA graph prediction

R² adjusted= 0,86
RSE= 2,34
Data=283 points

Laboratory Y

Laboratory X

What is a PUFA?

1   2   3   4   5   6   7   8   9   10   ...   18

$CH_3 - CH_2 - C = C - CH_2 - C = C - CH_2 - C = C - (CH_2)_7 - COOH$

        H   H   H   H   H   H

| 18:3 n-3 | α-linolenic acid (ALA) |

PRECURSOR

| 18:2 n-6 | Linoleic acid (LA) |

Positive effects on health:
- Reduces risk of heart diseases
- Role in nervous system development

ω3 consumption : 0.8 g/d
ω3 requirement : 2.2 g/d

Δ5
désaturase

Elongase 5

18:3 n-3 → 20:5 n-3 → 22:5 n-3
              (EPA)   (DPA)

18:2 n-6 → 20:4 n-6   22:6 n-3

Δ5 & Δ6
désaturase   (ARA)   (DHA)

Only find in plants (grass, oilseed)

Only find in animals which already have synthetized them

ω3 PUFA class have a great health benefic but we don't enough consume them

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