SCIENTIFIC STUDY

INFLUENCE OF PACKAGING ON WINE PRESERVATION

12 MONTH RESULTS

12 May 2010

PRESS PACK

Does the packaging of the future match the future needs of wine?

A lot of contradictory information has been circulating in recent months regarding different packaging solutions suitable for wines, both red and white.

It is now necessary to establish the truth, based on scientific information and quantitative data, to determine the legitimacy of each package, as its main function is to preserve the flavour and characteristics of its content. This affects the future of both the most prestigious and the simplest of wines.

This is why, for the first time in the history of wine, the renowned Institute of Vine and Wine Sciences - ISVV – in Bordeaux (formerly known as the "Bordeaux Institute of Oenology") has carried out a major study into the storage of wine in several of the packaging solutions currently available on the market. This study, co-ordinated by Mrs Martine Pietton-Peuchot (joint Dean of the Bordeaux Faculty of Oenology), aims to evaluate the influence of packaging on the storage of wine, using three types of analysis:

1) chemical analysis of gases affecting the wine's development (oxygen, carbon dioxide and sulphur dioxide)
2) physical analysis of colour
3) sensory analysis, carried out by two groups of tasters – experts and novices

It is important to point out that the results are obtained from wines stored in laboratory conditions and that the figures would certainly be more pronounced in a traditional storage context, where temperature variations and transportation can have a noticeable impact on the development of the wine.

The gas and sensory analyses, including taste, revealed that the bag-in-box®, single-layer PET and small multi-layer PET altered the character of the white wines when stored over 6 months, with oxidation clearly noticeable.

Does the packaging of the future match the future needs of wine?

White wine

The results were convincing on the white wine within just 6 months of bottling.

It was clearly observed that the "bag-in-box®" wine boxes, single-layer PET bottles and small, multi-layer PET bottles allowed oxygen to penetrate after 6 months of storage, with a major reduction in carbon dioxide. This leads to a significant increase in levels of oxygen (the two gases function like communicating vessels – as nature abhors a vacuum, they take each other's place). There is therefore oxidation of the wine in the single- and multi-layer PET and the bag-in-box®.

The wine does, however, remain stable in glass bottles.

Sulphur dioxide (wine's antiseptic) drops significantly in bag-in-box® packaging, as well as single-layer PET bottles and the small multi-PET bottle, whose capacity is too low to ensure the wine's stability. This is important because sulphur dioxide prevents refermentation, microbial growth or maderisation. Again, only the white wine stored in glass remained unoxidised and retained its initial intensity.

The sensory analyses, including taste, revealed that the bag-in-box®, single-layer PET and small multi-layer PET altered the character of the white wines when stored over 6 months, with oxidation clearly noticeable.

Red wine

Oxygen reduces naturally in red wine, as it is consumed by the phenolic compounds specific to this type of wine. CO_2 should remain stable – any reduction would reflect a leak and consequent gas transfers, resulting in an overly high oxygen content, which would lead to oxidation of the wine.

The sulphur dioxide values for wine in PET and bag-in-box® packaging are lower than the stabilisation rate (between 5 and 10 $mg.L^{-1}$) and start to present a risk of oxidation. Final conclusions will be drawn later, during a future 18-month series of analyses.

Conclusion

After 6 months, the white wine clearly oxidised in single- and multi-layer PET, as well as the bag-in-box®. It did, however, remain stable in the two glass bottles. The chemical analyses were confirmed by the jury of expert and novice tasters, who were unanimous about it tasting of rotten fruit. Some initial signs were beginning to emerge in the red wine, but it is too soon to draw any definite conclusions. The 18-month analyses will be carried out in September and a specific communication will be sent out to wine professionals and oenologists at that time.

Influence of packaging on wine preservation
The research

Objective
The aim of the study is to analyse the storage of white wine and red wine in several of the packaging solutions currently available on the international market – glass bottle, single-layer PET bottle, multi-layer PET bottle and bag-in-box. Tetra-packs and cans were not studied as they pose a problem with bottling. This is the first time that such a wide-ranging study has been carried out.

Duration
May 2008 to May 2011. Analyses are carried out at close intervals initially, then every six months.

Methodology

Oxygen analysis

Oxidation of wine is a natural phenomenon caused by the oxidation of compounds found in wine, in the presence of oxygen in the air. Oxidation is noticeable through a change in colour and taste.

Red wines tend to fade to a brownish red and gradually lose their aromatic intensity, as the colour fades. In our study, the red wines had blackcurrant and red fruit aromas when protected from oxygen. However, when oxidised, prune flavours sometimes appeared.

White wines develop a more golden colour, before turning amber. The white wines selected for the study included Sauvignon grapes, which develop a grapefruit aroma. When the wines oxidised, rotten apple overtones can emerge.

These descriptions should be taken with caution, as all tasters are sensitive to different aromas, which they may describe differently.
From a taste point of view, oxidation destroys the particularities of the different vines and regions. There is, unfortunately, nothing which can be done to improve an oxidised wine.

The oxidation of the wine must not be treated separately from the question of reduction, as both of these phenomena are complementary. Reduction occurs when the wine is deprived of an oxygen supply. For wine to age well, this supply must be minimal and consistent.
Luckily, reduction, which is noticeable for its strong animal smells when opening a bottle, can eventually be corrected by airing the wine for a certain period of time, notably in a carafe.

Carbon dioxide and sulphur dioxide analysis

When ageing wine, it is important to monitor other dissolved gases, such as CO_2 and SO_2. Carbon dioxide is used to limit the oxygen supply during bottling. It is used to inert bottles to prevent any excess oxygen supply. Sulphur dioxide is also used in the wine-making process, as it inhibits or stops the development of yeasts and bacteria and sterilises the wine.

It is not possible to guarantee the preservation of wine (preventing refermentation, microbial diseases or maderisation,) without repeatedly testing its free SO_2 content.

These parameters are therefore analysed and monitored throughout the ageing process.
The Carbo QC and Oxy QC are high-precision appliances used to measure CO_2 and O_2 content, respectively. It is important that both parameters are correlated, as when a reduction in CO_2 is detected, there is a potential risk of an increase in O_2.

SO_2 is monitored by chemical analysis, using an automatic device (Iodomatic).

Finally, the spectrophotometer monitors IPT and OD 420. These two parameters represent, respectively, the intensity of colour in red wines and the development of a yellow colour in white wines.

Influence of packaging on wine preservation
The protocol

Packaging solutions studied

- 75cl glass bottle, screw cap
- 250ml glass bottle, screw cap
- 75cl single-layer standard PET bottle, screw cap
- 250ml single-layer standard PET bottle, screw cap
- 75cl highly oxygen-resistant multi-layer PET bottle, screw cap
- 250ml highly oxygen-resistant multi-layer PET bottle, screw cap
- 3l Bag in Box

Wine types

One white and one red Bordeaux wine were used in this study. These wines were packaged in controlled conditions, in order to evaluate the influence of packaging on the storage of the wine.

Storage of bottles and other types of packaging

Once packaged, the containers were kept in a temperature-controlled room at 20°C. Bottles were stored upright.

Frequency of analyses

- Immediately after bottling: T+ 0
- After two weeks' storage: T+ 15 days
- After one month's storage: T+ 1 month
- After two months' storage: T+ 2 months
- After six months' storage: T+ 6 months
- After one year's storage: T+ 12 months
- After 18 months' storage: T+ 18 months

Analyses

The aromas and compounds typical of ageing in wines were measured initially and, when tasting, allowed significant differences to be observed between the wines. Two analyses were carried out for each type of packaging.

Triangular tests and wine-tasting by a professional jury from the Faculty of Oenology were organised at the various sampling points. Following the initial tasting, additional tastings were only carried out if the results of the triangular tests revealed a difference between the types of packaging. If no difference was noticed in the triangular tests, only one wine was tasted, in order to evaluate the global development of the wine being tested.

It was essential that 10 bottles be reserved for each analysis, in order to ensure the repeatability and reliability of the tests.

For each point, 10 containers of each wine in each material were analysed. Various chemical and microbiological analyses were carried out, and are summarised in the table on the next page.

Influence of packaging on wine preservation

Types of Analysis

	Analyses	Red wine	White wine
	Content level in bottles and/or volume of air	X	X
Chemicals	Volumetric alcohol content	X	X
	Total acidity	X	X
	Volatile acidity	X	X
	Sugars	X	X
	pH	X	X
	Free SO_2	X	X
	total SO_2	X	X
Dissolved gases	Dissolved oxygen measurement	X	X
	Dissolved CO_2 measurement	X	X
Indices	HCl, dialysis and gelatine	X	
Absorbencies	DO280	X	X
	DO420	X	X
	DO520	X	
	D0620	X	
	Colour calculation	X	
	Colour intensity calculation, IPT	X	
Microbiological	Total yeasts	X	X
	Lactic bacteria	X	X
	Acetic bacteria	X	X
Aromas and compounds from oxidation	thiols		X
	sotolon	X	
	ethanal	X	

What is the ISVV?

More information on the Bordeaux Institute for Vine and Wine Sciences

ISVV is the largest wine and vine research and technology transfer centre in Europe.

It has three objectives:
- scientific excellence,
- internationalism,
- partnerships with the vine-growing and wine-producing sector.

ISVV aims to be an international reference point within the scientific community and within the vine-growing and wine-producing sector. It aims to be attractive to scientists and create highly-qualified and related job opportunities.

The institute has three main priorities in carrying out its work:
- the environment: finding eco-solutions for vine-growing and wine-making activity which respects the environment as a whole (air, water, ground, landscapes, human health),
- authenticity: production of unique and inimitable wines,
- the market: development of exchanges creating value between producers, wholesale merchants and retail distributors.

The Institute of Vine and Wine Sciences includes all research, training and technology transfer teams in the vine-growing and wine-producing field from:
- Bordeaux 1 University, science & technology
- Victor Segalen Bordeaux 2 University, life sciences and health
- Michel de Montaigne Bordeaux 3 University, arts and humanities
- Montesquieu Bordeaux IV University, law and economics
- National Agronomic Research Institute
- The Bordeaux National School of Agricultural Engineering
- Bordeaux School of Management

Teams and fields of research

From a methodological point of view, the range of approaches and techniques used by researches is at the height of modernity in many fields: agronomics, ecophysiology, microbiology, epidemiology and population studies, chemistry and biochemistry, molecular biology, cytology, biomedical analysis, statistical studies etc. This work has led to many collaborations and exchanges, notably within the profession, locally, nationally and internationally, with the major wine-producing countries, and both in terms of research and teaching.

ISVV's three missions – research, teaching and transfer of technologies – are broken down into six main transversal themes, designed to help the vine and wine sector's development:

1. Improving the quality of wine and grapes, by developing better knowledge of:
- ecophysiology and vine genetics and rootstock quality,
- the chemistry and physical chemistry of aromas and phenolic compounds,
- the functional genomics of the micro-organisms used in wine-making.

2. Explaining the biological properties of polyphenols, by studying their effects on:
- the stimulation of plants' natural defences,
- human health, nutritional and pharmacological content.

3. Optimising cultural practices to preserve sustainable vine-growing, using new techniques such as:
- prevention of stem diseases,
- effective but responsible phytosanitary protections,
- organic, biotechnic or genetic methods.

4. Improving environmentally-friendly growing processes by developing:
- awareness of soil quality characteristics,
- research into environmentally-friendly processes,
- vine-growing and wine-production waste water processing.

5. Improving the economic efficiency of the wine industry, through knowledge of:
- innovations in wine company strategies,
- efficiency in production and sales structures,
- socio-economic dynamics in wine companies,
- comparative advantages of the vine-growing economy in the Aquitaine region.

6. Developing the legal, cultural and economic dimensions of the wine industry:
- legal status of quality wine producers,
- legal status and operating conditions of wine companies,
- product status,
- customer protection,
- globalisation and competition with regard to products and production techniques,
- the cultural role of the vine and wine,
- the economy of innovation.

What is the ISVV?

More information on the Bordeaux Institute for Vine and Wine Sciences

Training

Training is the second pillar of the Institute of Vine and Wine Sciences.
The ISVV has almost 400 students.

ISVV has brought together a community of over 80 professors and lecturers, based around the Bordeaux University of Oenology and its partners (the Universities Bordeaux 3, Bordeaux IV, ENITA and BEM), covering themes ranging from plant biology to vine and wine law and including oenology and marketing of wines and spirits.
Professors and students have access to an exceptional technical support centre, including the latest analytic equipment, wine cellars and tasting rooms.

Promotion and transfer of technologies

The promotion and transfer of technologies within the ISVV includes 3 aspects:

- the development of activities in the 2 promotion and transfer of technology units:
Microflora and Polyphenols Biotech

- participation in the Bordeaux-Aquitaine Inno'vin competitiveness group

- industry relations

ISVV aims to extend quality scientific research through applications meeting the industry's requirements.

In partnership with the industry, and notably the CIVB (the Bordeaux Interprofessional Wine Council), ISVV is developing jointly-funded research programmes covering questions directly related to scientific approaches: characterisation of the biology and epidemiology of Vine pathogens, understanding of the development of grape quality.

Work more directly linked to service provision or the routine running of previous research projects is carried out in the UMRs, which are increasingly research and development companies or promotion and transfer units:

- Microflora (linked to the UMR Oenology): microbiological and oenological characterisation of wines

- Polyphenols Biotech (linked to the GESVAB): fine dosages of polyphenols on various plant products, particularly vines.

Research groups also carry out contracted tests each year, in partnership with industrial firms (phyto-pharmaceutical industry and phytosanitary products). Finally, the ISVV teams are heavily involved in projects within the Bordeaux-Aquitaine Inno'vin competitive development unit, for which ISVV represents a necessary extension for research and higher education.

Resume of Martine Mietton-Peuchot

Vice-dean and Professor at the Bordeaux Faculty of oenology

FRENCH UNIVERSITY QUALIFICATIONS	
17 September **1991**	**Accreditation to supervise research** 62nd section, Process Engineering, Institut National Polytechnique de Toulouse (INPT)
Thesis presented ☐ 10 September **1984**	**Doctorate of Engineering in "Chemical Engineering"** Institut National Polytechnique de Toulouse "Contribution to the study of tangential microfiltration. Application to the filtration of beverages"
June **1980**	**Research-based Master's Degree in Industrial Chemistry, option "Water – pollution"** Université des Sciences et Techniques du Languedoc, "Brevibacterium R312 fixing tests on "
June **1979**	**Engineering degree** Institut des Sciences de l'Ingénieur de Montpellier (ISIM) "Water Sciences and Technologies, option Sanitary Engineering"

OTHER QUALIFICATIONS	
June **1981**	**Master's Degree in "Environmental Management"** Ecole Polytechnique de Montréal, Canada
June **2000**	**University Diploma in Wine-tasting** Bordeaux 2 Victor Segalen University, Bordeaux Faculty of Oenology

PROFESSIONAL ACTIVITIES	
Since January 2007	Vice-principal, Faculty of Oenology Université Victor Segalen Bordeaux
1997- 2006	**Professor, 68th section** **Director of the Laboratory for Process Engineering and Environment - EA 3673 (2003-2006)** Université Victor Segalen Bordeaux 2
1988 - 1997	**Lecturer 62nd section** **ENSAT** Institut National Polytechnique de Toulouse
1987 - 1988	**Research and teaching assistant** UFR IGEPA (Institute for Food Process Engineering) Institut National Polytechnique de Toulouse
1984 - 1986	**Post-doctorate -** IFTS (Institute for Filtration and Separative Techniques, Agen) - Responsible for a DGRST programme "tangential filtration"

Resume of Rémy Ghidossi

Lecturer at the Bordeaux Institute for Vine and Wine Sciences

TRAINING	
2007-2010	Lecturer - ISVV
2006-2007	ATER at the Ecole Centrale in Marseille
2003-2006	Doctorate from Université Provence Aix Marseille I (Distinction)
2002-2003	Research-based Master's degree, Université Montpellier II (Merit)
2000-2002	Bachelor's degree, Université Claude Bernard, Lyon I (Merit)
1997-2000	Associate's degree in Chemistry, Université de Reims (Merit)

RESEARCH	
2007-2010	**Lecturer,** UMR 1219 Oenology, Faculty of Oenology, ISVV
2006-2007	**RESEARCH AND TEACHING ASSISTANT** Subject: Filtration of solid suspensions using metallic foam for gas processing Supervisor: Prof. P. Moulin Department of Clean Processes and Environment, UMR CNRS 6181
2003-2006	**Thesis presented 6 October 2006** Speciality: Membrane processes Title: Ceramic membranes: optimisation of geometry using digital simulation and industrial applications Thesis supervisor: Dr D. Veyret and Prof. P. Moulin IUSTI Laboratory (UMR CNRS 6595)
2002-2003	**Research-based Master's degree in Process Engineering** Title: Textile industry waste water processing using inverse osmosis Supervisor: Prof. G. Grasmick Process Engineering Laboratory, Université Montpellier II – UMR 016

ADDITIONAL INFORMATION

English: working knowledge
IT: use of office software, Fluent and Fidap

Photos available