Determination of fatty acid groups in intramuscular fat of pig by FT-NIRS within the project TREASURE

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Task 3.2: Evaluation of sensory, healthy, technological and typical attributes of regional pork products from untapped breeds and new products issued from local chains

developed by partners within national or European research projects. In particular the fresh meat and pork products submitted to chemical analyses will be utilized to perform NIRS analysis in order to create a regression equation and implement the NIRS methodology as new method to predict meat quality, with special emphasis on prediction of lipid content and fatty acid composition (UNIFI, KIS).

Quantitative chemical analyses used for the determination of FA are:

a. costly **b.** time consuming

NIRS

- rapid and non-destructive: neither requiring reagents nor producing waste
- widely used **in research** for large-scale **meat quality evaluation**
- already applied to study the FA content in Iberian pig fat, intact pork loins and grounded beef.

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Animals	Lipid	Fatty Acid Fat	IMF	Fatty Acid lean
512	**270**	**372**	**452**	**197**

Present research considered <u>165 fresh samples</u> of:

Partner	Breed	Sampled
KIS	Krskopolje	5
CICYTEX	Iberico	15
UNIFI	Cinta Senese	20
LUHS	Lithuanian White	24
LUHS	Lithuanian Wattle	9
CSIC	Iberico	5
UNIZG	Turopolje	5
PFOS	Crna Slawonska	16
IRTA	Negre Mallorqui	5
BESH	Schwabish Hallisches	16
UEVORA	Alentejana	10
UEVORA	Bisara	9
IPVC	Bisara	16
INIA	Iberico	5
INRA/IFIP	Gascon	5
Total		**165**

12 breeds in 8 different countries:

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Samples collection: *Longissimus dorsi*

TREASURE

Slices

Grounded

FT- NIRs spectra acquisition

Analysis with reference methods

From 3999 a 9999 wavenumber (cm^{-1})

- ❑ **Lipid were extracted from intramuscular samples**
- ❑ **Fatty Acid Profile through Gas Chromatography**

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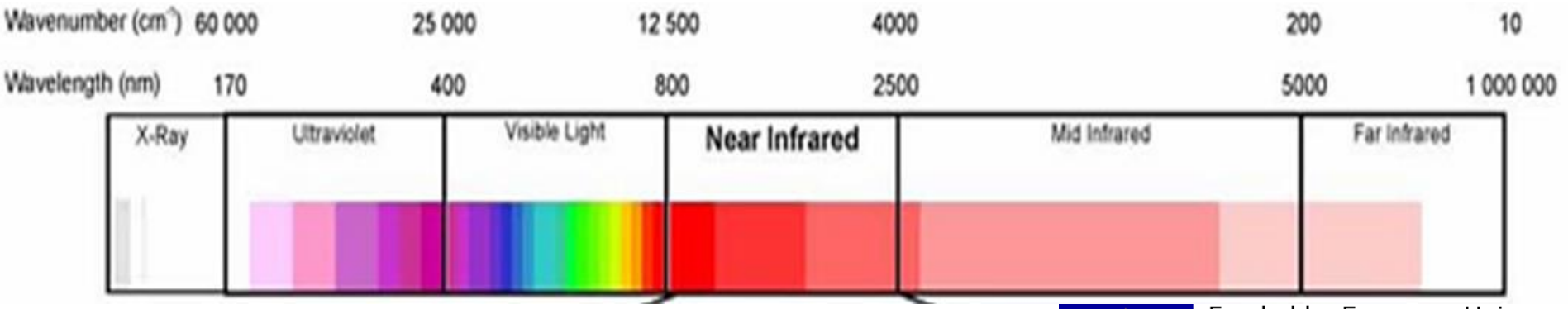
Specific Aim

To evaluate the potential use of FT-NIRS for predicting:

- Intramuscular Fat IMF
- fatty acids C18:1n9ct C18:3n3 C20:3 n6
- FA groups SFA MUFA PUFA
  n-6 PUFA n-3 PUFA n-4 PUFA n-1 PUFA
- Ratios PUFA/SFA n-6/n-3



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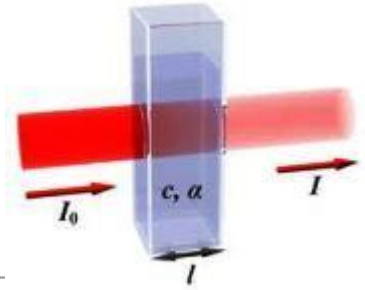
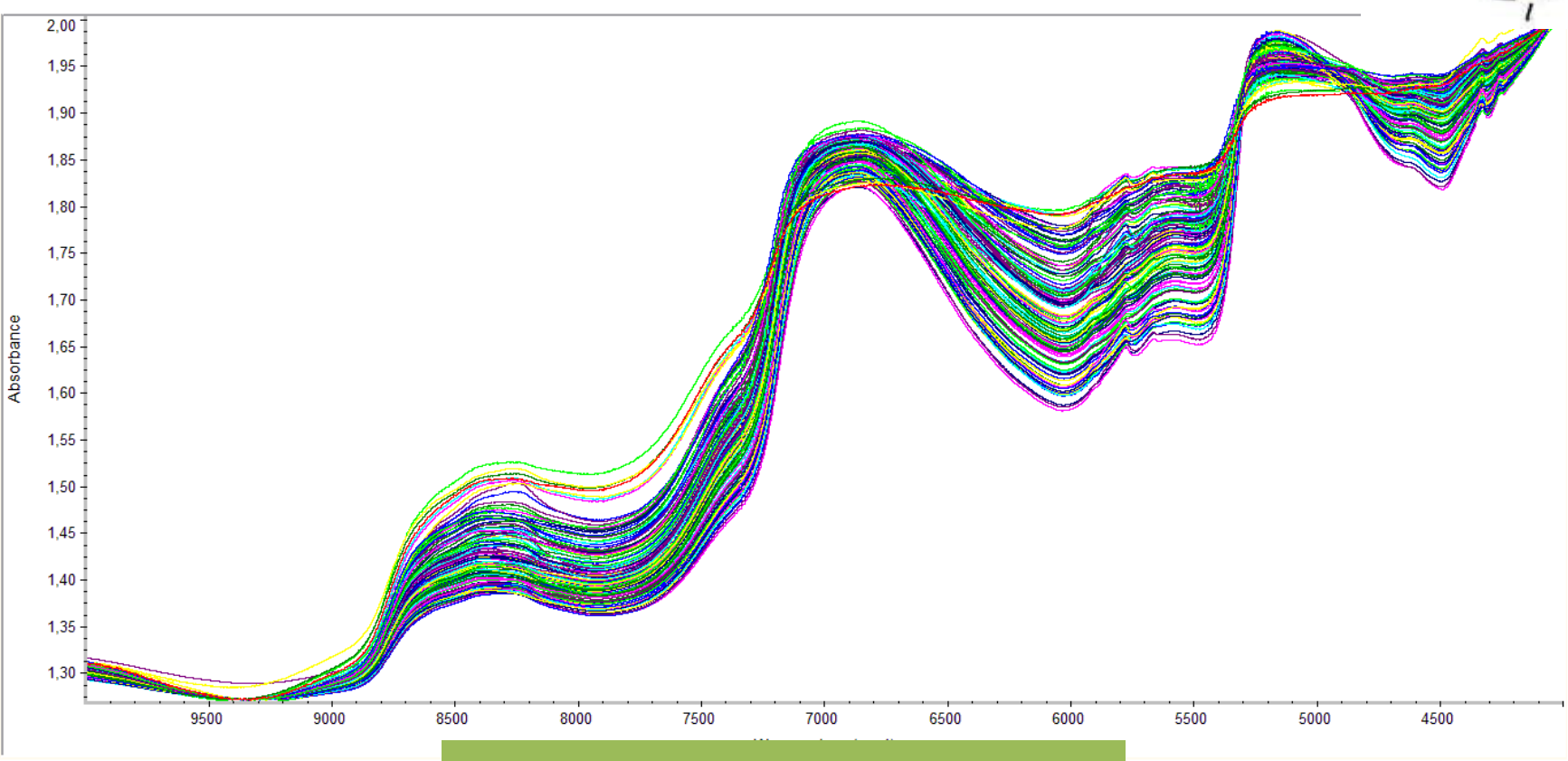
Scan of samples

FT- NIRS (Antaris II)**:**

- **2 scan for each sample (32 scans 16^{-1} cm)**
- **Absorbance mode**





Wavenumbers (cm^{-1})

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Data analysis

Mathematical pre-treatments

- Multiplicative Scatter Correction
- 1st and 2nd derivative
- Smoothing: Savitzky-Golay Filter
- outliers' spectra

Calibration

Partial Least Square Regression
80% of total samples

Validation

20% of total samples
(randomly selected)

Results

R^2	Coefficient of determination	**Rp^2**
RMSEC	Root mean square error	**RMSECP**

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DATA SET

Intramuscular Fat and Fatty Acid composition (all units in %)

Parameter n= 165	Mean	SD	Minimum	Maximum
IMF	4.30	2.33	0.56	14.15
SFA	38.71	2.44	31.87	45.61
MUFA	52.48	3.22	43.23	59.45
PUFA	8.26	2.72	3.31	19.50
n-6 PUFA	8.01	2.61	3.24	18.40
n-3 PUFA	0.26	0.14	0.07	1.10
n-4 PUFA	0.01	0.01	0.00	0.08
n-1 PUFA	0.20	0.14	0.03	1.04
C18:1n9ct	42.30	2.45	34.47	48.19
C18:3n3	0.31	0.13	0.11	0.78
C20:3n6	0.16	0.08	0.04	0.58
Ratios				
PUFA/SFA	0.22	0.08	0.08	0.55
n-6/n-3	35.23	11.84	16.69	61.35

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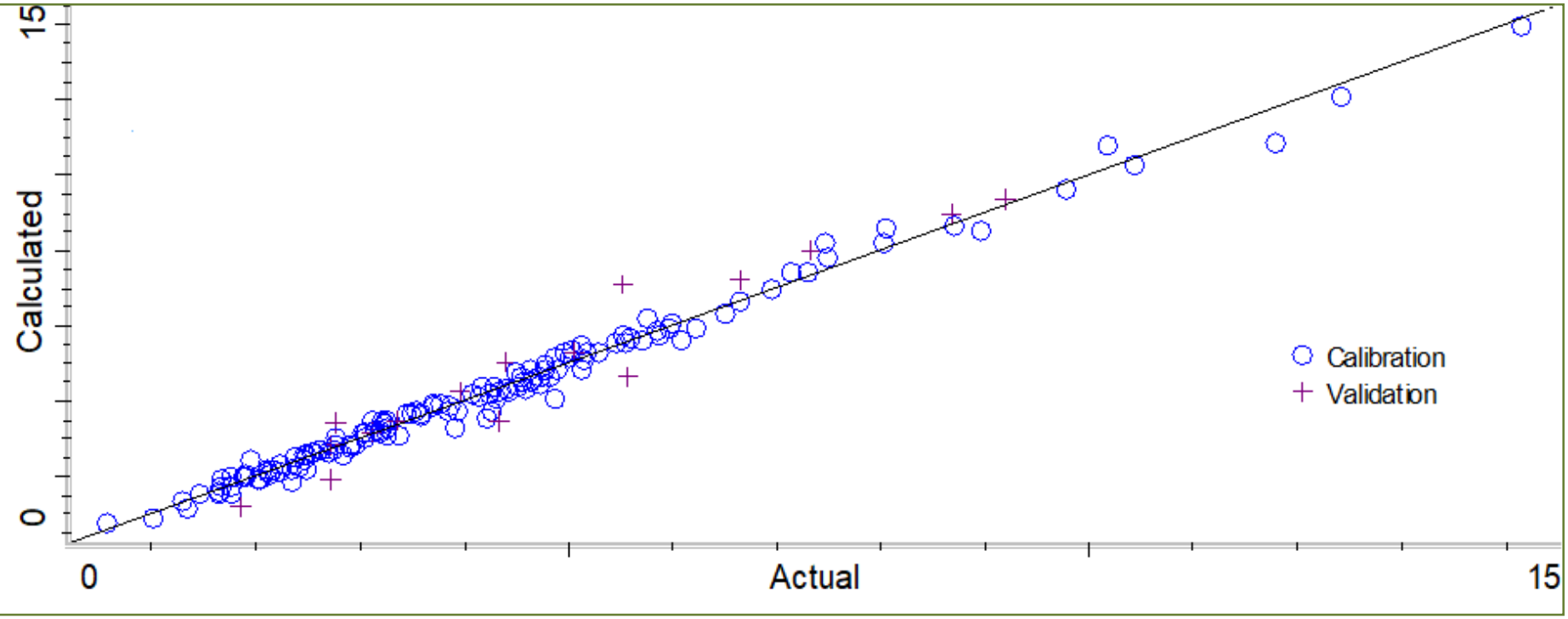
NIRS spectra of grounded meat

IMF

R^2_c	0.994	R^2_p	**0.966**
RMSEC	0.245	RMSEP	0.664



Prevolnik Povše et al. 2017
Pork fresh meat **LD muscle** (n = 75)

	R^2_c	SE_C	R^2_{cv}	SE_{CV}
IMF	0.99	0.14	0.95	0.25

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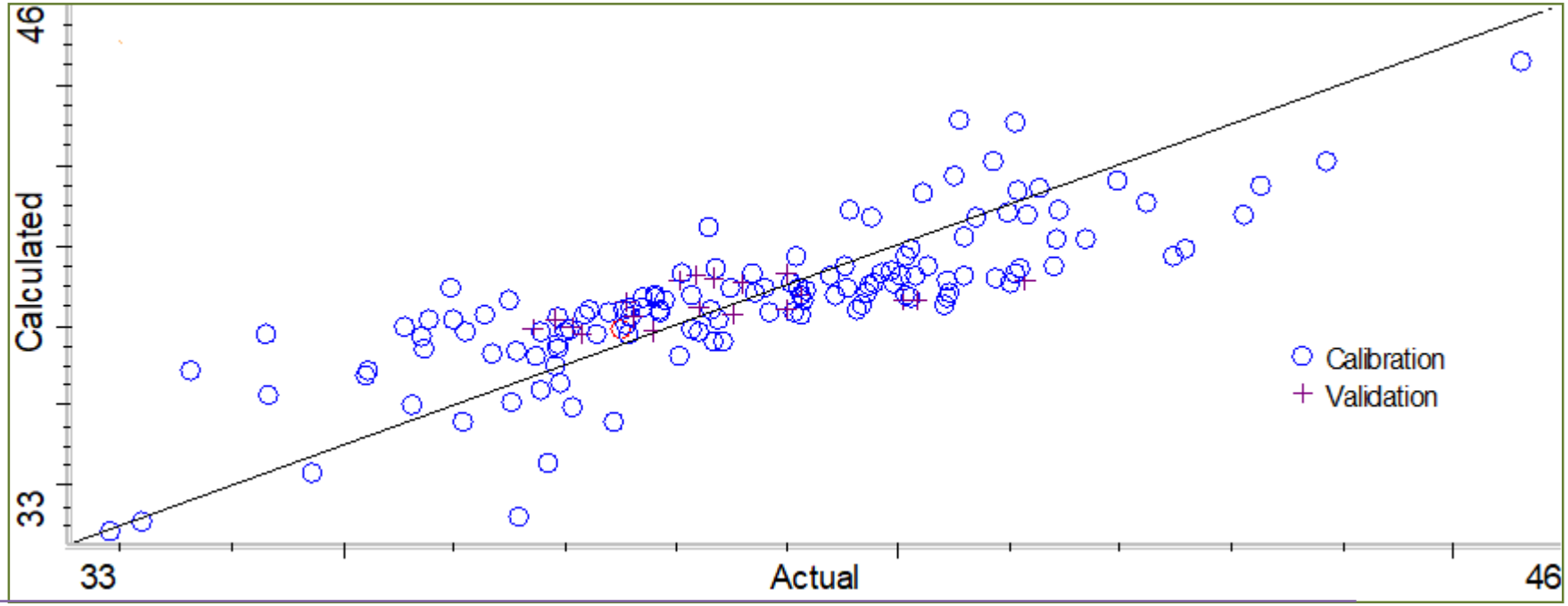
SFA

R^2_c **0.817** R^2_p **0.771**

RMSEC 1.30 RMSEP 0.975



Gonzalez Martins et al. (2003) in subcutaneous fat of Iberian pig

	RSQ	Se_C or SE_P	SE_{CV} SEP_C	Range	n	N. PC
Saturated						
CALIBRATION	0.96	0.86	1.10	22.09-47.31	157	12
EXT. VALIDATION	0.90	1.18	1.18	29.26-40.75	23	

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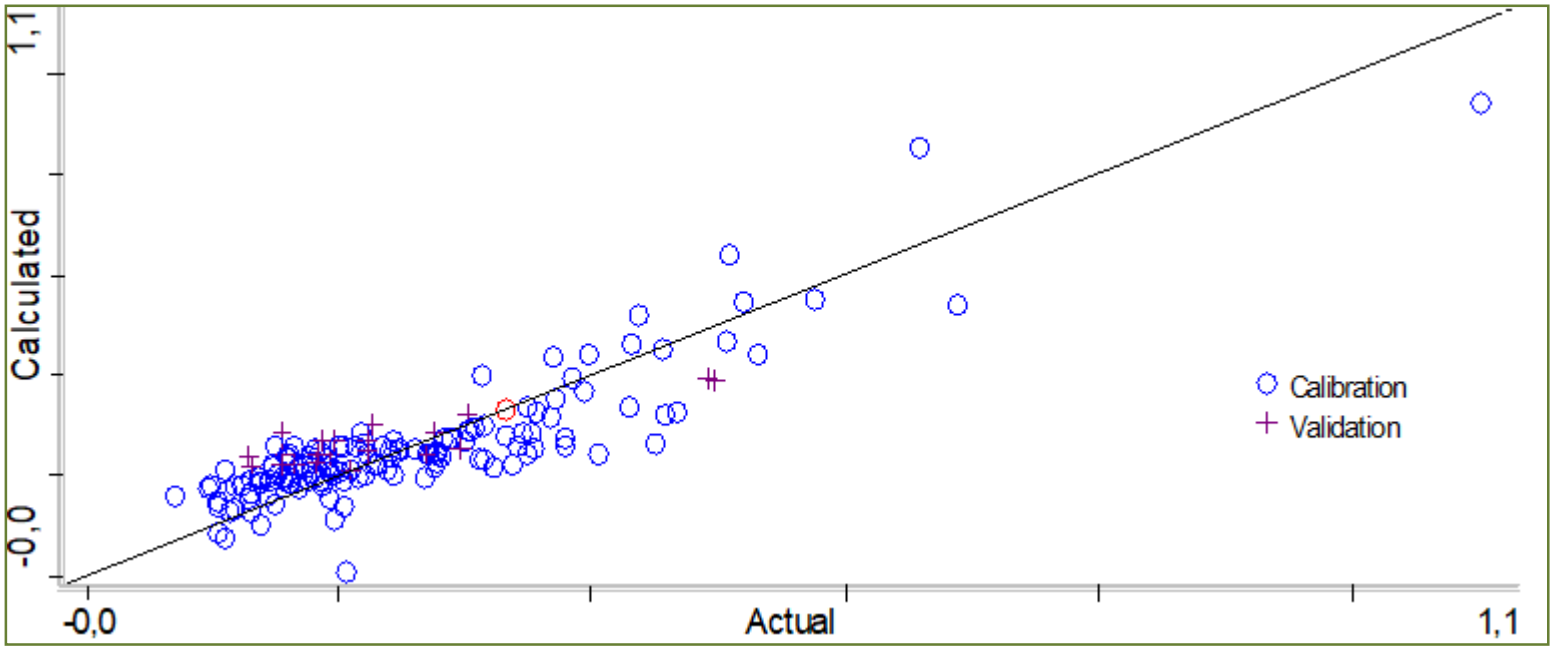
PUFA

R^2_c 0.881 R^2_p **0.872**

RMSEC 0.066 RMSEP 0.070



Gonzalez Martins et al. (2003) in subcutaneous fat of Iberian pig

	RSQ	Se_C or SE_P	SE_{CV} SEP_C	Range	n	N. PC
Polyunsaturated						
CALIBRATION	0.95	0.47	0.60	2.31-14.82	157	12
EXT. VALIDATION	0.88	0.76	0.78	5.44-13.31	23	

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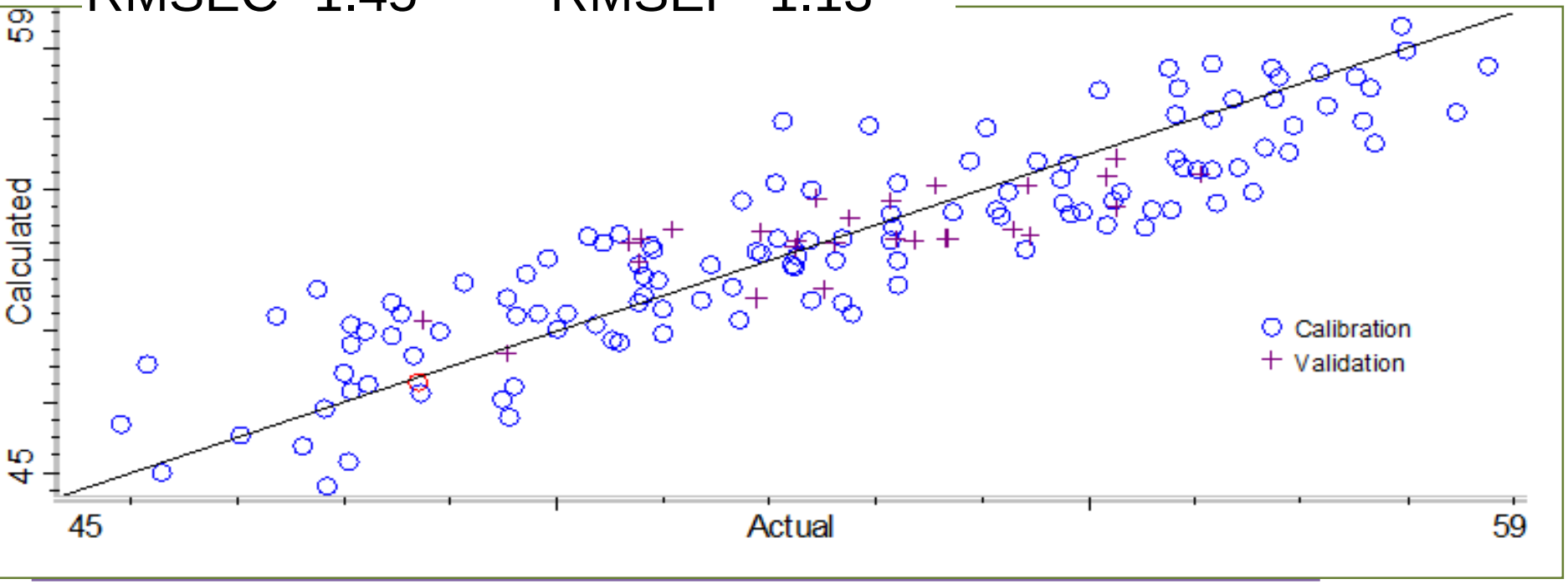
MUFA

R^2_c **0.894** R^2_p **0.770**

RMSEC 1.45 RMSEP 1.13



Gonzalez Martins et al. (2003) in subcutaneous fat of Iberian pig

	RSQ	Se_C or SE_P	SE_{CV} SEP_C	Range	n	N. PC
Monounsaturated						
CALIBRATION	0.89	0.98	1.50	47.37-65.62	157	12
EXT. VALIDATION	0.74	1.21	1.23	51.43-60.70	23	

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PLS calibration and validation models

Trait	Calibration		Validation		Math treat
	R^2_c	RMSEC	R^2_p	RMSEP	
IMF	0.994	0.24	0.966	0.66	1;2
SFA	0.817	1.30	0.771	0.97	1;3;4
MUFA	0.894	1.45	0.770	1.13	1;3;4
PUFA	0.881	0.66	0.872	0.70	1;3

Math treatment:

1. Multiplicative Scatter Correction
2. First Derivative
3. Second Derivative
4. Savitzky-Golay filter

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PLS calibration and validation models

Trait	Calibration		Validation		Math treat
	R^2_c	RMSEC	R^2_p	RMSEP	
n-6 PUFA	0.754	1.43	0.694	1.52	1;3
C18:1 n9ct	0.768	1.46	0.687	1.19	1;3;4
Ratios					
n-6/n-3	0.824	***6.77***	0.801	5.94	1;3

Math treatment:

1. Multiplicative Scatter Correction **2.** First Derivative

3. Second Derivative **4.** Savitzky-Golay filter

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PLS calibration and validation models

Trait	Calibration		Validation		Math treat
	R^2_c	RMSEC	R^2_p	RMSEP	
n-3 PUFA	0.756	0.07	0.701	0.06	1
n-4 PUFA	0.721	0.00	0.671	0.00	1;3;4
n-1 PUFA	0.834	0.06	0.648	0.05	1;2
C18:3 n3	0.812	0.07	0.768	0.07	1;2;4
C20:3 n6	0.740	0.05	0.721	0.04	1;2;4
Ratios					
PUFA/SFA	0.704	0.44	0.686	0.37	1;3

Math treatment:

1. Multiplicative Scatter Correction
2. First Derivative
3. Second Derivative
4. Savitzky-Golay filter

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Resuming ….

- Developed model applicable for IMF quality control
- Promising results for FA groups
- Good results even when low proportion of FA
- Single fatty acid even if highly represented gave poor result
- Mathematical pre-treatments needed
- Possible application for Nutritional Label
- Additional work expected …..

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Thanks for your attention

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