

## SESSION 2

# Physico-Chemical Analysis

<b>Analytical Methods for Measurement of Typicality of Wine and Ham</b> I. Colquhoun, IFR	p. 43
<b>Chemical analysis of dry cured ham aroma by electronic nose and SPME-GC</b> D.L. Garcia Gonzalez, CSIC	p. 58
<b>Factors influencing typicality of selected products, application to wine</b> V. Cheynier, INRA Montpellier	p. 69
<b>Prediction of sensory traits by analytical methods</b> D. Bertrand, ENITIAA-INRA	p. 82

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## Typical Food Products in Europe: Consumer Preference and Objective Assessment

### TYPIC

2003-2005 QLK1-CT-2002-02225



### Analytical Methods for Measurement of Typicality of Wine and Ham

Ian Colquhoun, IFR Norwich UK



## Range of analyses performed

1. Aroma volatiles (wine & ham)
2. Polyphenolics (wine)
3. General profiling and other methods (wine & ham)

Statistical analysis for discrimination, correlation and interpretation

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## 1. Aroma volatiles

### SPME-GC

- Solid phase microextraction/ gas chromatography (wine & ham)

Electronic nose (ham)

### AEDA

- Aroma-Extract-Dilution-Analysis (wine)

Wine ([DLR Rheinpfalz](#))

Ham ([IG-CSIC Sevilla](#))

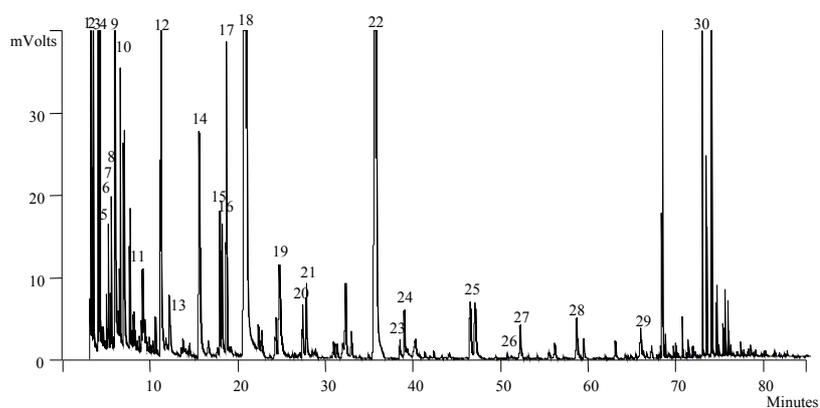
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## SPME-GC (wine & ham)

- Profiling of aroma compounds in headspace of sample
- Adsorption of compounds in headspace onto fibre
- Desorption in injection port of GC and quantitative analysis
- ~42 compounds (wine), ~30 compounds (ham) -> mostly known compounds
- Different parts of the ham sampled -> different information

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## SPME-GC of volatiles of the *biceps femoris* muscle of a Spanish Iberian ham

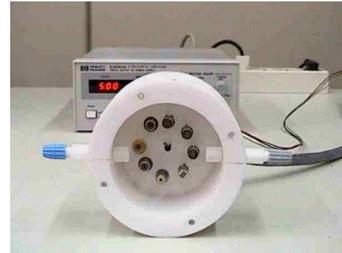


Numbered peaks are identified compounds

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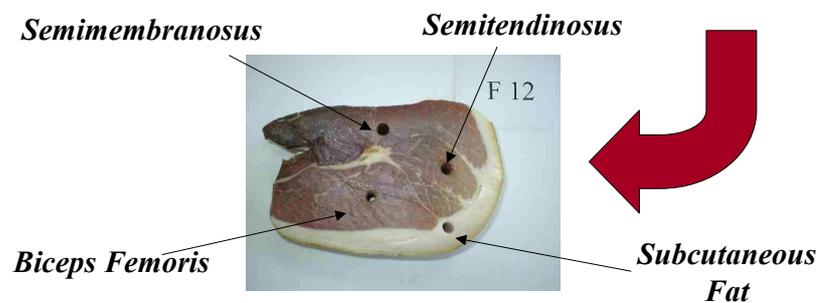
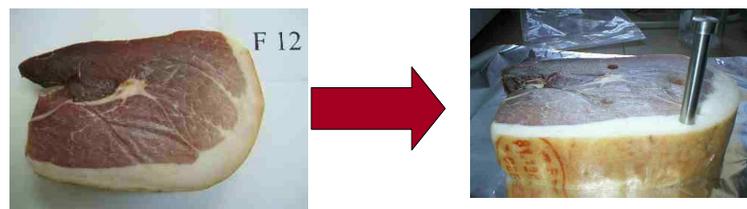
# Electronic nose (ham)

- Multiple (18) metal oxide sensors
- Signal recorded as function of time for all sensors simultaneously
- Different parts of ham sampled
- Advanced chemometrics to identify most useful sensors



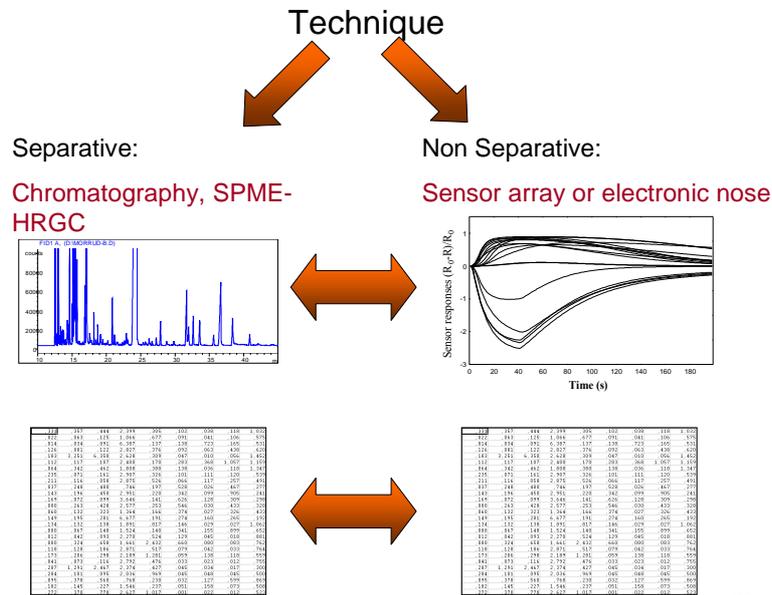
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## Sampling method for electronic nose



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## Volatile compound analysis: SPME/GC and electronic nose compared



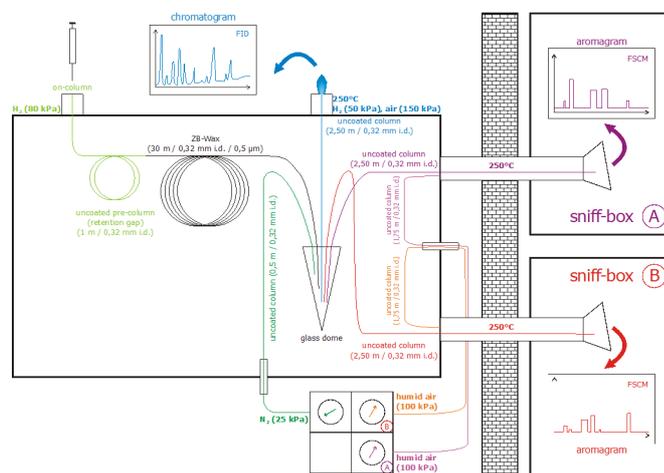
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## AEDA Aroma Extract Dilution Analysis (wine)

- Liquid/liquid extraction
- Fractionation of extracts to separate components of different classes (polarity)
- GC/Olfactometry
- Identification (GC)
- Simultaneous sensory description (sniffing)
- Quantification – 10 fold dilution steps to establish threshold
- Selection of wines for analysis from QDA (sensory) results

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## Schematic of GC/olfactometry apparatus



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## Results of Beaujolais-GC/O

B55 (2002 Beaujolais Villages) Fraction1

KI-Wax	Substance	Testperson 1		Testperson 2	
		FD	Description	FD	Description
982	Ethylpropanoate	10	sweet, fruit	100	fruit candy; fruit, flower
988	Propylacetate	100	apple	1000	fruit; light flower
1030	2-Methylpropylacetate	1	sweet	10	fruit; raspberry
1046	Ethylbutanoate	10	artificial fruit; sweet	1	fruit
1064	2-Methylethylbutanoate	10	sour	1	sour
1240	Ethylhexanoate	10	sweet, fruity; light sour		
1822	Ethylphenylacetate	10	flower; fruit, light sweet		
1892	unknown	100	flower, sweet		

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## 2. Polyphenolics in wine

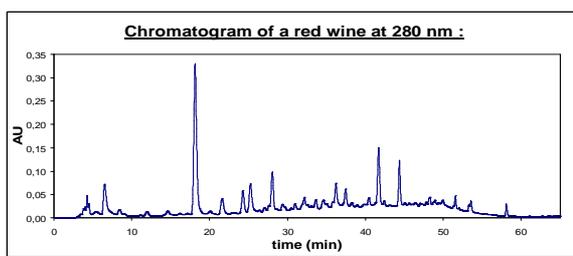
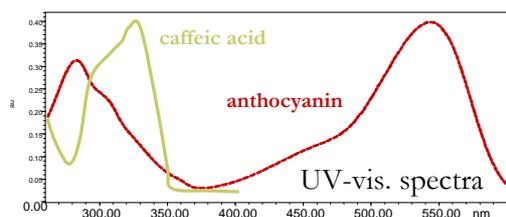
- HPLC chromatography with UV-vis spectra detection. 30 compounds (pigments, phenolic acids, flavonols)
- Tannins – degradation of polymers followed by HPLC to analyse fragments
- Colour measurement by spectrophotometry
- Direct injection mass spectrometry
- (INRA Montpellier)

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Phenolic Analysis      Chemical Consensus      QDA      Relationship



### A – Reference method 1 = HPLC-DAD-MS

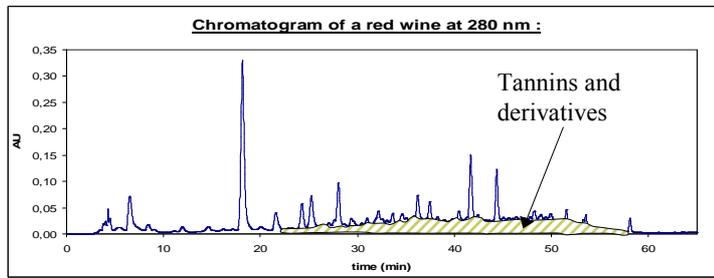


- 19 native and derived red pigments
- 4 phenolic acids
- 7 flavonols

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## B – Reference method 2 = HPLC after thiolysis

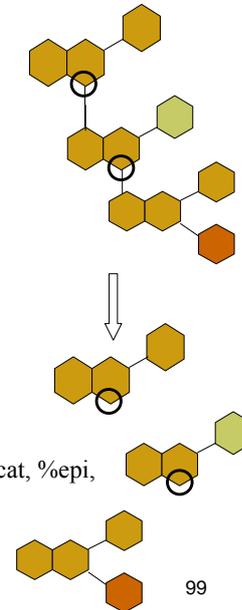


**Thiolysis** = depolymerization in the presence of a strong nucleophile

→ quantity of tannins (Tannins)

→ percentages of the 6 terminal and upper constitutive units : %cat, %epi, %cat-SH, %epi-SH, %EGC-SH and %E3OG-SH

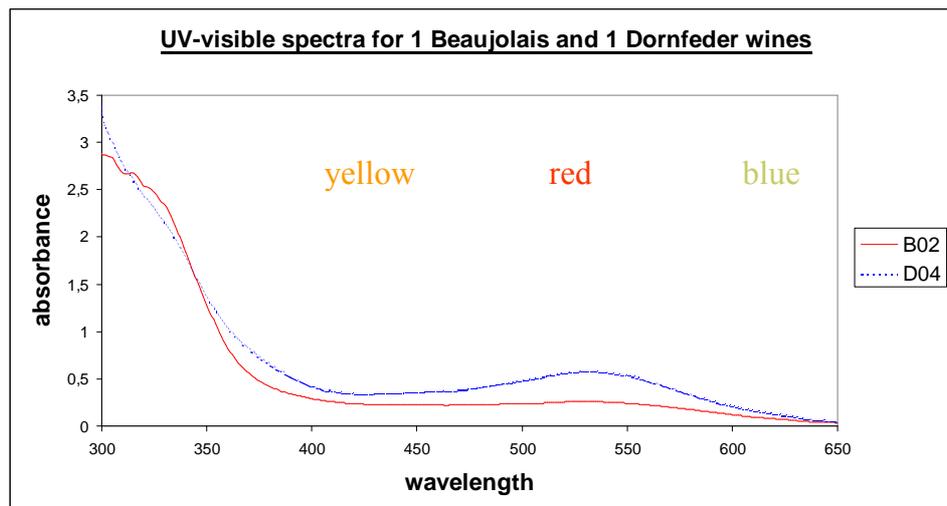
→ the mean Degree of Polymerization (mDP)



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## C – Global method = Spectrophotometry



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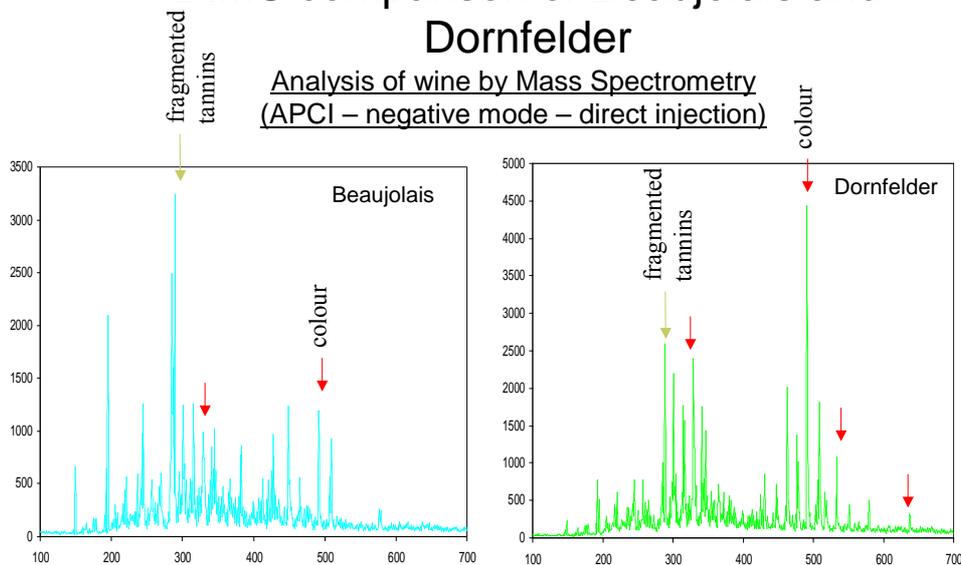
## Direct injection mass spectrometry (wine)

- No chromatography – very rapid
- Separating factor is  $m/z$  – TOF instrument gives high mass resolution
- Detects ionised compounds – choice of ionisation methods (2), choice of polarity (+/-)
- Fingerprinting method – chemometrics essential for analysis

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## DIMS comparison of Beaujolais and Dornfelder

Analysis of wine by Mass Spectrometry  
(APCI – negative mode – direct injection)



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### 3. General profiling and other methods

- Vibrational spectroscopy (CRA Gembloux)
- Front face fluorescence (ENITA C-F)
- NMR (IFR Norwich)
- LC/MS (hams) (IFR)
- Protein gel electrophoresis (hams) (IFR)
- Mechanical testing (hams) (IFR and Zaragoza)
- Exploratory methods, different classes of compound, chemometrics essential (Individual partners & INRA Nantes)

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#### Vibrational spectroscopy –ham. Near infrared system (400-2500nm)

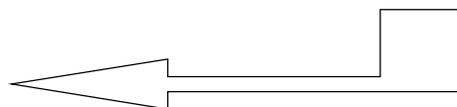
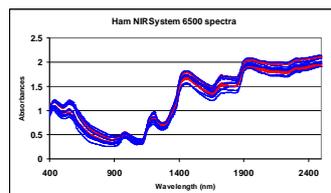
- Removing the external fat



- Grinding samples (Grindomix™ GM 200)  
-> homogenization



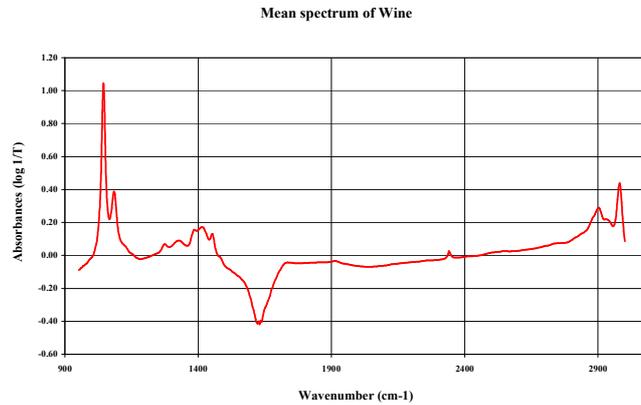
- Filling the sample holder and taking spectrum (3 to 5 replicates).



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# Vibrational spectroscopy of wine

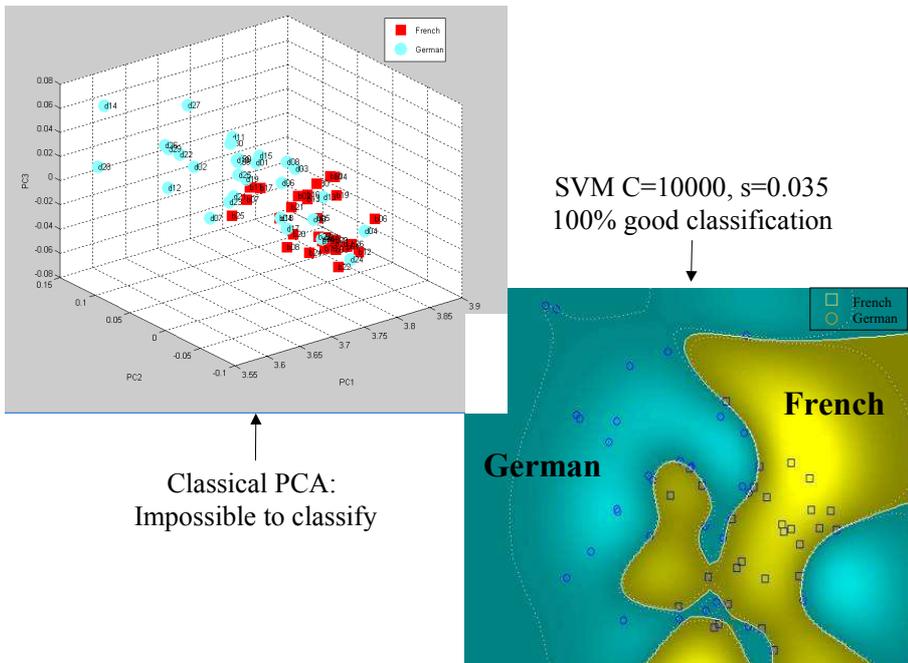
## Mid-infrared spectroscopy



Typical MIR spectrum of wine. Samples were analysed in transmission with 16 $\mu$ m path length flow cell

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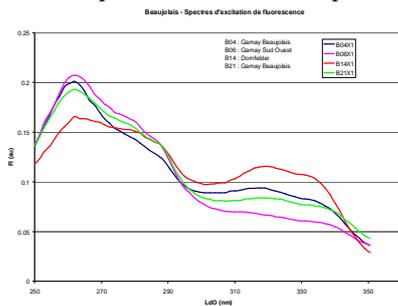
## Mid-infrared French wines vs German wines



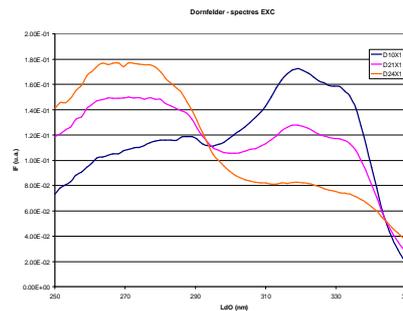
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## Front face fluorescence: excitation spectra recorded on French and German wines

- rapid, no sample preparation
- excitation spectra: 250 - 350 nm
- spectra recorded in triplicate



Beaujolais

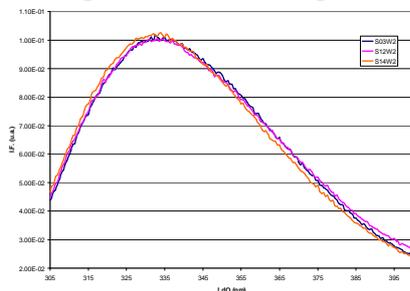


Dornfelder

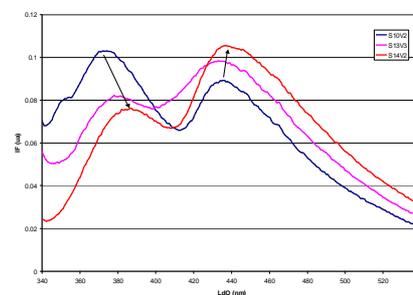
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## Front face fluorescence spectra. Emission spectra recorded on French and Spanish hams

- **muscle**: TRP emission spectra: 305 - 400 nm
- **fat tissue**: vit A emission spectra: 340 - 540 nm
- spectra recorded in triplicate



**muscle**: TRP emission spectra



**fat tissue**: vit A emission spectra

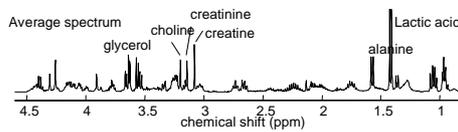
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# NMR of wines and hams



600 MHz NMR spectrometer

- ✓ 120 wines (20-40 metabolites)
- ✓ 42 hams (34 metabolites)



Average spectrum from ham extracts, (region 0.8-4.5 ppm)

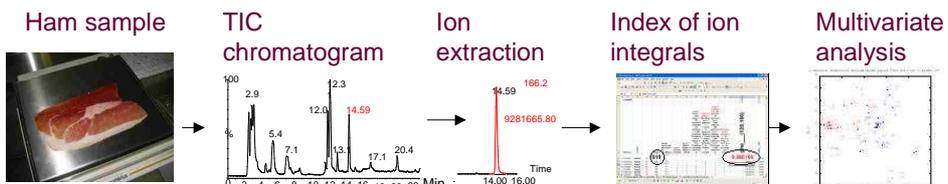


# HPLC/MS of hams



HPLC/MS

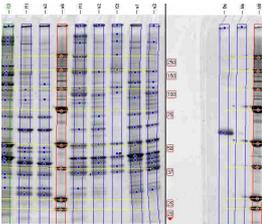
- ✓ 42 hams (97 metabolites)



Semi-quantification of metabolites by ESI-HPLC/MS (ESI+)



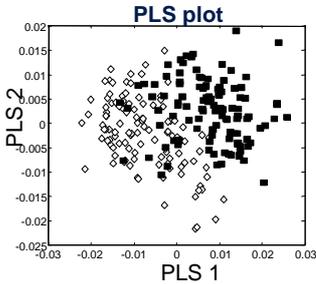
# Protein analysis of hams



✓ Study = 134 gels

## 1D gel electrophoresis

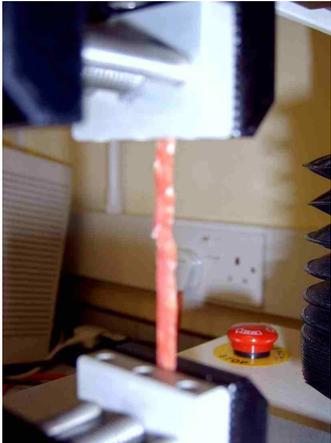
✓ 42 hams (20 protein bands, 50-150 kDa)  
 X 6 replicates in 4 fractions = 1008 lanes  
 from 134 gels



Fraction 2  
 Spanish ◊  
 French ■



# Mechanical properties of hams (Norwich method)

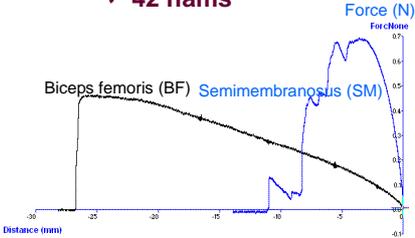


## Mechanical testing

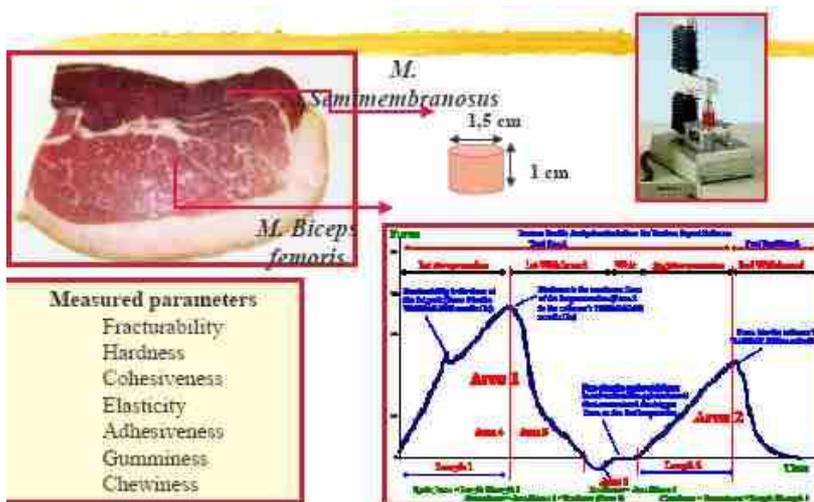
- Failure stress
- Failure strain
- Stiffness

Analysis of full force distance curves

✓ 42 hams

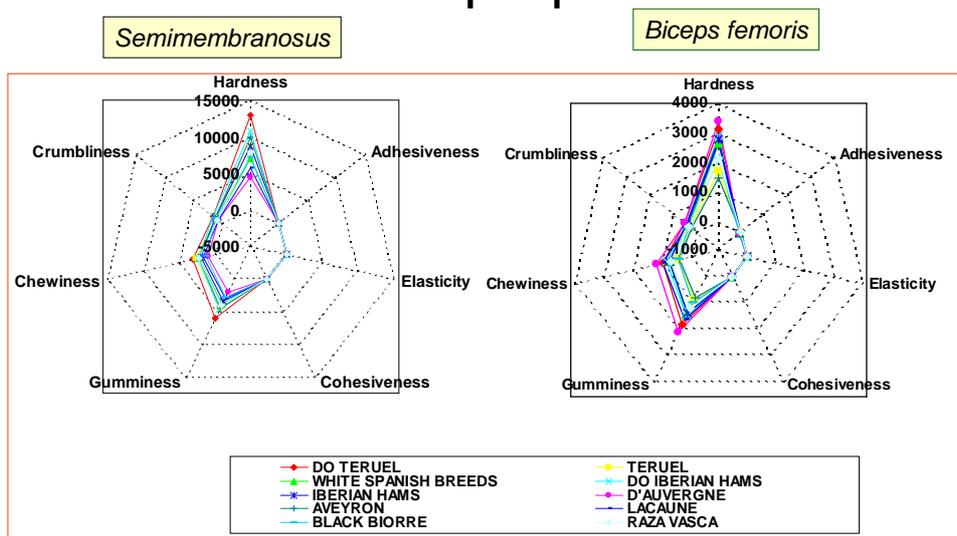


## Mechanical properties of hams: TPA (Zaragoza method)



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## Mechanical properties: TPA



- Large differences between muscles / zones: Higher values in SM (external)
- SM: French hams show lower Hardness and related parameters
- BF: Auvergne hams are harder; Teruel, Aveyron and Bigorre show lower hardness

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# Conclusions

- All the analytical methods were able to distinguish samples at the 'top' level
  - ▀ Country, cultivar, breed
- Much more difficult at the next level down
  - ▀ PDO vs non-PDO
  - ▀ Same cultivar, different region
- Next talks will look in detail at analysis of data from specific ham and wine methods

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## Typical Food Products in Europe: Consumer Preference and Objective Assessment

**TYPIC**

2003-2005 QLK1-CT-2002-02225



### CHEMICAL ANALYSIS OF DRY CURED HAM AROMA BY ELECTRONIC NOSE AND SPME-GC

Diego L. García González



## Objectives

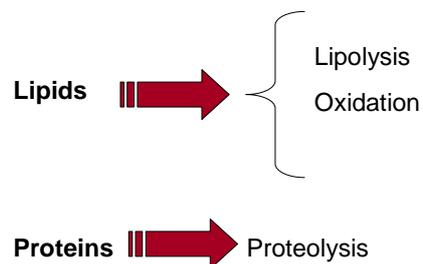
AROMA

Taste (retronasal olfactory perception)

1. To develop **objective methods** to evaluate the aroma vs. the consumer subjectivity
2. To **characterize** the ham aroma by different typicity factors (breed, geographical origin)
3. To select **volatile compounds** that are predictors of ham typicity
4. To **explain** the sensory evaluation of the hams by experts and consumers.

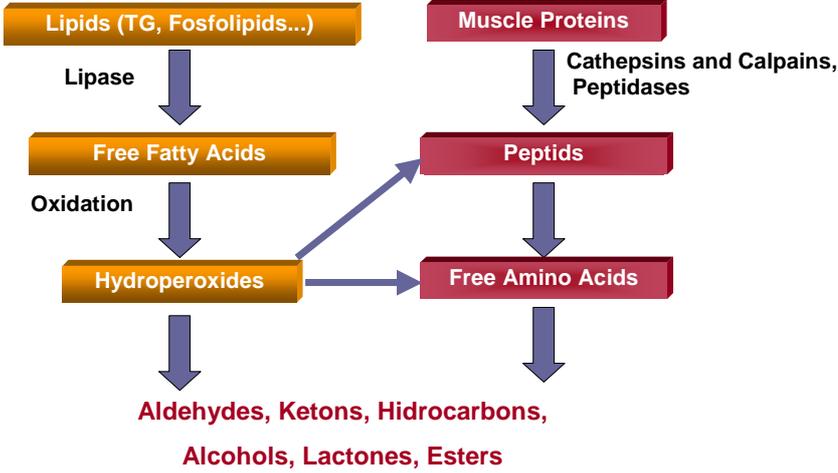
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## Generation of Volatiles



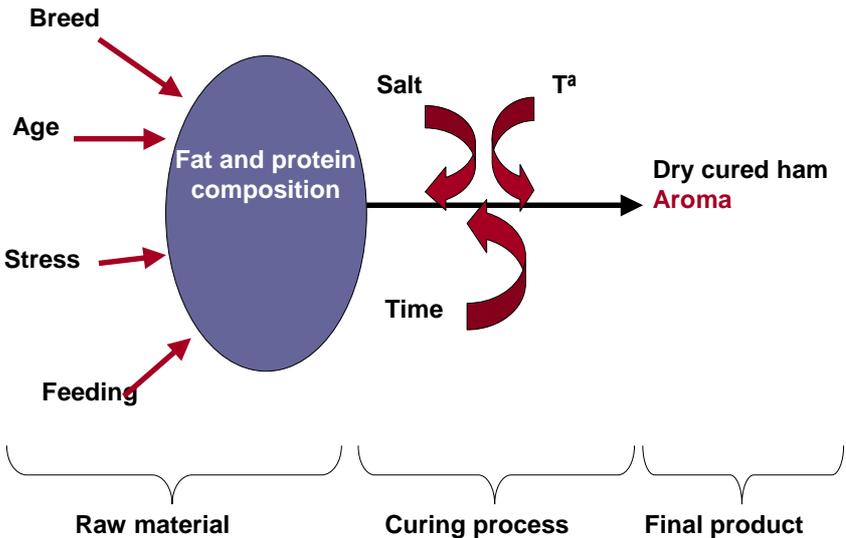
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### Lipolysis, Oxidation, Proteolysis



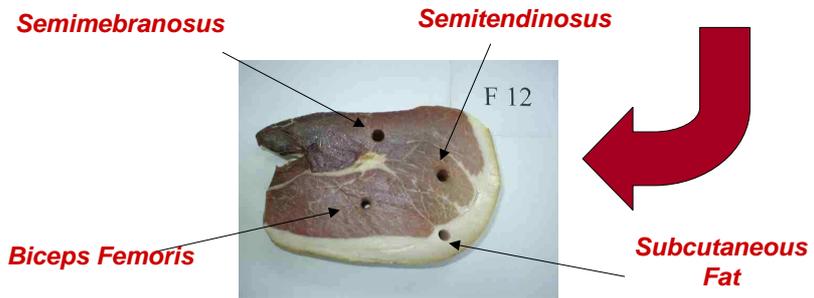
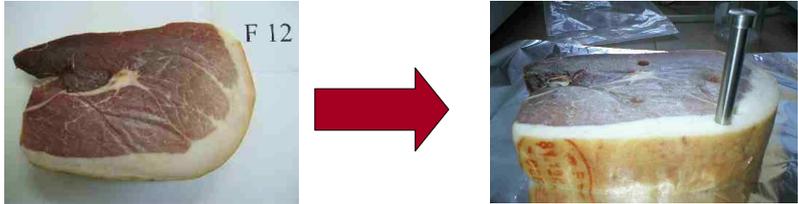
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### Variables affecting aroma



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## Sampling Method



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## Protocol for Electronic Nose Analyses

- **Sensors:** 18 Metal oxide Sensors (MOS)
- **Carrier gas:** Air
- **Sampling T<sup>a</sup>:** 34°C



García-González et al., *Eur. Food Res. Technol.*, 218 (2004) 484-487

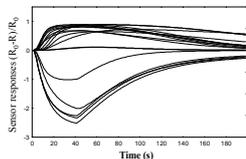
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# Volatile compound Analysis

## Technique

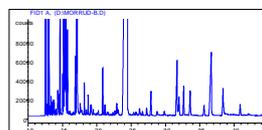
**Non Separative:**

**Sensor array or electronic nose**



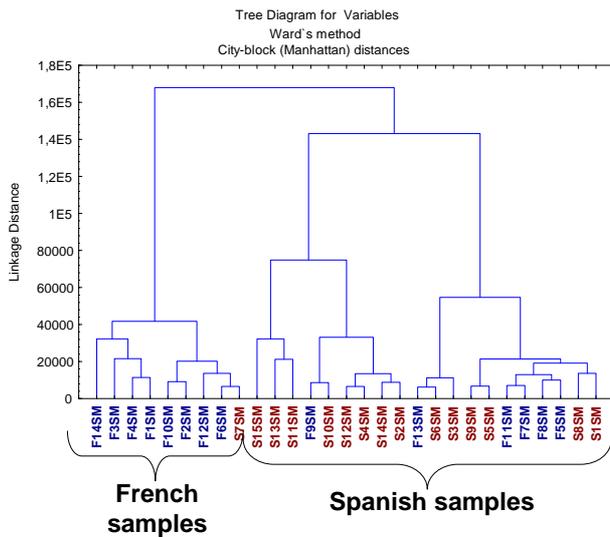
**Separative:**

**Chromatography, SPME-HRGC**



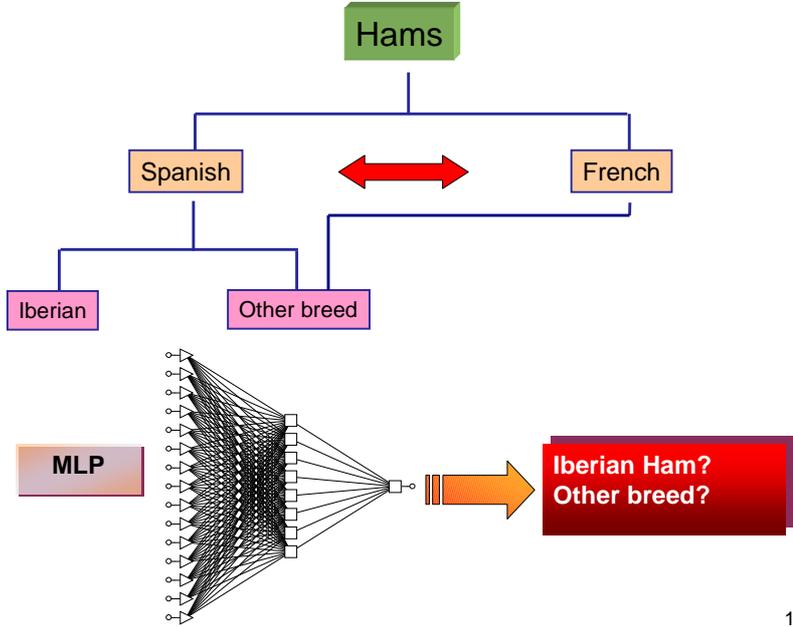
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# Cluster Analysis on SM samples



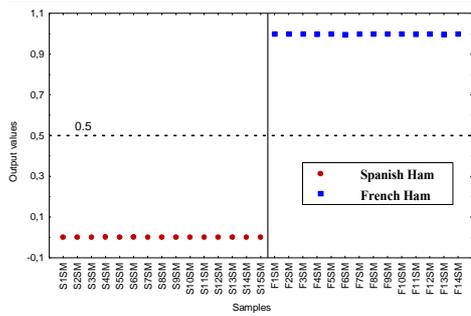
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## Structure of the Statistical Study



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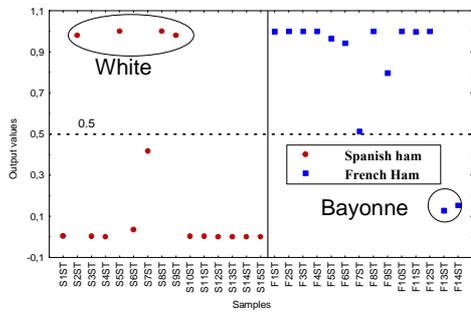
## MLP: 15:6:1. French vs Spanish



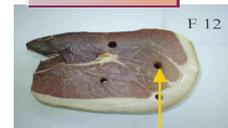
*Semimembranosus*



**Training**

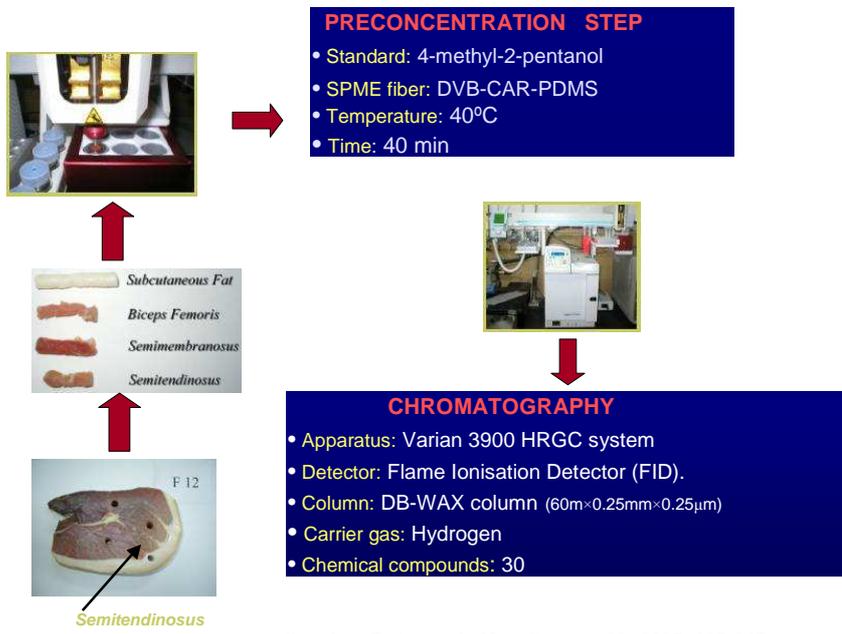


**Test**

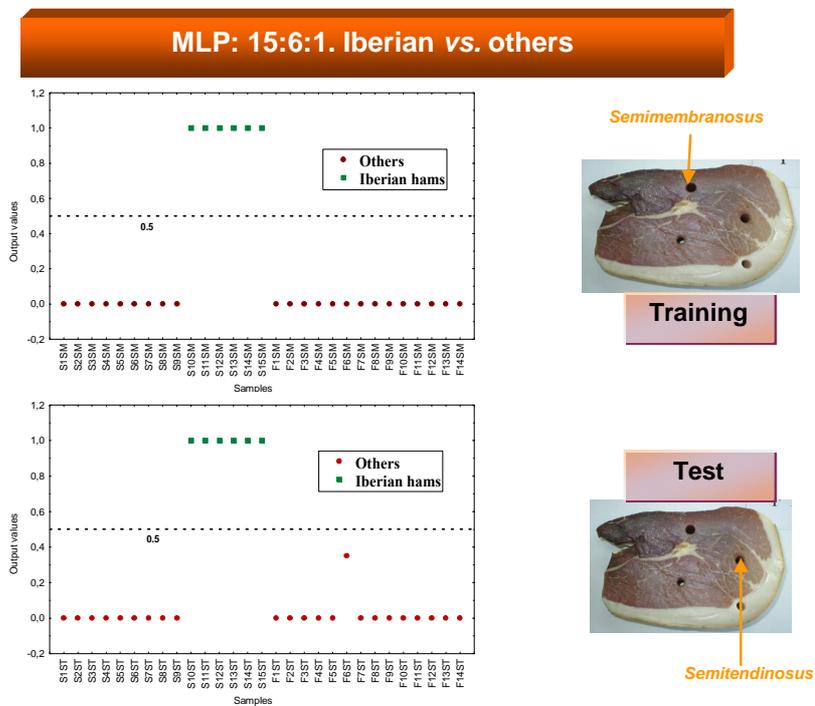


*Semitendinosus*

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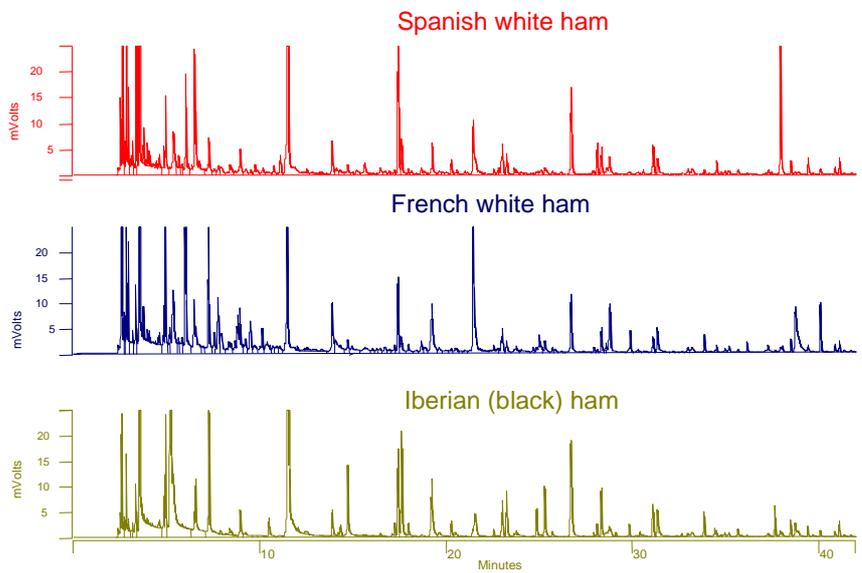


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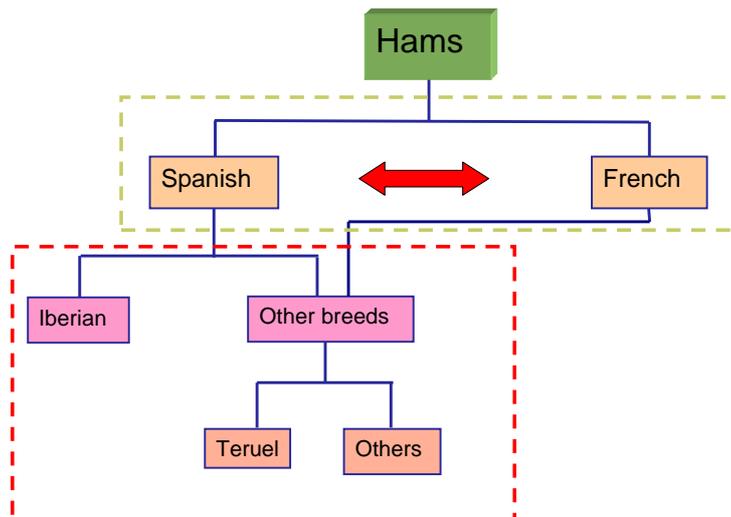
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## SPME-GC Analysis



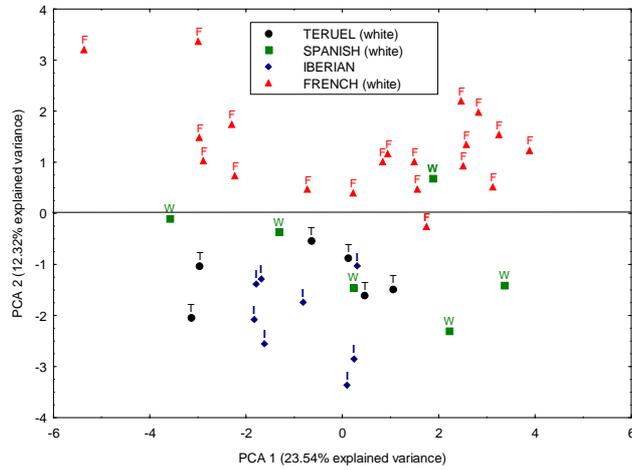
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## Structure of the Statistical Study



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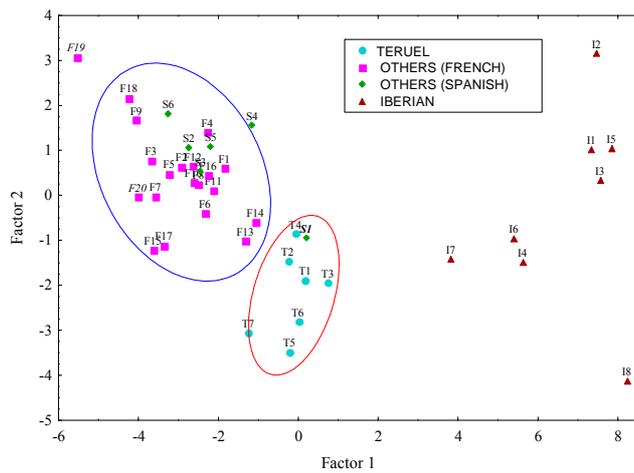
## French vs. Spanish Hams



Sánchez-Peña *et al.*, *Meat Science* 69 (2005) 635-645

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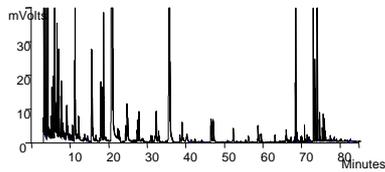
## Iberian vs. other breeds



Luna *et al.*, *Food Chemistry*, In Press, Available on-line

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## Sensory Analysis vs. volatiles



**SPME-HRGC**



**SENSORY ANALYSIS**  
(Universidad de Zaragoza, Rodez)



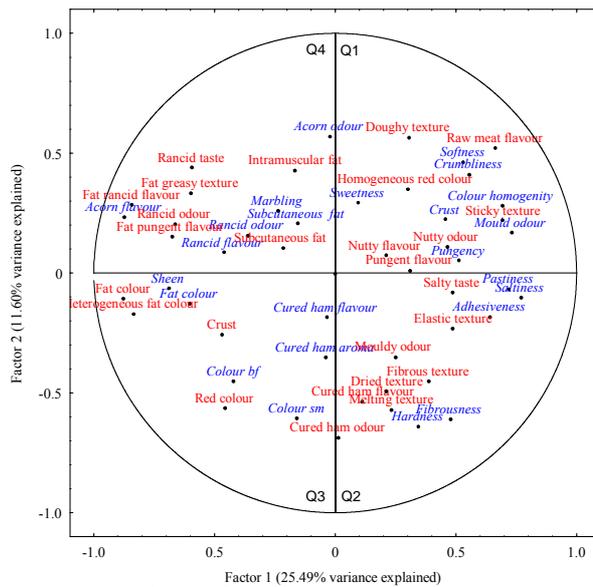
- Dry cured ham Aroma
- Dry cured ham Flavour
- Rancid odour
- Acorn odour
- Mould odour

- Rancid flavour
- Acorn flavour
- Pungency
- Sweetness
- Acceptability



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## Agreement between panels



García-González et al., *Meat Science*, In Press

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### **Instituto de la Grasa (CSIC)**

Ramón Aparicio

Diego L. García-González

María del Pilar Viera Macías

María Teresa Morales

Guadalupe Luna

Carolina Sánchez-Peña

Ana Sayago

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## **Typical Food Products in Europe: TYPIC 2003-2005**

Factors influencing typicality of selected  
products - Application to wine

Véronique Cheynier

*INRA - UMR Sciences pour l'Oenologie, Montpellier*



# Factors influencing typicality of selected products - Application to wine

V. Cheynier<sup>1</sup>, S. Preys<sup>1</sup>, G. Mazerolles<sup>1</sup>, A. Samson<sup>1</sup>,  
 U. Fischer<sup>3</sup>, J. Schröder<sup>3</sup>, V. Lempereur<sup>4</sup>, B. Labarbe<sup>4</sup>,  
 P. Courcoux<sup>5</sup>, M. Hannafi<sup>5</sup>, E. Vigneau<sup>5</sup>, D. Bertrand<sup>5</sup>

<sup>1</sup>INRA – UMR Sciences pour l’Oenologie - Montpellier, France and

<sup>2</sup>INRA – UE Pech rouge - Gruissan, France

<sup>3</sup>DLR-Rheinpfalz, Dept. Viticulture & Enology, Neustadt, Germany

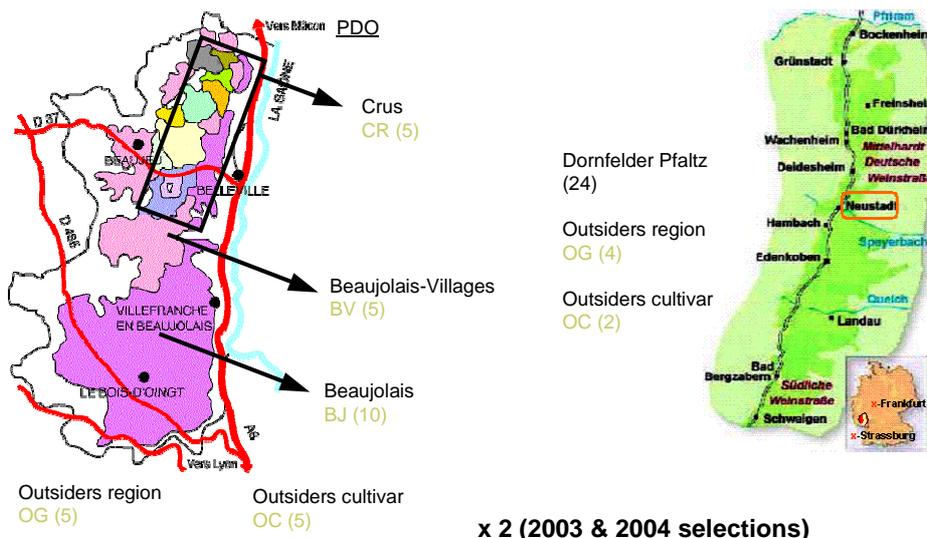
<sup>4</sup>Sicarex Beaujolais, Villefranche sur Saone, France

<sup>5</sup>ENITIAA-INRA, Unité de Sensométrie et Chimiométrie, Nantes, France



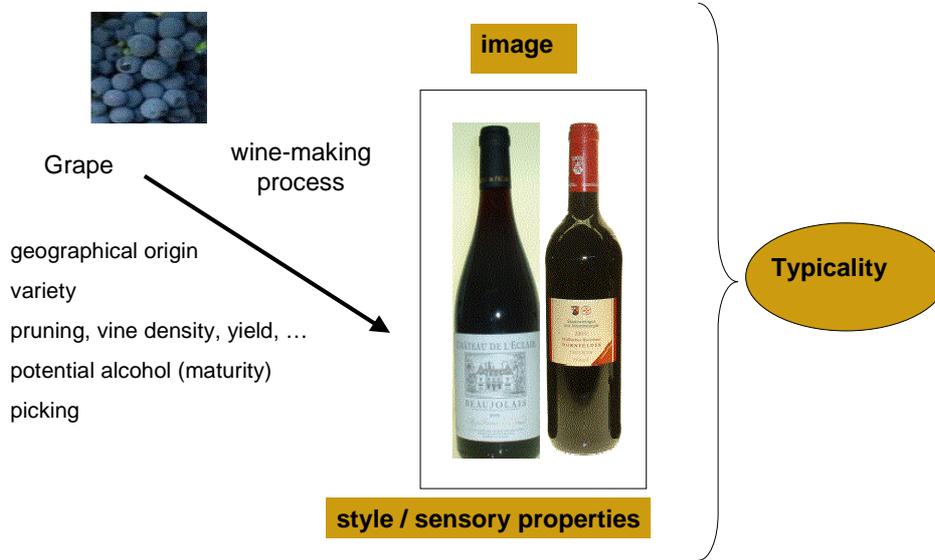
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## Beaujolais and Dornfelder red wines



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# Bases of wine typicality

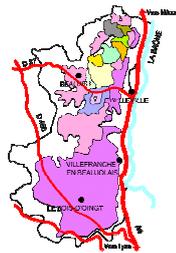


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# Bases of wine typicality

## Beaujolais PDO rules

Grape



Gamay

pruning, vine density, yield, ...

> 9.5° (BJ) / 10° (BV)  
+ sugar (2°) up to 12.5 / 13 °

picking « whole grapes »

wine-making (local, loyal  
and constant practices)

carbonic maceration  
thermovinification  
cold soak...

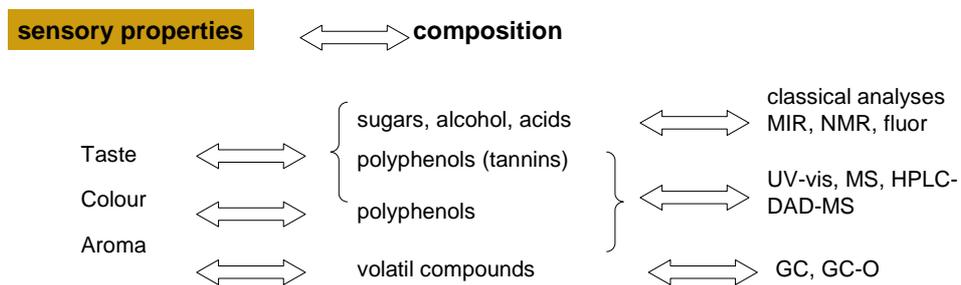


Typicality

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# Relationships between composition & typicality

depend on grape & wine-making

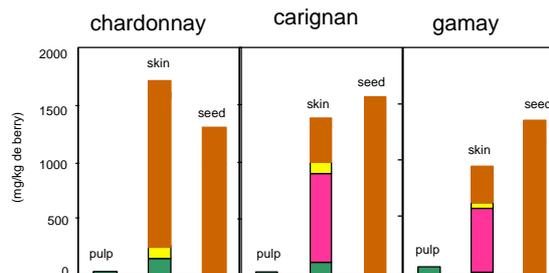


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## Polyphenol composition & wine typicality

Grape polyphenols include:

- phenolic acids
- flavanols (tannins)
- anthocyanins (red pigments)
- flavonols



Polyphenolic profiles = varietal characteristics

Change with ripening (e.g. anthocyanins ++)

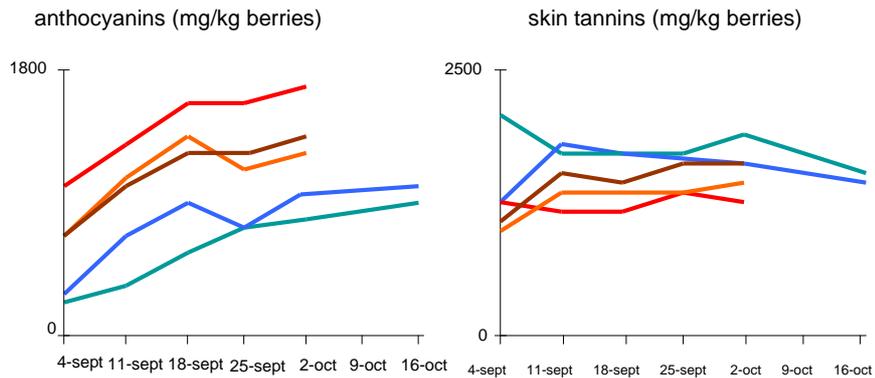
sugar ++, acidity --

↔ origin, climate, ...  
also pruning

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# Polyphenol composition & wine typicality

➤ changes during ripening and « **terroir** » effect



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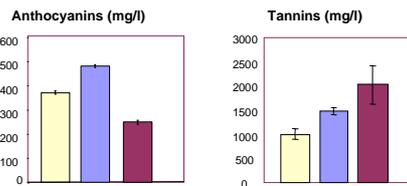
## Factors influencing wine phenolic composition

grape

wine making -> extraction into wine

/ reactions

tannins & **anthocyanins** extracted by skin maceration



**cold soak**, thermovinification ++ anthocyanin & tannin extraction

**long maceration** (esp. + enzyme, flash release,...) ++ tannin extraction

high temperature, oxidation ++ anthocyanin degradation

Carbonic maceration ++ anthocyanin degradation

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# Factors influencing wine aroma composition

grape

some varietal aromas and precursors  
(biosynthesis modulated by environmental factors)

wine making -> extraction into wine

- > release from precursors (enzyme)
- > degradation (oxidation, high temperature)
- > fermentation aromas

Carbonic maceration generates specific aroma compounds

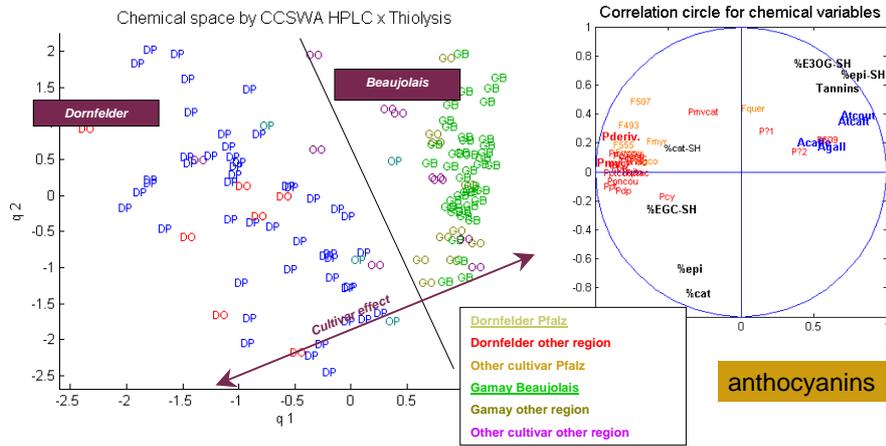
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## Wine polyphenol analyses

- HPLC chromatography with UV-vis and MS detection. 30 compounds (pigments, phenolic acids, flavonols)
- Tannins – degradation of polymers followed by HPLC to analyse constitutive units
- UV-visible spectrophotometry (phenols, pigments)
- Direct injection mass spectrometry

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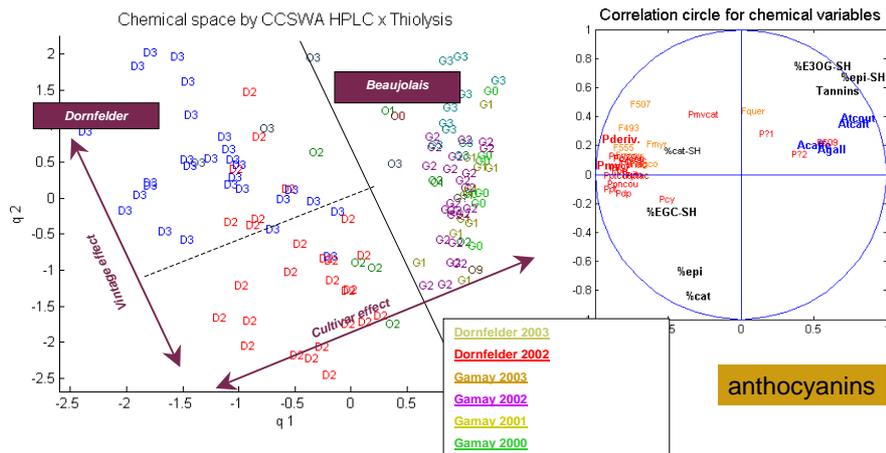
# Wine differentiation from polyphenolic data



dim 1 : Dornfelder/Beaujolais <-> red pigments - %EGC / tannins - mDP - %gall. - ph. acids

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# Wine differentiation from polyphenolic data



Is there a data structure related to the polyphenolic composition ?

dim 1 : Dornfelder/Beaujolais <-> red pigments - %EGC / tannins - mDP - %gall. - ph. acids

dim 2 : 2003 > 2002 in tannins and red pigments

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## Wine differentiation from polyphenolic data

**Dornfelder**  
anthocyanins  
flavonols

**Beaujolais**  
phenolic acids  
tannins

Variety > climate, wine-making & vine growing practices, ...

Beware : all factors are linked

**AOC Beaujolais : Gamay + region + carbonic maceration**

**Dornfelder + Germany + other wine-making practices**

-> focus on the Beaujolais wines

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## Prototypicality approach for authentication

Exploratory analysis  $\Rightarrow$  authentication (decision-making)

Factorial discriminant analysis: weak robustness

-> prototype approach:

does the unknown sample belong to a reference group ?

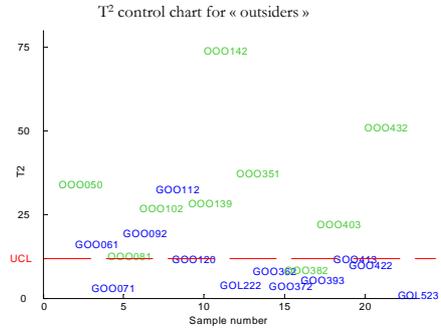
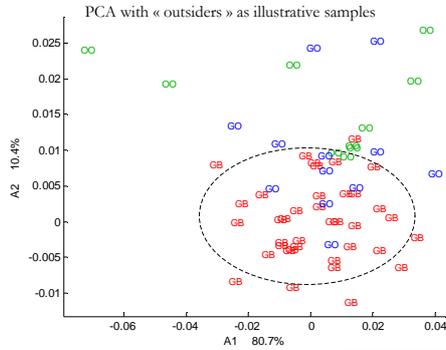
Adapted from multivariate control charts (statistical process control)

-> probabilistic calculation of « upper control limit »

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# Authentication of AOC Beaujolais wines

## By means of the polyphenolic identity (profiles)



GB : AOC Beaujolais  
 GO : Gamay (other regions)  
 OO : Other cultivar

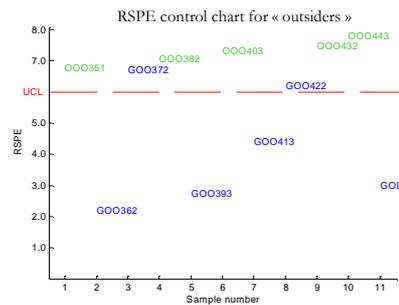
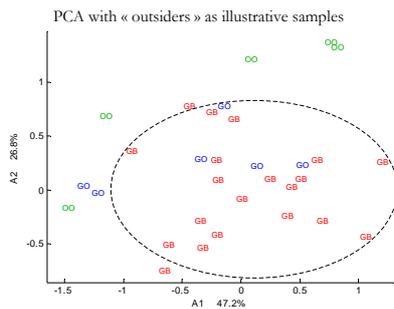
→ partial authentication

		Decision			
		AOC Beaujolais		Non-AOC Beaujolais	
a priori classes	AOC Beaujolais	33	87 %	5	13 %
	Côt. Lyon. (GOL)	2	100 %	0	0 %
	GO	6	60 %	4	40 %
	OO	1	10 %	9	90 %

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# Authentication of AOC Beaujolais wines

## By means of sensory descriptive analysis



GB : AOC Beaujolais  
 GO : Gamay (other regions)  
 OO : Other cultivar

→ similar authentication

-> heterogeneity within AOC

-> Good performance for the polyphenolic composition

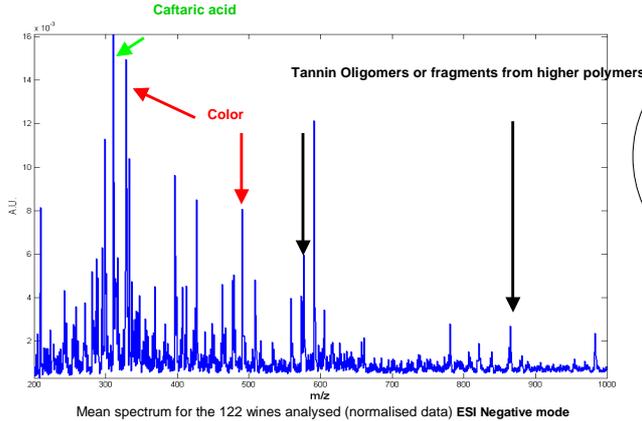
		Decision			
		AOC Beaujolais		Non-AOC Beaujolais	
a priori classes	AOC Beaujolais	19	95 %	1	5 %
	Côt. du Lyon. (GOL)	1	100 %	0	0 %
	GO	3	60 %	2	40 %
	OO	0	0 %	5	100 %

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# Atmospheric Pressure Chemical Ionisation (APCI) and Electropray Ionisation (ESI) for direct analysis of wines

➤ Wine is introduced in the mass spectrometer by flow injection

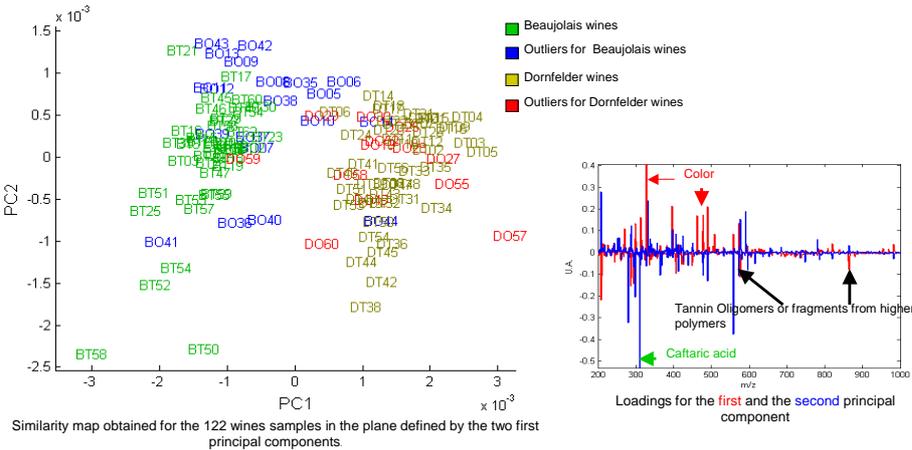
➤ separation of ions formed on the basis of their molecular mass.



The resulting mass spectrum can be seen as a fingerprint of wine analysed.

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## PCA of the mass spectra library



**Principal Component 1** : Opposition between Beaujolais and Dornfelder wines.

**Principal Component 2** : year effect (first year samples labelled from 1 to 30) + tendency to discriminate the outliers from the Beaujolais wines

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## Wine differentiation from polyphenolic data

- Polyphenolic profiles were able to distinguish wine samples at the 'top' level (D/B) related to variety, vintage, wine-making,...
- "Prototype" approach is well adapted for authentication when a reference group is well characterised
- Application to Beaujolais showed that some outsider 'Gamay' wines were not distinguished from AOC wines
- Replacement of time consuming HPLC analysis with flow-injection MS fingerprinting appears promising

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## Wine volatile analysis

### Extraction Methods:

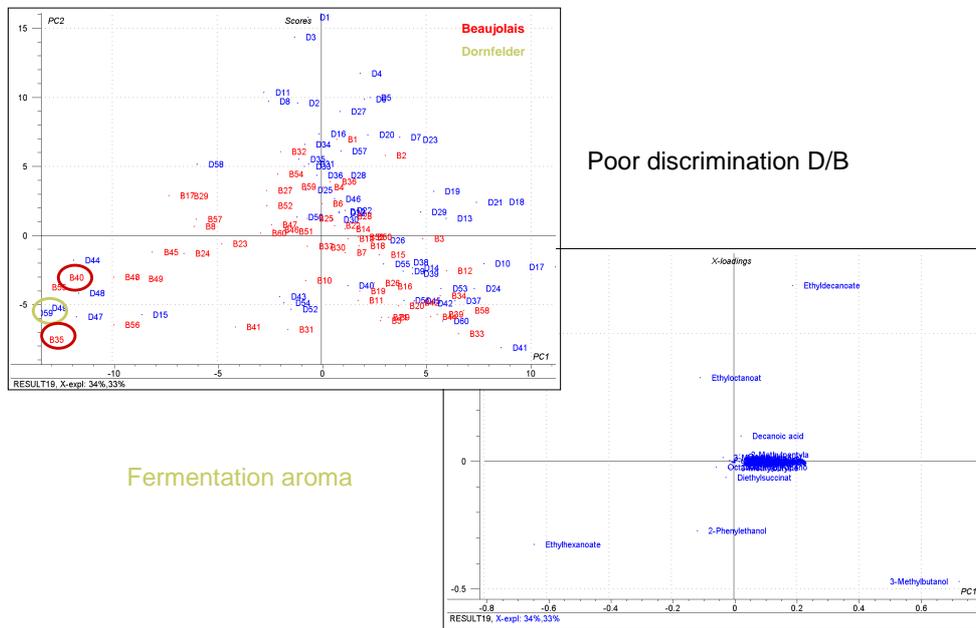
- Solid-Phase-Microextraction
- Liquid-liquid-extraction

### Chromatographic Methods

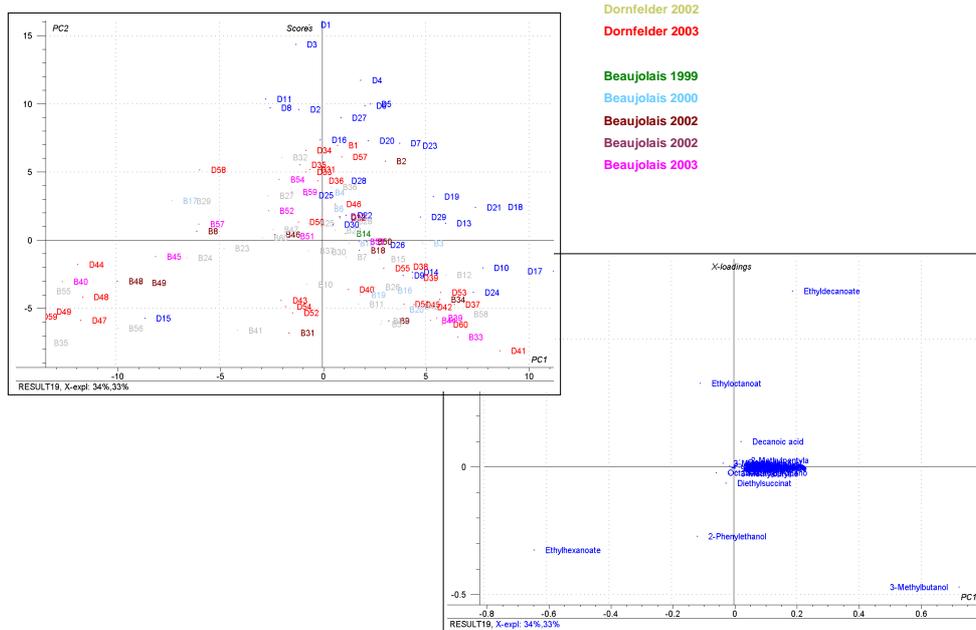
- GC/FID and GC/PFPD
- GC/MS
- GC/Olfactometry

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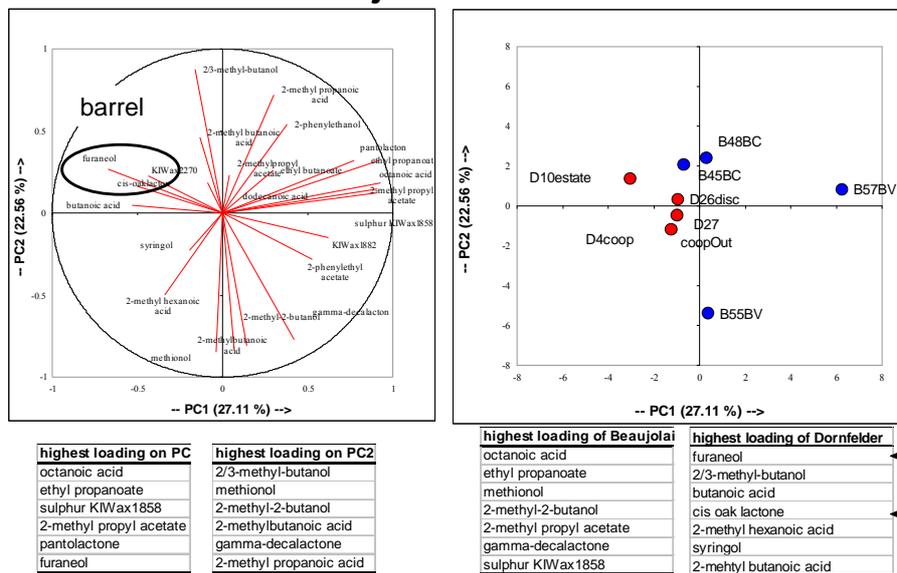
## PCA of headspace aroma compounds of 60 Beaujolais and 60 Dornfelder wines



## PCA of headspace aroma compounds of 60 Beaujolais and 60 Dornfelder wines



## PCA of odour active aroma compounds with FD factors $\geq 100$ in 4 Beaujolais and 4 Dornfelder wines



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## Conclusions

- Various analytical methods -> complementary information related to typicality  
"prototype" approach -> unknown sample / reference group
- Based on the two studied wine sets, Beaujolais wines appear more homogeneous than Dornfelder wines, presumably due to respect of rather strict AOC rules  
some Beaujolais wines did not correspond to the prototype (especially cold soak maceration) / some outsiders did (Gamay)
- Most methods show that major drivers of composition & typicality are: variety > vintage > wine-making process  
incomplete experimental design (due to local practices and AOC rules) : no evaluation of specific factor effects or technologies

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# Typical Food Products in Europe: **TYPIC** 2003-2005

## Prediction of sensory traits by analytical methods

D. Bertrand



## Characteristics of the studied products

### 3 kinds of characteristics:

#### Qualitative characters:

(for example: breed, cultivar, region, vintage, technology)

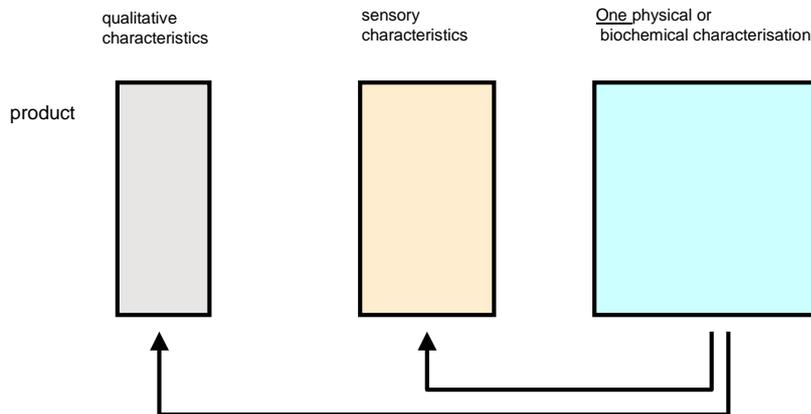
#### Sensory characteristics:

(as assessed from qualitative descriptive analyses)

#### Physical and biochemical measurements



## Characteristics of the studied products



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## Hams

### Qualitative characteristics of the samples

#### **1 Nature of the animal breed**

*White; Iberian; other*

#### **2 Way of feeding**

*Controlled; Free access*

#### **3 Presence of acorn in the feed**

*No acorn; acorn*

#### **4 Maturation time**

*Four groups of maturation time*

#### **5 Location of production**

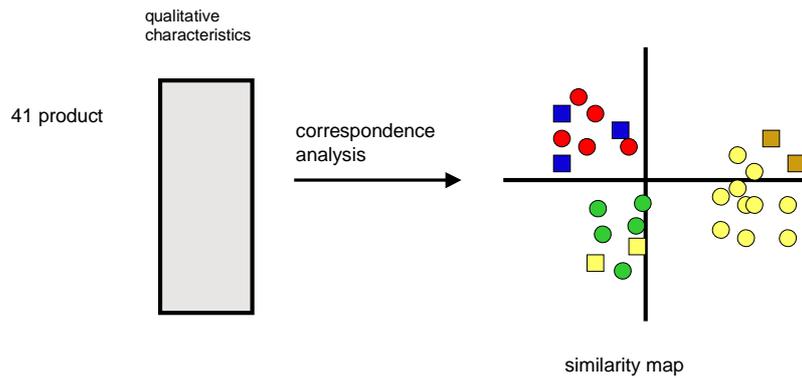
*7 locations (French or spanish)*

#### **6 Scale of production**

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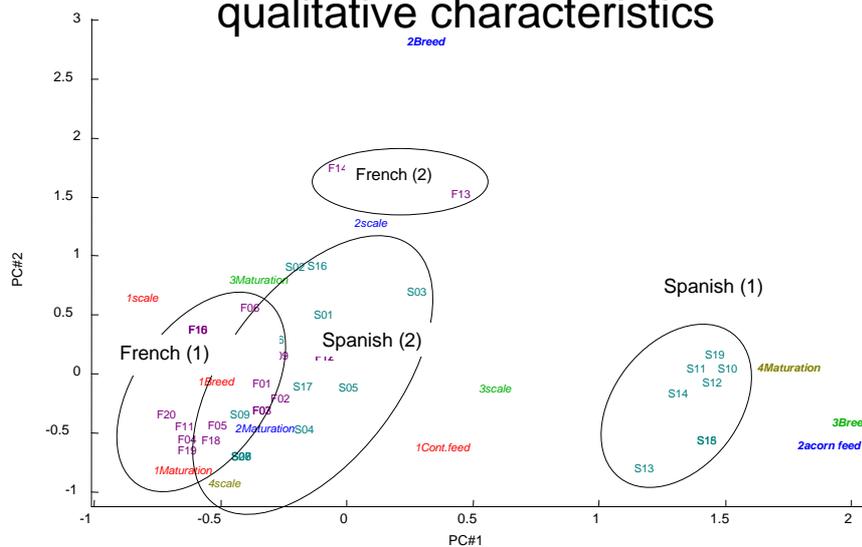
# Hams

## Correspondence analysis of the qualitative characteristics



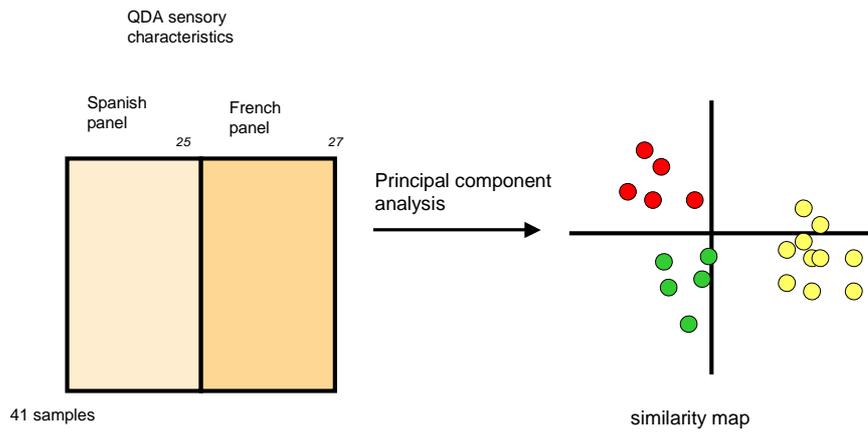
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## Hams: Correspondence analysis of the qualitative characteristics



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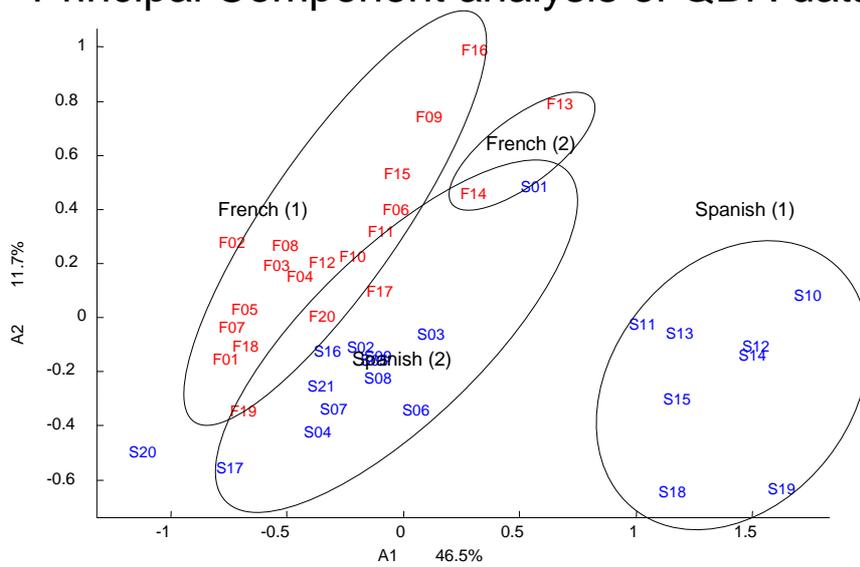
# Principal component analysis of QDA data



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## Hams

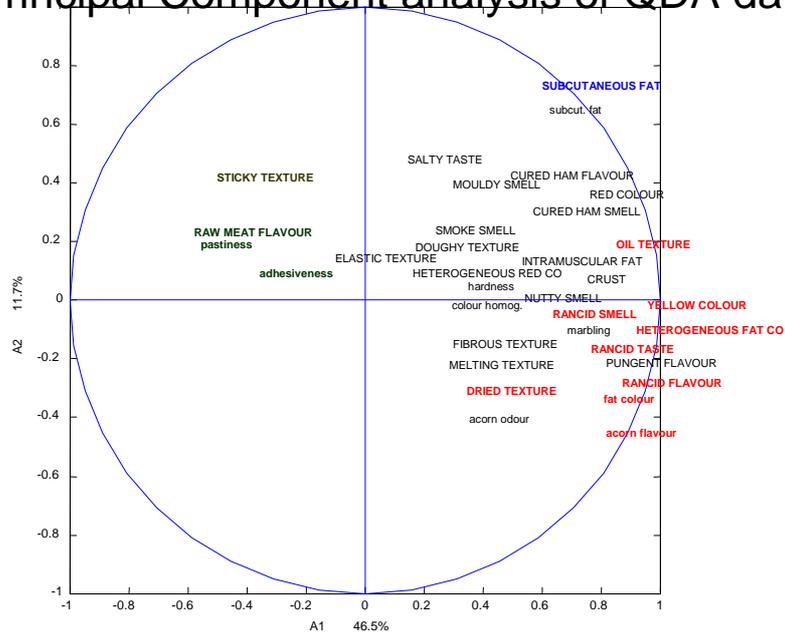
### Principal Component analysis of QDA data



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# Hams

## Principal Component analysis of QDA data



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## Physical characterisations

### Spectroscopic methods:

- Visible NIR spectroscopy
- NMR
- Fluorescence spectroscopy

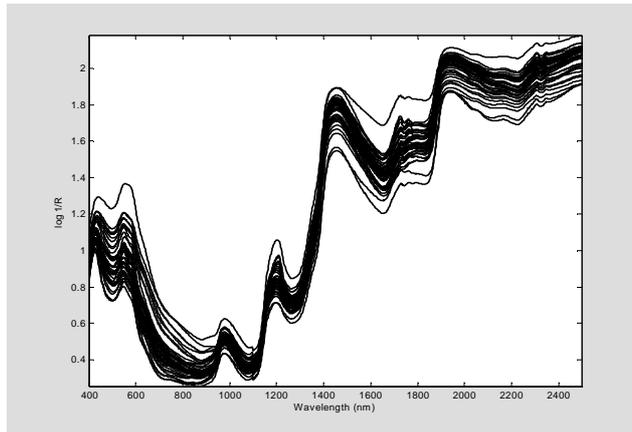
### Chromatographic methods

- HPLC/MS
- SPME-HRGC
- SDS-PAGE

### Mechanical testing

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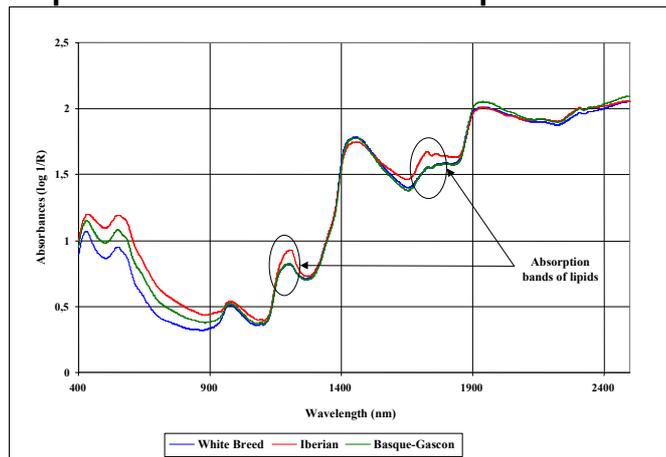
## Physical characterisation: example of Visible-NIR spectroscopy



Visible - NIR spectra of hams

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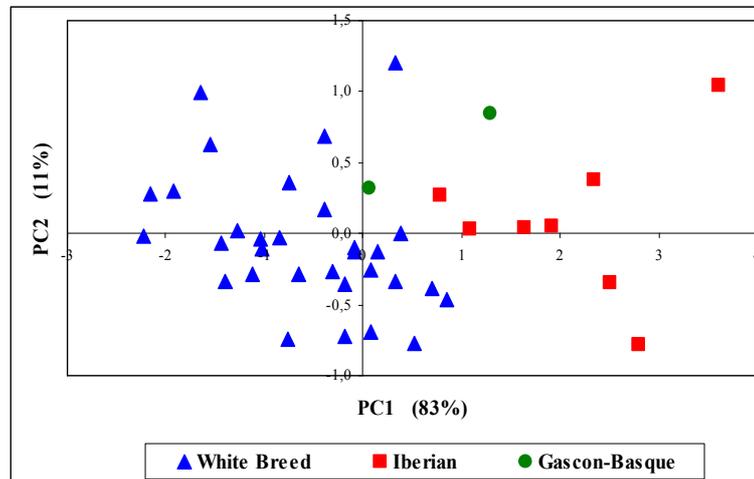
## Physical characterisation: example of Visible-NIR spectroscopy



Visible - NIR spectra of hams averaged according to breed

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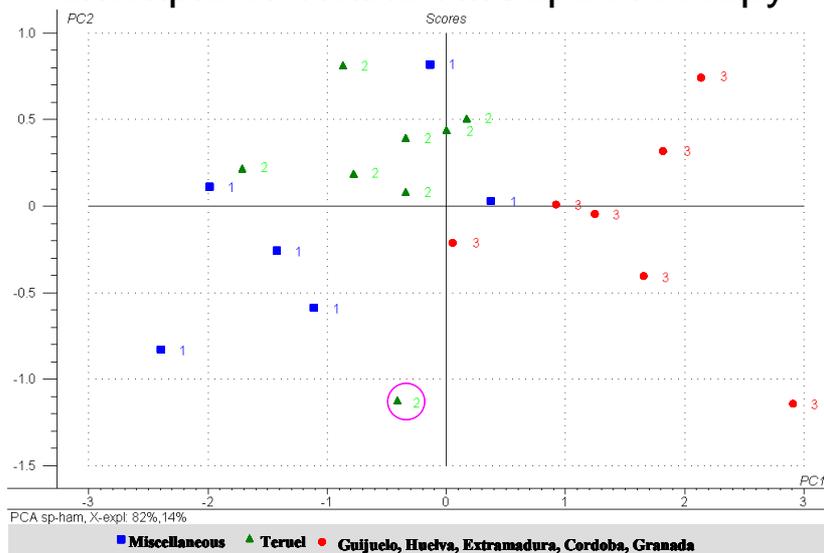
## Physical characterisation: example of Visible-NIR spectroscopy



Principal component analysis of Visible - NIR spectra  
colouring according to breed

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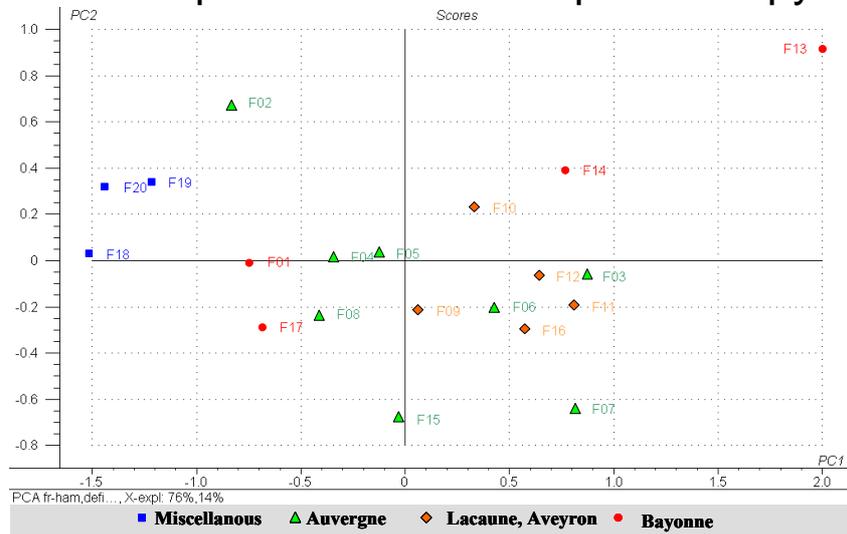
## Physical characterisation: example of Visible-NIR spectroscopy



Principal component analysis of Visible - NIR spectra  
colouring according to region of origin (Spain)

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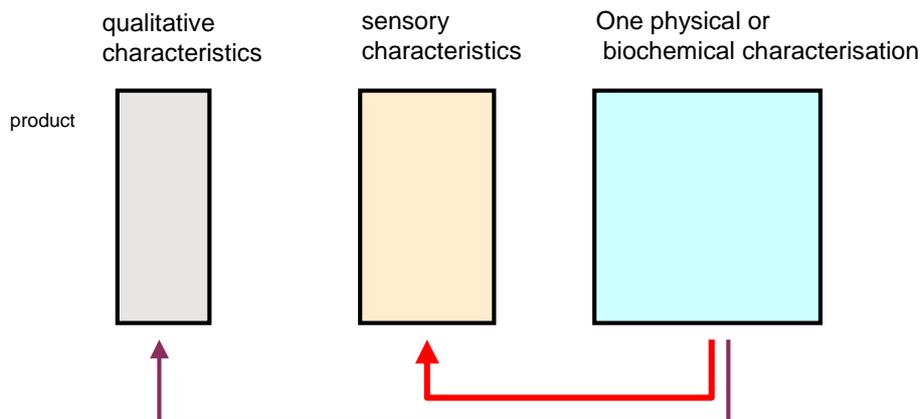
## Physical characterisation: example of Visible-NIR spectroscopy



Principal component analysis of Visible - NIR spectra  
colouring according to region of origin (France)

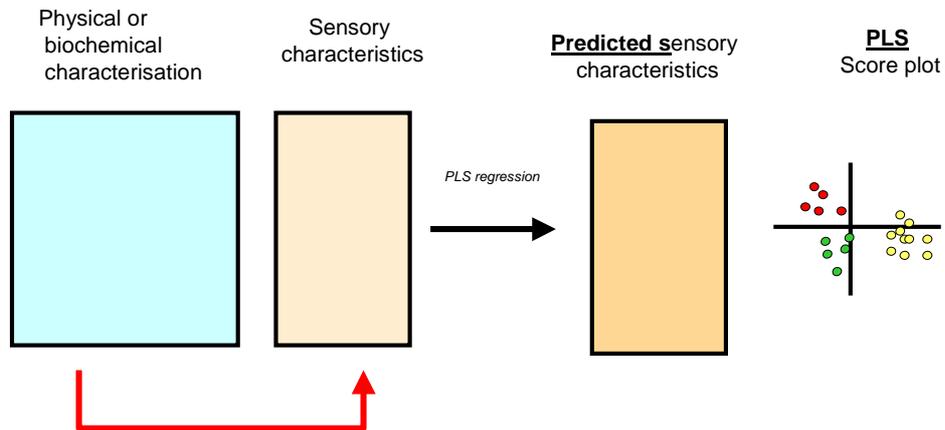
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## Characteristics of the studied products



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## Linking physical characteristics with sensory data from QDA



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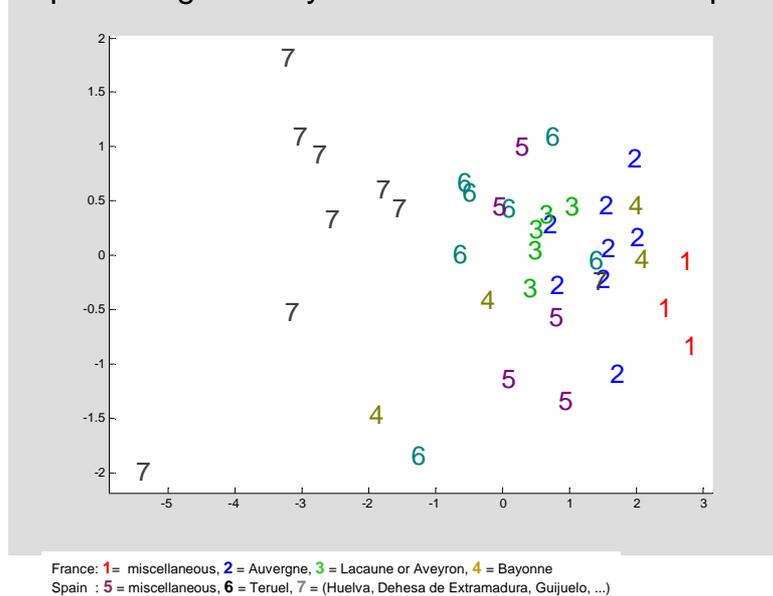
## Prediction of some sensory scores obtained in QDA using Visible-NIR spectra

	RMSECV	r2	Ndim	std
colour bf	0.71	0.61	9	1.13
fat colour	0.71	0.52	9	1.03
rancid flavour	0.57	0.50	9	0.81
acorn flavour	0.82	0.80	9	1.87
sheen	0.99	0.64	9	1.64
CRUST	0.77	0.60	2	1.22
RED COLOUR	1.07	0.55	10	1.55
YELLOW COLOUR	0.66	0.78	10	1.41
HETEROGENEOUS FAT CO	0.56	0.84	7	1.43
INTRAMUSCULAR FAT	0.87	0.63	10	1.45
RANCID SMELL	0.56	0.53	8	0.82
RAW MEAT FLAVOUR	0.48	0.56	10	0.71
RANCID FLAVOUR	0.80	0.68	7	1.42
PUNGENT FLAVOUR	0.66	0.53	6	0.97

Result of a validation test by leave-one-out  
 RMSECV: root mean square error of cross\_validation  
 r2: squared correlation coefficient between observed and predicted values  
 Ndim: number of PLS dimensions of the best model  
 std: standard deviation of the considered variable  
 Lowercase: descriptors of the Spanish panels; higher case: French ones

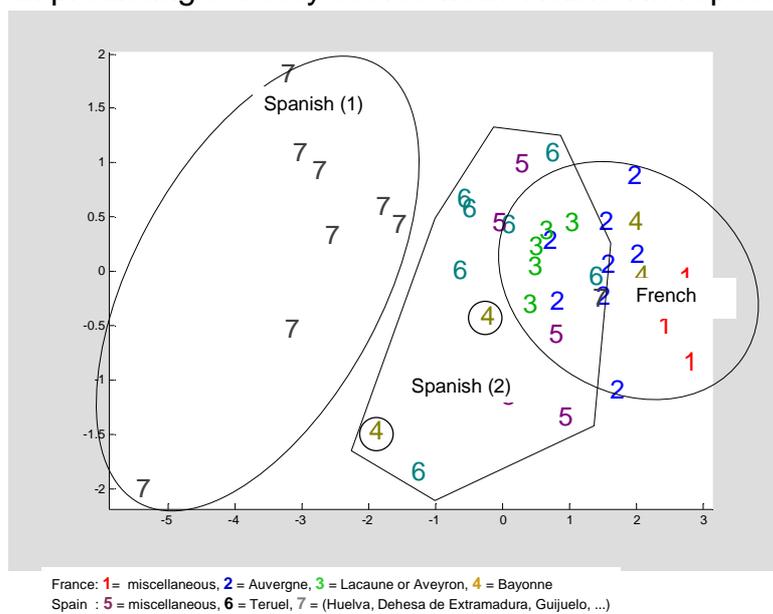
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Score plot of PLS regression model  
in predicting sensory scores from Visible-NIR spectra



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Score plot of PLS regression model  
in predicting sensory scores from Visible-NIR spectra



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## Hams

	Simplicity	Accuracy	Finger printing	Specific use
Visible NIR	+++	+++	+++	
Fluorescence	+++	+++	++	
NMR		+++	+	Metabolite study
HPLC/MS		++	+	Volatiles
SPME-HRGC		++		Volatiles
SDS-PAGE		++		Protein fraction
Mechanical testing				Characterisation of texture

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## WINES

### Qualitative characteristics of the samples

120 wines from the region of Beaujolais (France) or Pfalz (Germany).

a priori typical nature of the wines: typical or outsider

The nature of the cultivar : Dornfelder; Gamay; X .

The regions of cultivation : Pfalz; Beaujolais; Beaujolais-Village; Crus de Beaujolais; unknown, French; unknown German

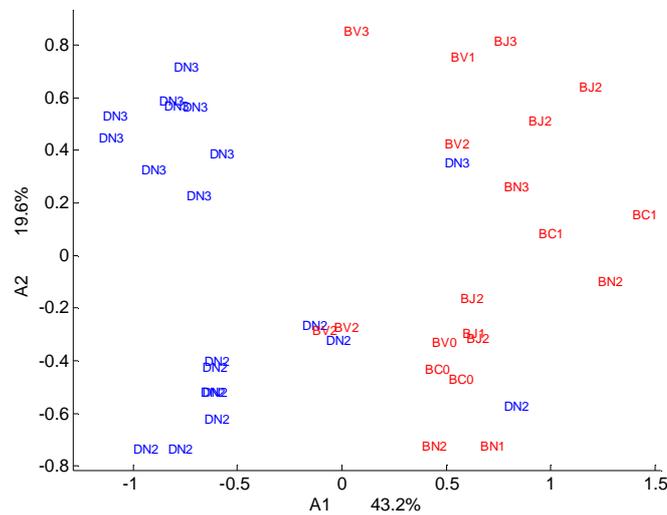
The nature of the appellation: Beaujolais; Beaujolais-village; crus; No appellation

The vintages: 1999; 2000; 2001; 2002; 2003.

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## Wines

### Principal component analysis of QDA data

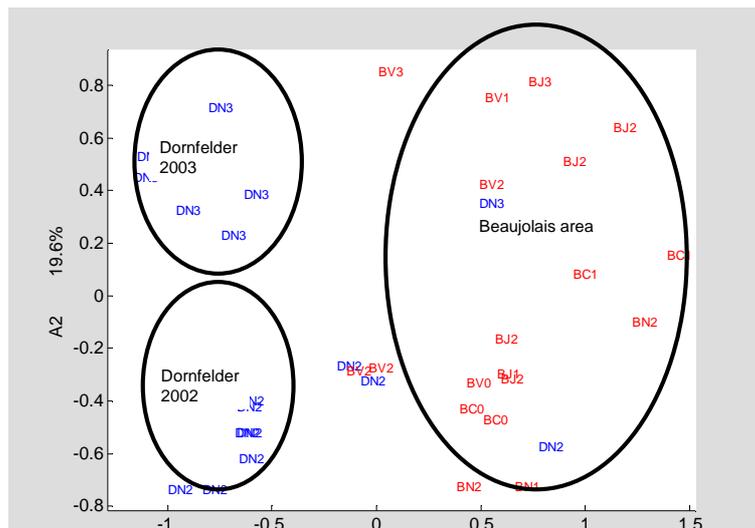


B Beaujolais/D Dornfelder area  
 Nature of the appellations: J Beaujolais/C Crus/N Beaujolais Villages/N no appellation  
 Vintage 1 2001/2 2002/3 2003

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## Wines

### Principal component analysis of QDA data



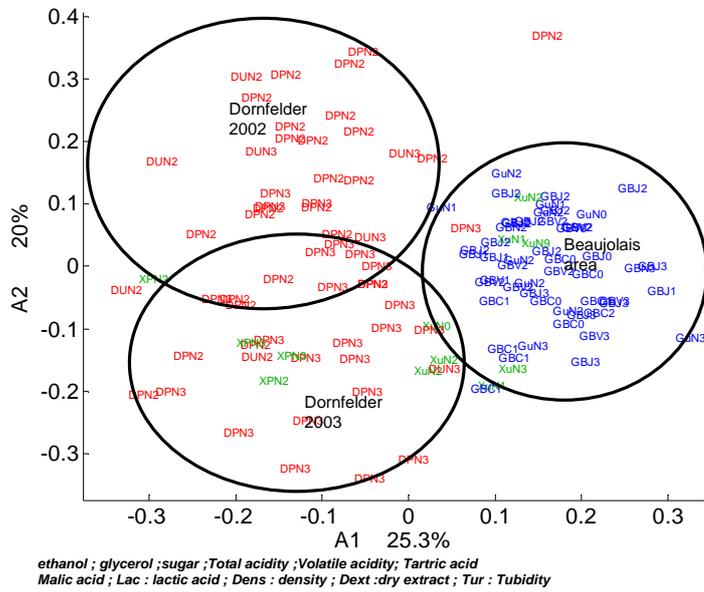
B Beaujolais/D Dornfelder area  
 Nature of the appellations: J Beaujolais/C Crus/N Beaujolais Villages/N no appellation  
 Vintage 1 2001/2 2002/3 2003

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## Wines

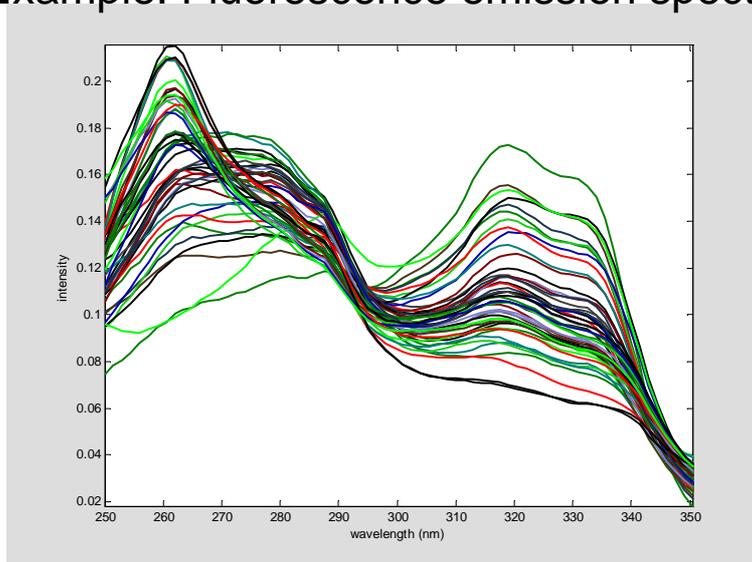
### PCA of the standard eonological analyses



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## Wines

### Example: Fluorescence emission spectra



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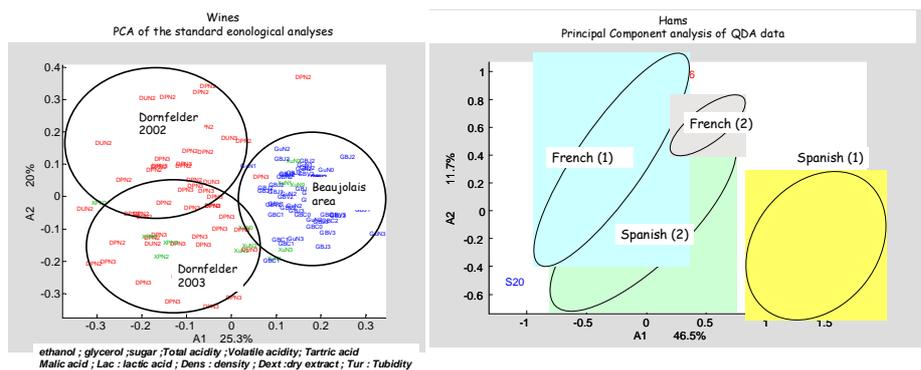


# Wines

	Simplicity	Accuracy	Finger printing	Specific use
Enological analyses	++	+	+	
UV spectroscopy	+++	+	+	Colour
Mid Infrared Spectroscopy	+++	++	++	
Fluorescence	+++	+	+	
SPME-HRGC	+	+	+	volatiles
Polyphenol analysis by HPLC	+	++	++	Astringency
Mass spectroscopy		++	++	Metabolite study

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# Conclusion



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