A feasability study for the prediction of the technological quality of ham with NIR spectroscopy

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Introduction:

- Muscle quality is a key factor in the French cooked ham industry: no phosphate and carraghenan allowed in the « Jambon cuit supérieur » process

- Cooking yield is controlled by measuring the *Semimembranosus* ultimate pH

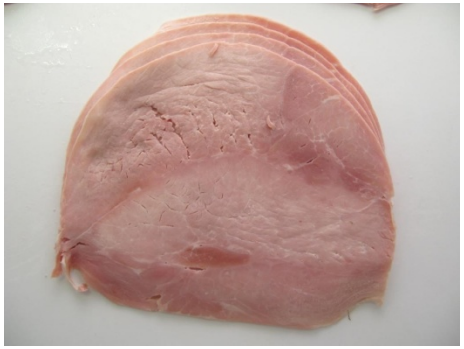
pH24 / cooking yield corr. r =	publication
0.70	Gueblez *et al.* (1990)
0.84	Alviset *et al.* (1995)
0.79	Vautier *et al.* (2011)

Introduction:

- Ultimate pH - one of the best indicators for the « PSE-like zone » defect risk level

  (Vautier *et al.*, 2008)

- This defect increases the rate of « paste-like » structure on slices of cooked ham



Introduction:

- Ultimate pH measurement is difficult in industrial conditions:
  - rate of production lines
  - calibration stability
  - versatile environment
  - maintenance (electrodes)

- Nowadays, processed meat industry need a more accurate technique to predict process yields

Introduction:

- Visible + NIR spectroscopy appears as a dedicated alternative for meat quality prediction:

  - Some interesting work on **drip loss** (Savenije *et al.,* 2006; r =0,58)
  - Visible spectroscopy produced satisfying cross validation results for **cooking yield** prediction (Vautier *et al.,* 2011)
  - Spectrum collection frequency **up to 600/hour**
  - Low effect of industrial environment on NIRS device (contact probes)

Objectives:

- To confirm the precision of NIRS prediction of the **cooking loss** and **PSE-like zones**
  - External validation data set
- To explore multiple **muscle/probe** couples for bone-in and deboned pork hams

Materials and methods:

Sampling:

- **110** individual cooked hams
- "**Jambon Cuit Supérieur**"
- Processing performed following **industrial standards** and materials

2 data sets:

- **Calibration** data set **(n= 74)**
  - ↳ PLS regression determined by cross validation
- **External validation** data set **(n=36)**

Materials and methods:

Spectrometer:

- **ASDI labspec5000** device
- Spectrum range used**:** between **350** and **1800nm**
- **2** contact **probes**

Labspec5000

Insertion probe (two ways optical path)

Surface probe

Materials and methods:

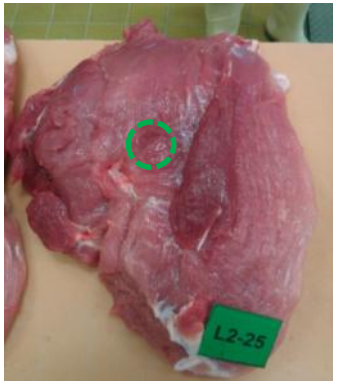
Raw material = deboned hams

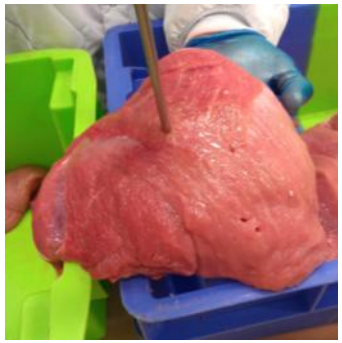
Semitendinosus *R.Femoris + Vastus* *Biceps Femoris* *Semimembranosus + Adductor* *Gluteus Medius*

Materials and methods:

NIRS measurements:

- ***Semimembranosus*** (SM)





Surface probe

-

Internal surface

Insertion probe

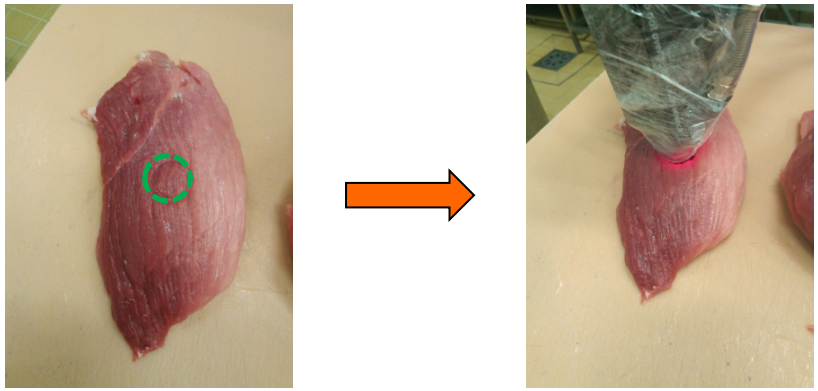
-

Muscle inside, 2cm from the internal surface

Materials and methods:

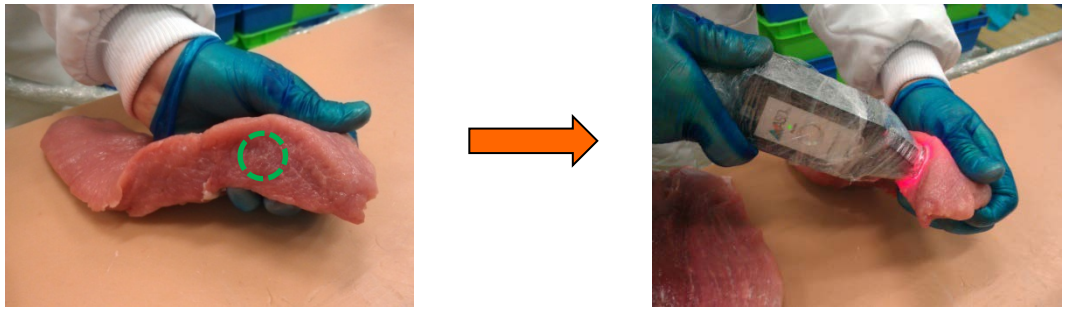
NIRS measurements:

- ***Semitendinosus*** (ST)



Surface probe
-
Internal surface

- ***Gluteus Medius*** (GM)

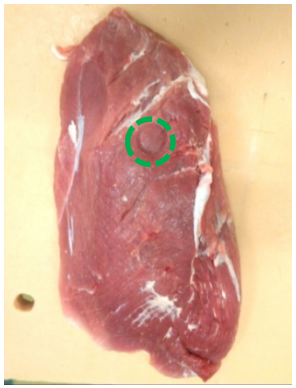


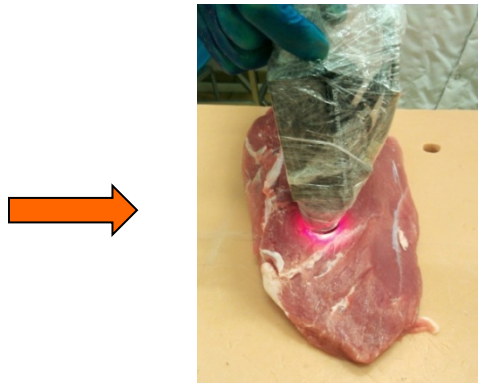
Surface probe
-
Muscle section

Materials and methods:

NIRS measurements:

- ***Biceps Femoris*** (BF)





Surface probe
-
Internal surface

- ***Vastus Lateralis*** (VL)

Surface probe
-
External surface

Materials and methods:

Ham processing with individual traceability:

deboning

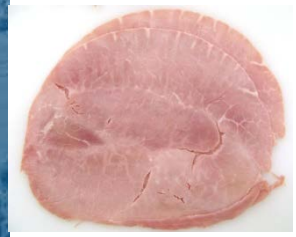
- *PSE-like zone quotation*
- *NIRS measurements*
- *Ultimate pH*

brine injection

- *cooking yield*

tumbling and cooking / individually vacuum packed hams / 5 hams per mould

- *slicing yield*

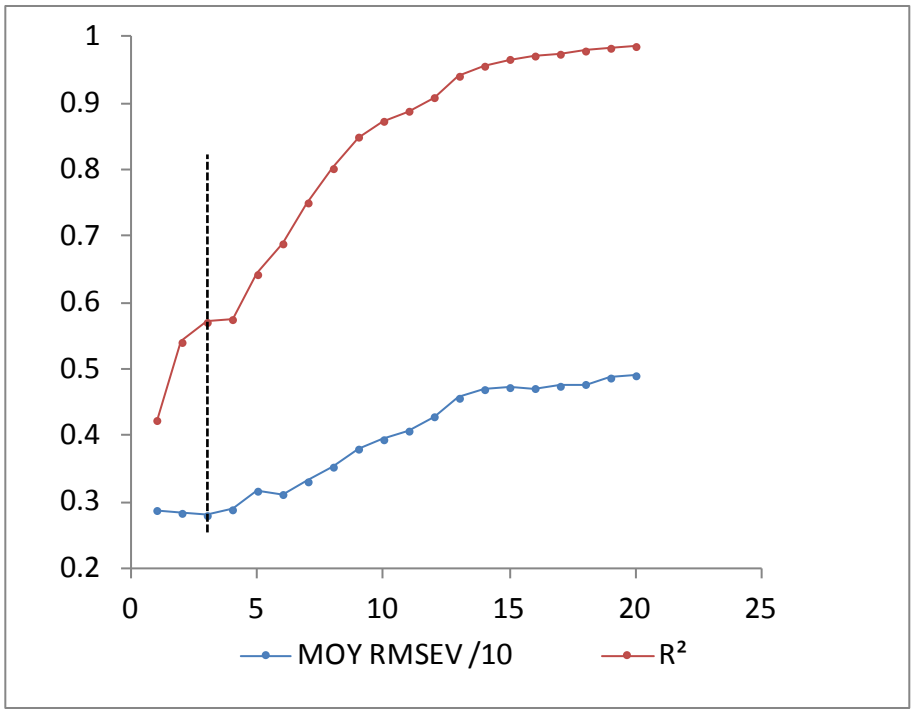


High frequency slicing line

Commercial product

Results for cooking yield prediction:

1 – *Gluteus Medius* calibration



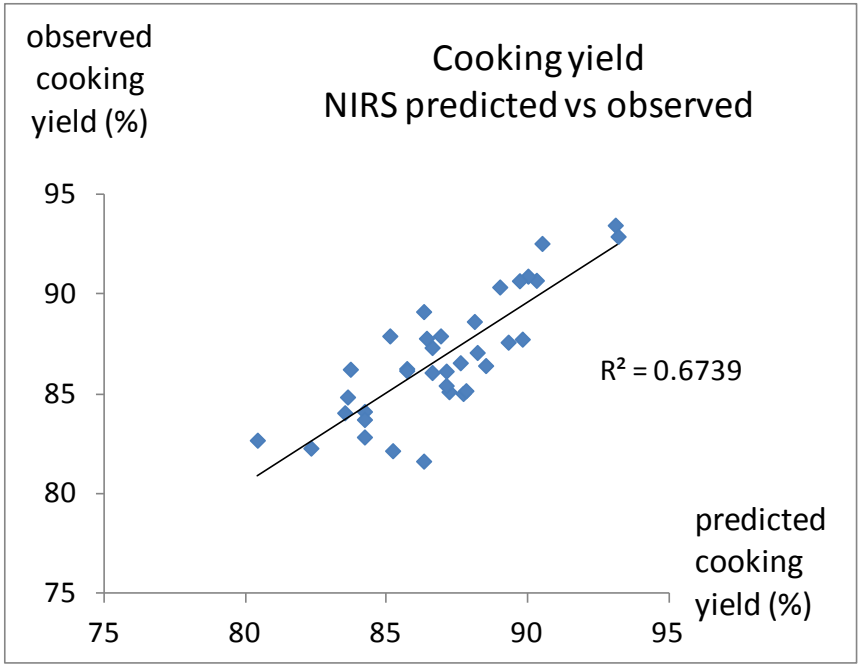
(n = 74)

Cross validation (1/3)		Calibration (3/3)
Rmsev min.	Nb PLS factors	R^2
2.80	3	0.57

Results for cooking yield prediction:

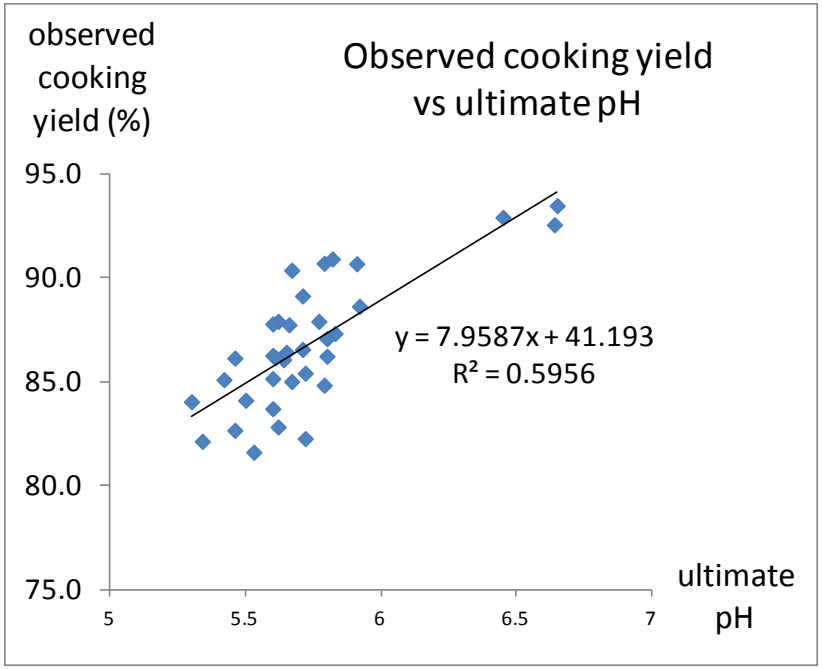
1 – *Gluteus Medius* external validation

(n = 36)



r = **0.82** / error = **1.62**

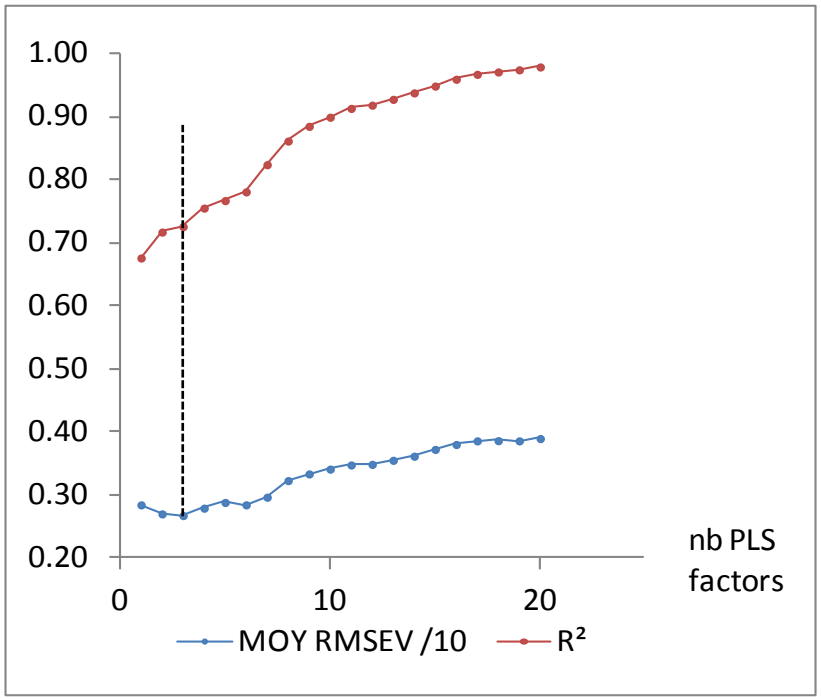
(n = 36)



r = **0.77** / error = **1.53**

Results for cooking yield prediction:

2 – *Semimembranosus* calibration



Surface probe

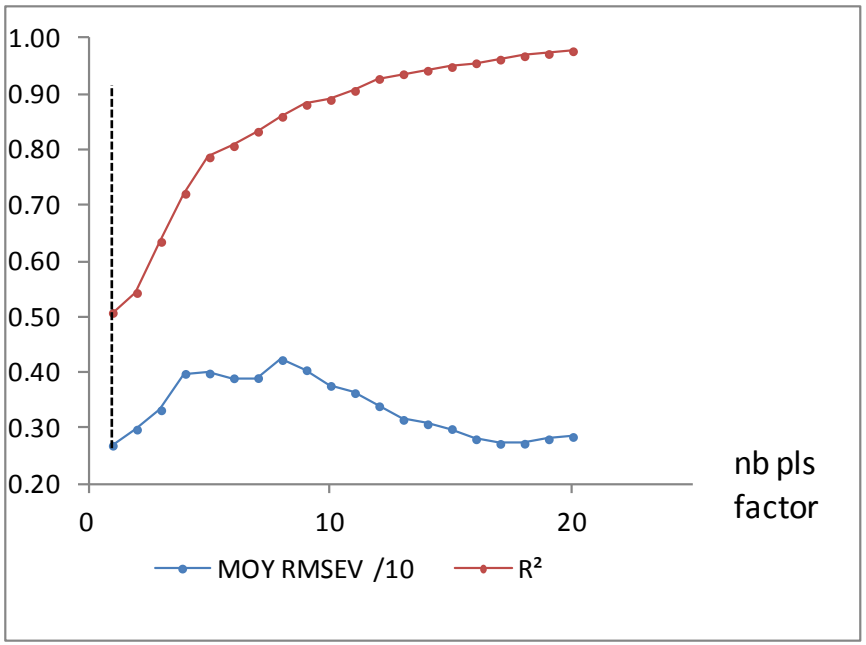
-

(n = 74)

Cross validation (1/3)		Calibration (3/3)
Rmsev min.	Nb PLS factors	R^2
2.68	3	0.73

Results for cooking yield prediction:

2 – *Semimembranosus* calibration



insertion probe

-

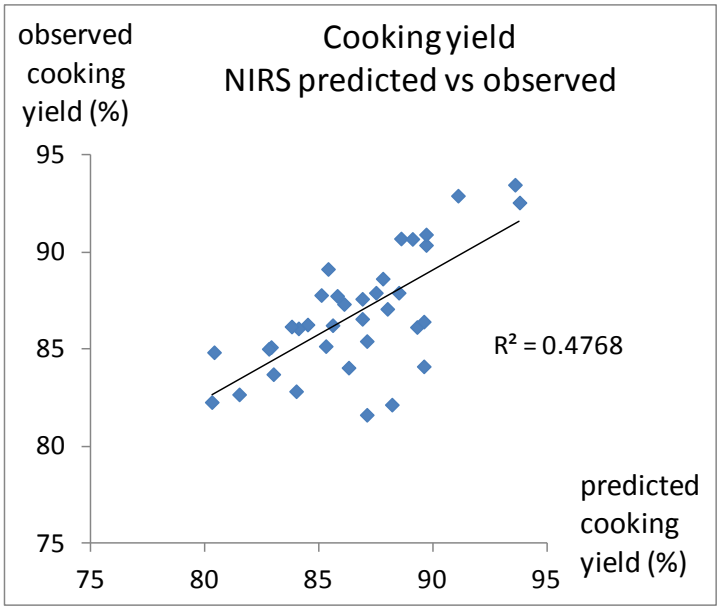
(n = 74)

Cross validation (1/3)		Calibration (3/3)
Rmsev min.	Nb PLS factors	R^2
2.69	**1**	**0.51**

Results for cooking yield prediction:

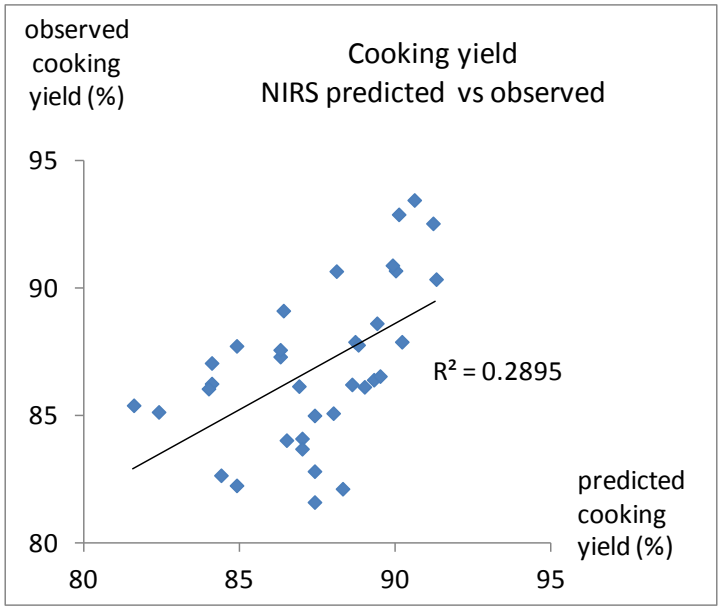
2 – *Semimembranosus* external validation

Surface probe



r = **0.69** / error = **2.37**

Insertion probe



r = **0.54** / error = **2.11**

Results for cooking yield prediction:

3 – Other muscles external validation

Probe	Muscle	External validation (n=36)	
		NIRS predicted / observed cooking yield (r =)	Error
Surface probe	*Vastus Lateralis*	**0.60**	**1.87**
	Biceps Femoris	**0.53**	**1.94**
	Semitendinosus (internal surface)	**0.55**	**1.88**
	Semitendinosus (external surface)	**0.28**	**2.64**

Results for PSE-like zones classification:

- Only presence/absence classification was used (IFIP scale shows 4 grades)
- Same PLS procedure as for cooking yield but based on discriminant analysis

Results for PSE-like zones classification:

External validation results

Probe	Muscle	External validation (n=50)	
		Correctly classified (%)	% false positive/ % false negative
Surface 	*Gluteus Medius*	60	77 / 23
	Semimembranosus (internal surface)	84	57 / 43
Insertion 	*Semimembranosus* (muscle inside)	77	65 / 35

Conclusions:

1 – Cooking yield prediction

- Best results for:

  contact probe / *Gluteus Medius*

external validation: **r=0.82** / error=**1.62**

(cooking yield standard deviation=3.6)

- Availability on **deboned** and **bone in** hams

Conclusions:

2 – PSE-like zone classification

- Efficient on ***Semimembranosus*** only
- Best results with the **contact probe**

84% correct classification

vs

77% (insertion probe)

Thank you for your attention