

Authentification of Trappist beers:

Assesement of the discrimination of « Rochefort 8° » beer



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Beer consumption in the world

Consumption per capita (2004)

Rank 2004	Consumption (Litres)	Country
1	156,9	Czech Republic
2	131,1	Ireland
3	115,8	Germany
4	109,9	Australia
5	108,3	Austria
6	99,0	United Kingdom
7	93,0	Belgium
8	89,9	Denmark
9	85,0	Finland
10	84,4	Luxembourg
11	84,1	Slovakia
12	83,8	Spain
13	81,6	United States
14	81,2	Croatia
15	79,0	Netherlands

Belgium, paradise of beer

Moderate climate present in Belgium



In the air, we find wild yeasts being used to manufacture beers of spontaneous fermentation (lambic, gueuze, kriek, etc...).



Large number of ingredients to manufacture beer

Cultivated cereals



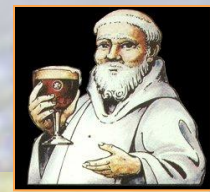
Basic ingredients of beer: water, a starch source able to be fermented (converted into alcohol), yeast to produce the fermentation and a flavouring such as hops.

Unique advantage in the world



Various types of beers





Trappist beer

“Authentic Trappist Product” hexagonal logo means that:



↪ **The beer is brewed in a Trappist abbey, by or under control of Trappist monks.**

↪ **The brewery, the choices of brewing, and the commercial orientations obviously depend on the monastic community.**

↪ **The economic purpose of the brewery is oriented to social assistance or to provide for their needs and not to a financial profit.**



There are currently seven breweries that are allowed to have their products wear the *Authentic Trappist Product* logo:



Brown, Draught blond (5%); Triple, Brown (8%); stronger Brown (9% alc .vol)



Red (7%); Triple (8%); Blue (9%); « dorée » (4.8% alc .vol)



double (7%); triple (9% alc.vol)



6 (7.5%); 8 (9.2%); 10 (11.2% alc.vol)



Abt(11%); Dubbel (4%); Extra (8%); Special(6%); Blond (5.8% alc.vol)

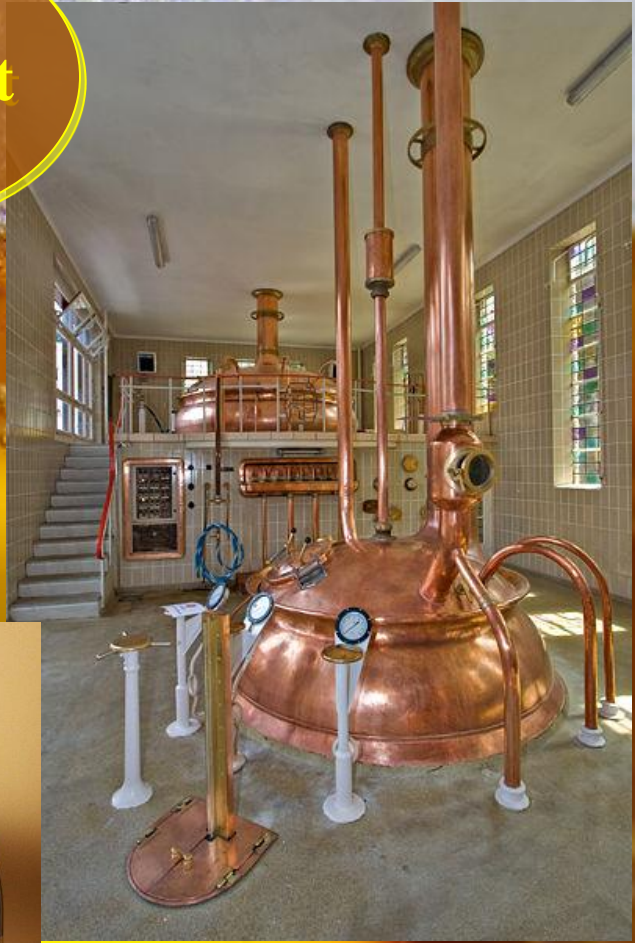


« classique » (6.2 %); green (3.5% alc.vol)



Blond (6.5%); Dubbel (7%); Tripel (8%); Quadrupel (10%); Witte Trappist (5.5%) Bockbier (7% alc.vol)

Rochefort



Rochefort 8

History

Born in 1955, it was brewed just for New Year's holidays.
From 1960 it was decided to brew it in regular way.

Production

Weekly production: 400 hl (Monday to Thursday)
Annual production: 20000 hl/year

Properties

Density:	20.8°Plato
Alcohol content (v/v):	9.2%
Colour:	60°EBC
Bitterness:	20°EBU
pH:	4.2
Pression in bottle (20°C):	4 bar
Saturation CO ₂ (20°C):	8g/l
Bottle capacity:	330 ml
Life preservation:	5 years

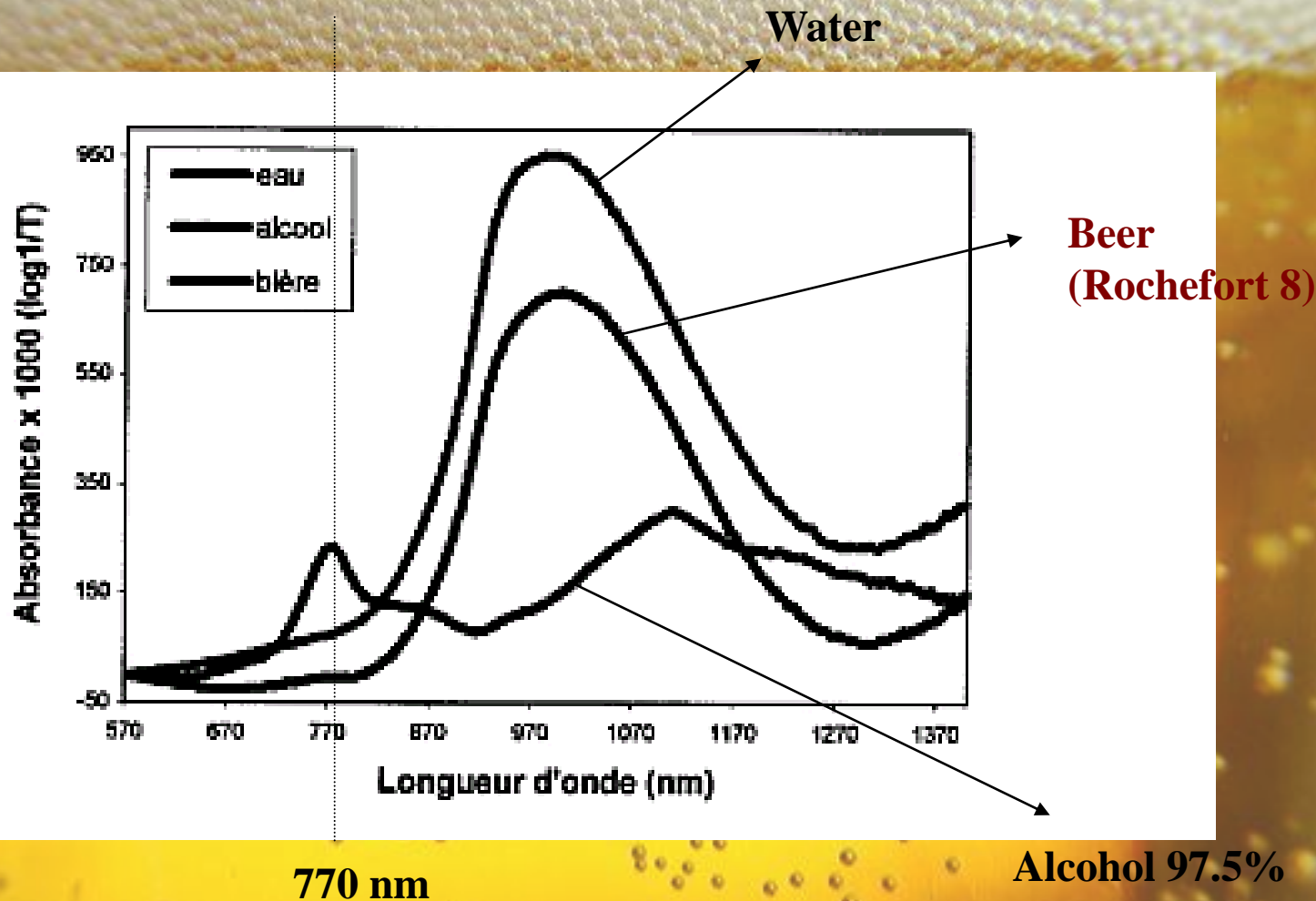


Source: A. Dewulf June 2007, Université Catholique de Louvain

VIDEO

Can we use fingerprint and profiling methods to confirm the identity of a beer which claims to be Trappist/Rochefort/Rochefort 8?

Spectra of water, alcohol (97.7%v/v) and beer



770 nm

Alcohol 97.5%

Source: A. Dewulf June 2007, Université Catholique de Louvain

Experimental Design

- **Collect samples of Trappist and non-Trappist beers from different production batches**
- **Collection was done at two time points; Rochefort 8 beers also collected from different production batches over a six month period**
- **Samples collected, coded, assembled into sets for each laboratory (6), and distributed by courier**
- **Beers distributed in two lots – 1 in autumn 2008 and 1 in January 2009**

Experimental Design

		STUDY 1	STUDY 2	STUDY 3
Trappist beer	Rochefort 8°	16	32	16
	Other trappist around 8° (Chimay triple, Archel brune, Westmalle, WestMetersen, Trappe)) + Other trappist (Rochefort 10°, Orval, Chimay dorée...)	41	0	41
Other Beers	"special" beers but not trappist (Leffe, Grimbergen, gueuze, Jupiler,...)	67	0	67
Total:		124	32	124

**Total bottles/team:
280**





The Trappist



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The Non Trappist



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Analytical tools

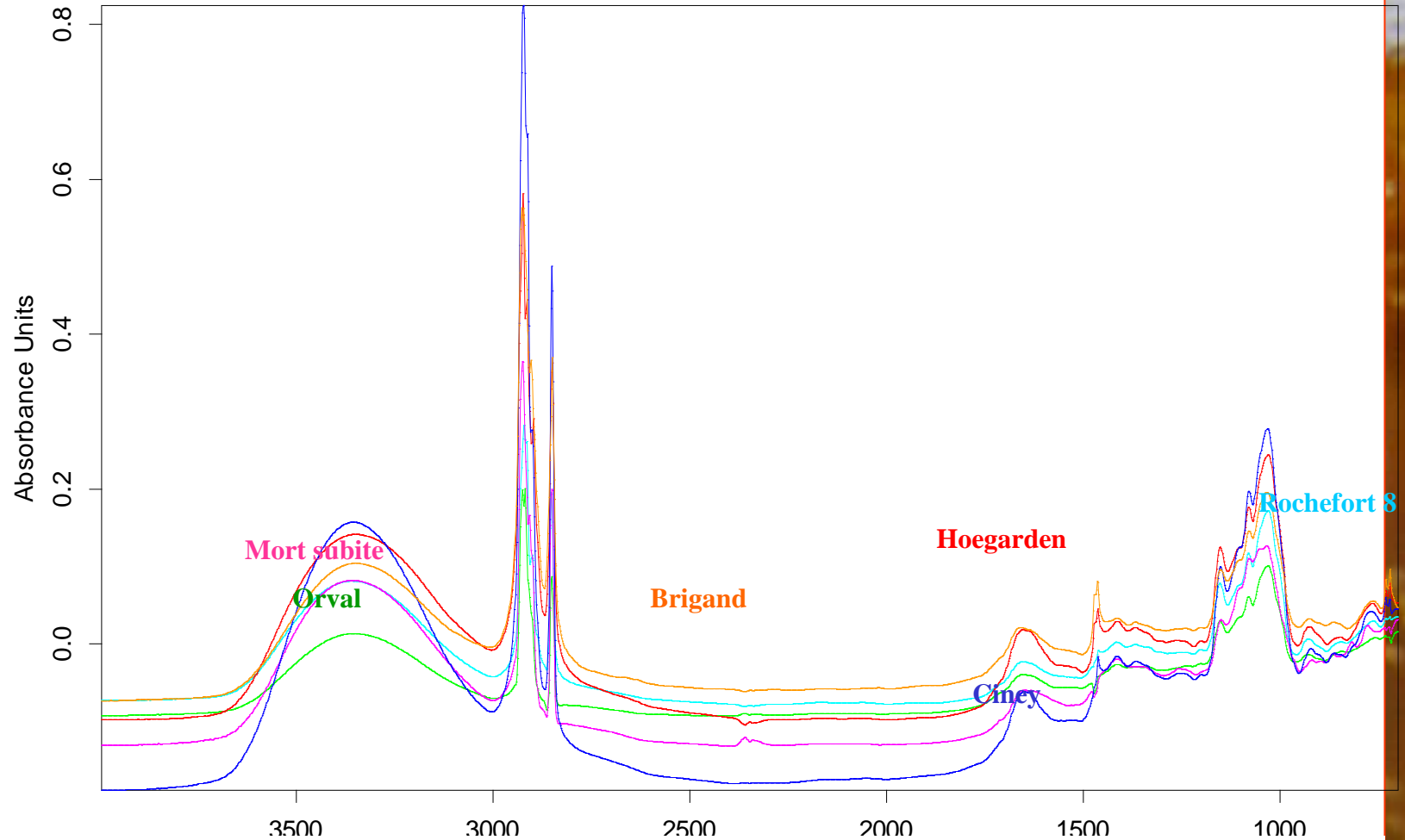
Analytical methods deployed:

- **NIR, FTIR (Teagasc, Ireland)**
- **Raman (CRA-W, Belgium)**
- **NMR (CSL, UK ; CNR, Italy)**
- **UPLC-QTOF-MS (JRC, Italy)**
- **DART-HRTOF-MS (ICT, Czech Republic)**
- **SPME-GC-MS (ICT, Czech Republic)**

What to do?

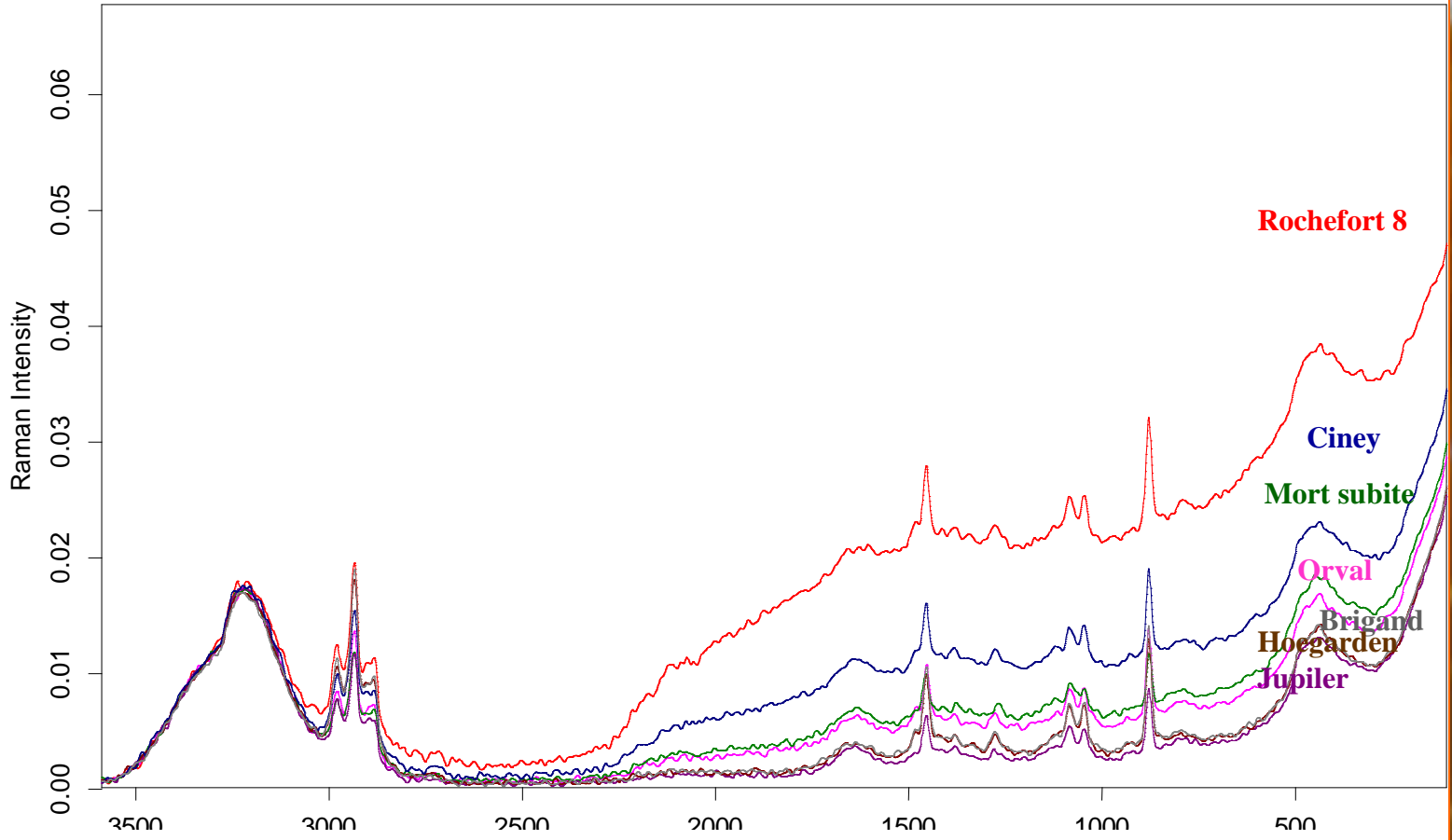
- **Recording Mid and Near Infrared, Raman, NMR, ... spectra of selected beers**
- **Treatment of spectral data by chemometric techniques**
- **Goal :**
Production of fingerprint models to confirm the identity of the selected beers.

Preliminary studies ~ Mid-Infrared spectroscopy



Examples of MIR spectra of different beers

Preliminary studies ~ Raman spectroscopy



Examples of Raman spectra of different beers

Chemometric analysis

Class Modelling methods

- Fisher discrimination
- Discriminant PLS (PLS-DA)
- k NN
- ANN
- SIMCA ...

Density methods

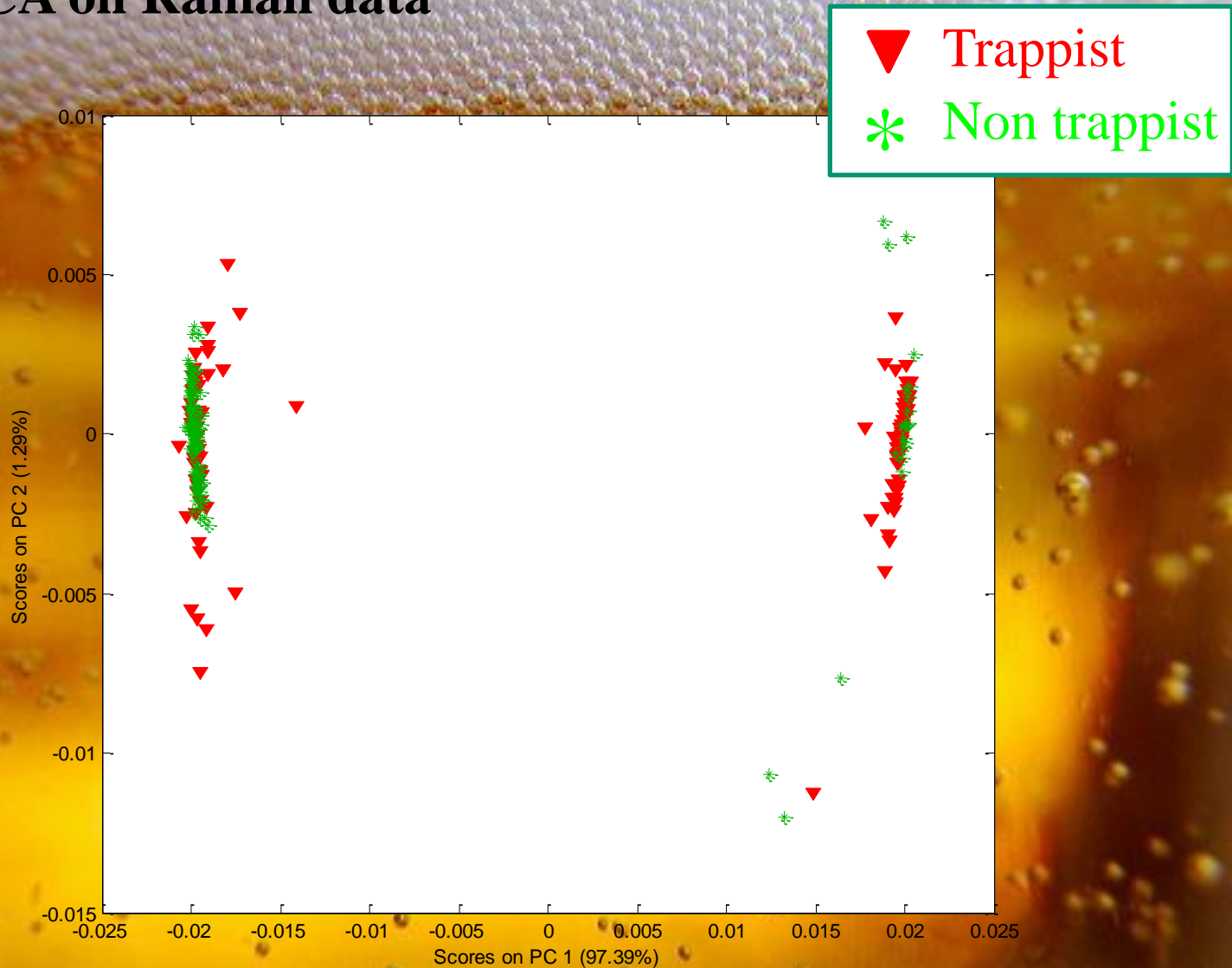
Determining the density of samples in a space defined by the original variables (or by the PCs).

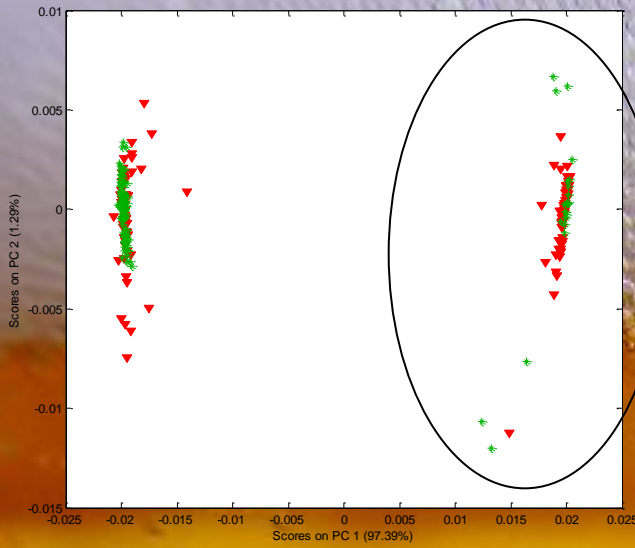
Probability calculation.

Boundary methods

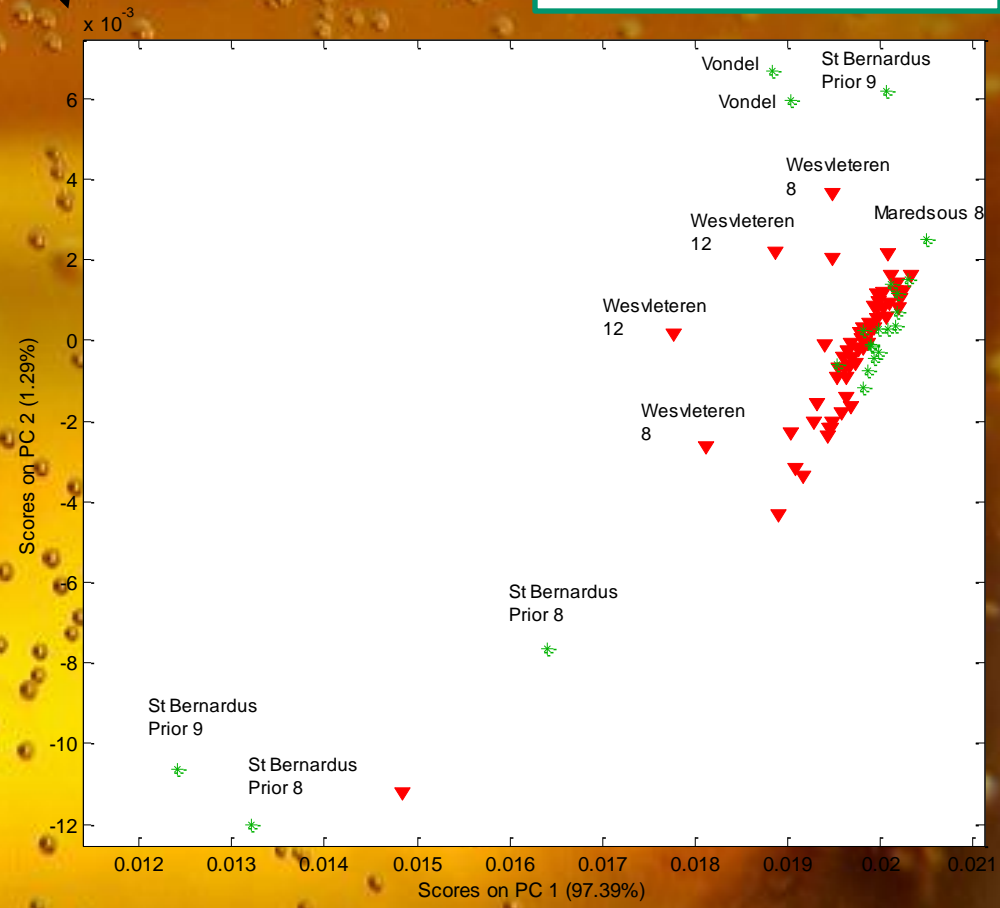
- Support Vector Machines (SVM) ...

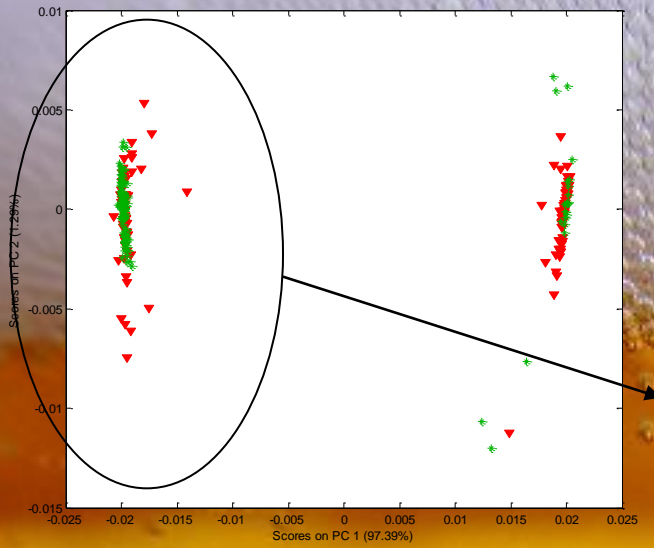
PCA on Raman data



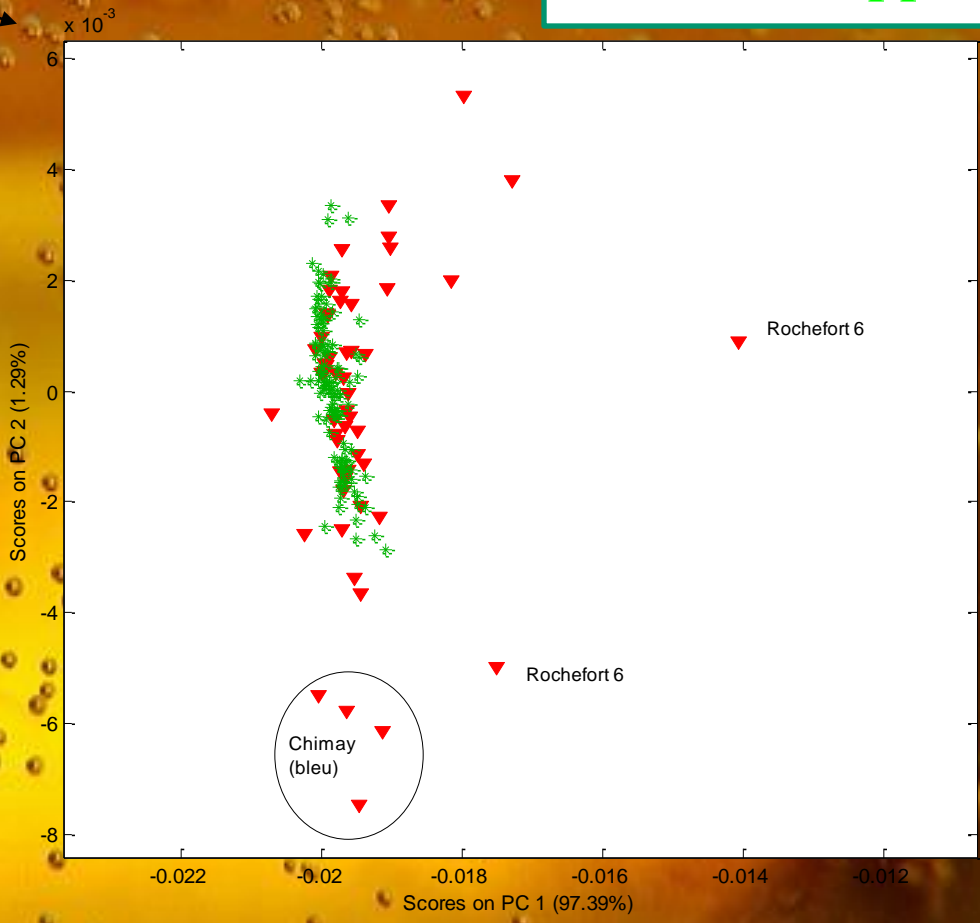


▼ Trappist
* Non trappist





▼ Trappist
✱ Non trappist

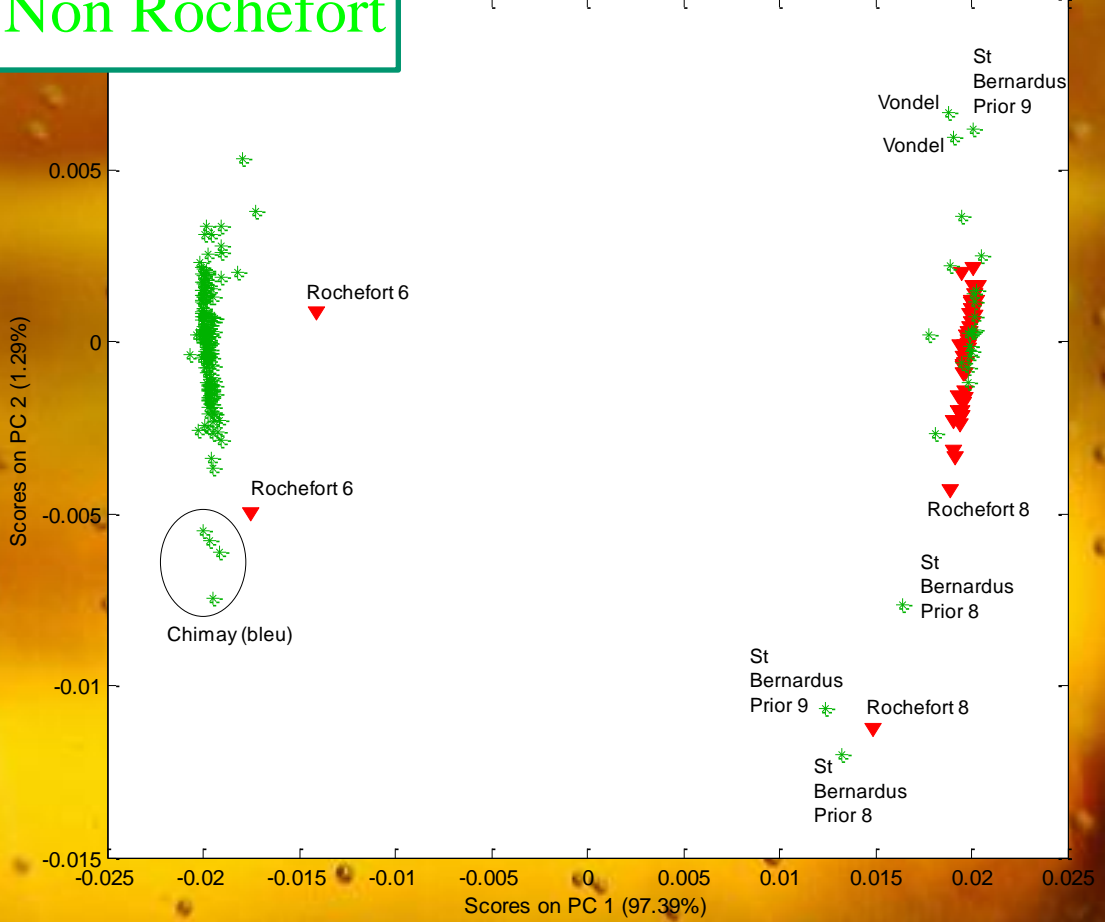


Rochefort vs. other

Mean centered + normalization

PCA

▼ Rochefort
* Non Rochefort



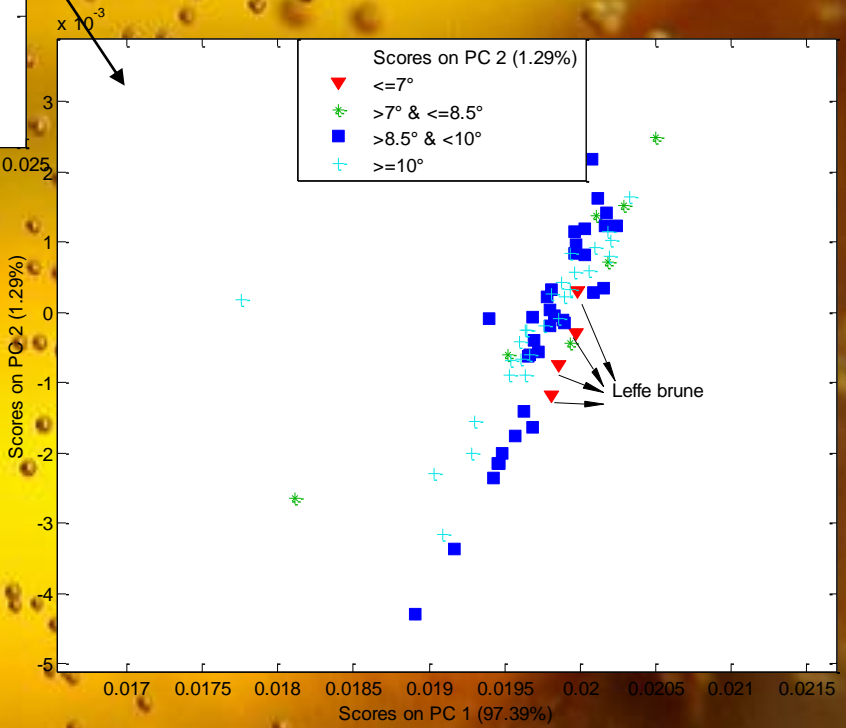
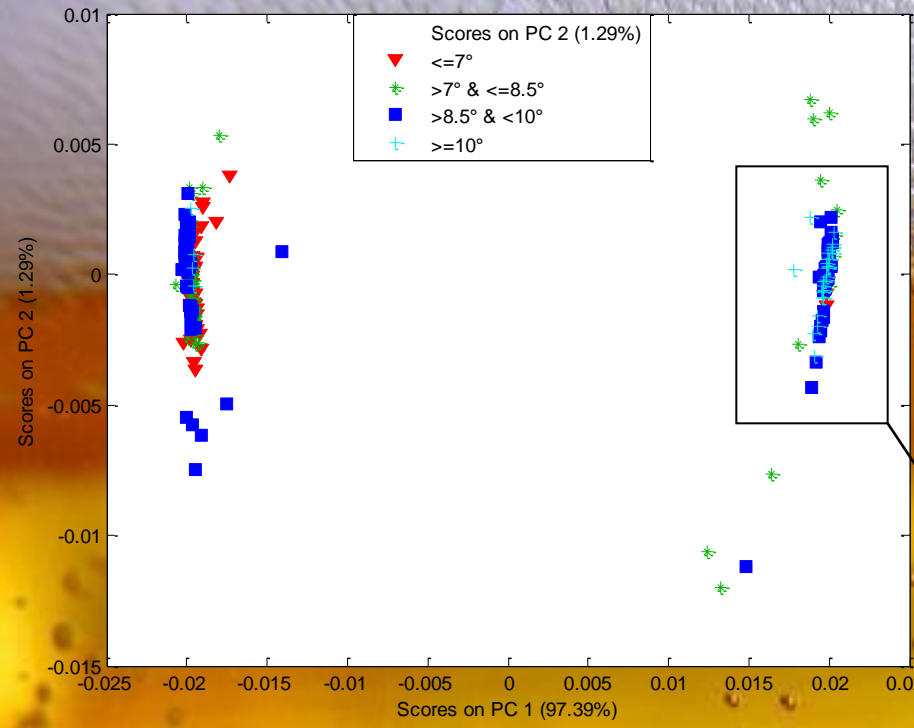
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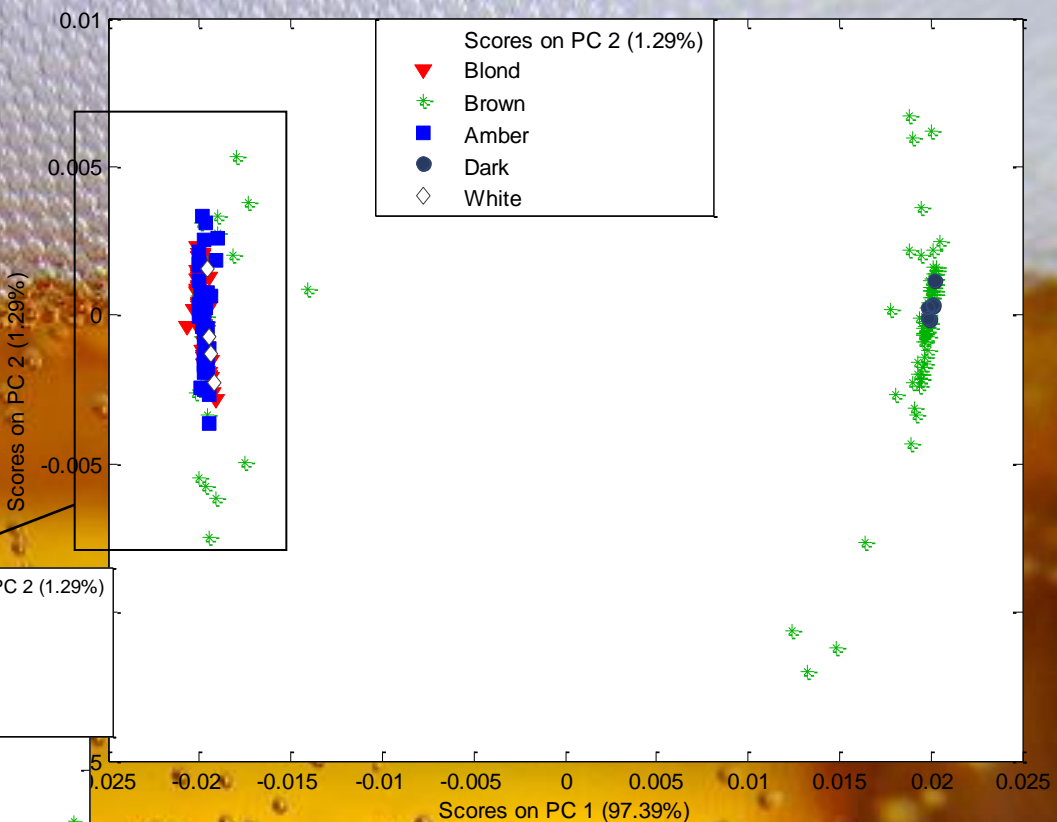
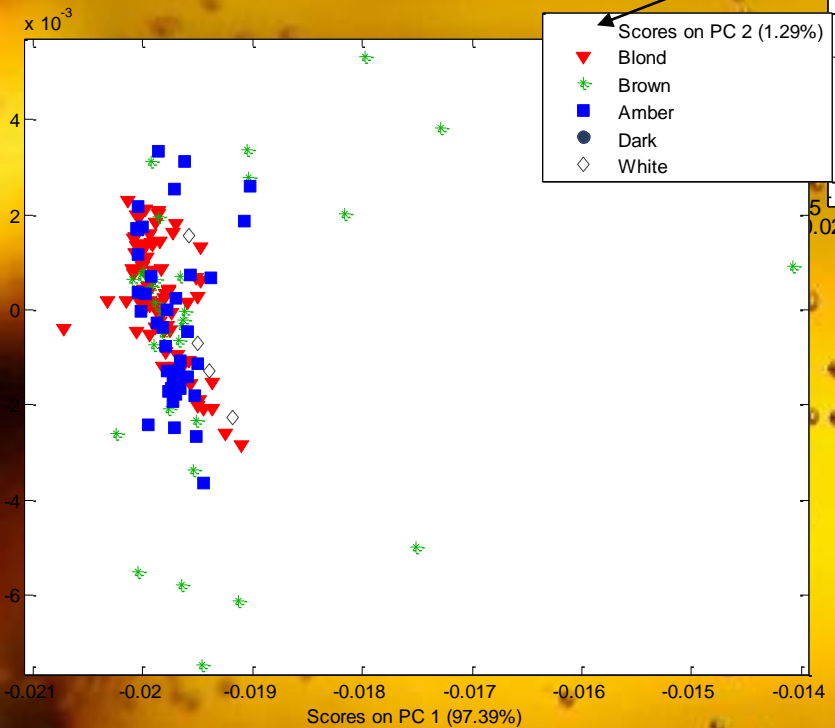
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According to the degree of alcohol



According to the colour



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Results – Trappist vs rest

	Belonging to...	TEST		
		% classified as...		average %
		Trappist	Rest	
Raman	Trappist	78.91	21.09	79.7%
	Rest	19.44	80.56	
NIR	Trappist	71.9	28.1	72.5%
	Rest	26.9	73.1	
FTIR	Trappist	-	-	-
	Rest	-	-	
NMR	Trappist	-	-	-
	Rest	-	-	
UPLC-QTOF	Trappist	85.1	14.9	86.3%
	Rest	12.5	87.5	
DART-HRTOF	Trappist	78,6%	21,4%	85,9%
	Rest	8,8%	91,2%	
SPME-GC-MS	Trappist	95,2%	4,8%	97,0%
	Rest	1,8%	98,2%	

Results – Rochefort vs rest

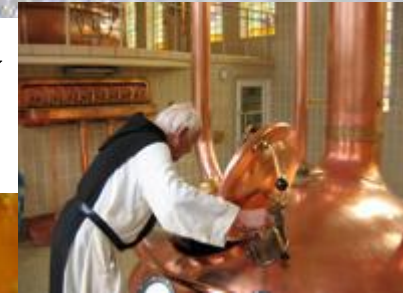
	Belonging to...	TEST		
		% classified as...		average %
		Rochefort	Rest	
Raman	Rochefort	94.87	5.13	90.9%
	Rest	13.11	86.89	
NIR	Rochefort	78.6	21.4	88.3%
	Rest	2.1	97.9	
FTIR	Rochefort	89.7	10.3	94.3%
	Rest	4.3	95.7	
NMR	Rochefort	-	-	-
	Rest	-	-	
UPLC-QTOF	Rochefort	-	-	-
	Rest	-	-	
DART-HRTOF	Rochefort	100,0%	0,0%	98,0%
	Rest	0,0%	100,0%	
SPME-GC-MS	Rochefort	100,0%	0,0%	100,0%
	Rest	0,0%	100,0%	

Results – Rochefort 8 vs rest

	Belonging to...	TEST		
		% classified as...		average %
		Rochefort 8	Rest	
Raman	Rochefort 8	97.73	2.27	94.1%
	Rest	9.62	90.38	
NIR	Rochefort 8	100	0	95.9%
	Rest	8.3	91.7	
FTIR	Rochefort 8	100	0	100%
	Rest	0	100	
NMR	Rochefort 8	72.20	27.8	75.6%
	Rest	21,10	78.90	
UPLC-QTOF	Rochefort 8	100	0	98.1%
	Rest	3.9	96.1	
DART-HRTOF	Rochefort 8	94,4%	5,6%	87,9%
	Rest	15,9%	84,1%	
SPME-GC-MS	Rochefort 8	97,2%	2,8%	93,9%
	Rest	7,9%	92,1%	

Acknowledgement

- Abbey of Rochefort in Belgium, specially to Gumer Santos.



- The CRA-W team.



- All the WP2 TRACE partners



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Cheers!

