Interest in measuring the grape texture to characterise grapes from different cultivation areas – Example of Cabernet franc from the Loire Valley

Intérêt de la maturité texturale des raisins comme nouvel indicateur de caractérisation des raisins issus de différents terroirs - Application au Cabernet franc en Vallée de la Loire

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Abstract

A two-bite compression test was applied on Cabernet franc grapes during two harvest seasons. The evolution of the texture parameters from véraison to harvest was studied and a new mechanical ripeness notion was introduced. The ripeness stage and the parcel type effects on the texture properties were investigated, considering ten sampling dates and three parcels. A sensory description of the same grape samples was also performed. The compression test and the sensory evaluation allowed discrimination between ripeness levels and parcels types. The influence of the parcel type and the harvest season were highlighted. Indeed each parcel behaved differently from the others toward climatic conditions. High correlations were observed between some sensory descriptors and texture indices in 2005. This work confirmed the interest of the grape texture as an indicator of the grape ripeness in relation with the terroir.

Key words: Grape, texture, sensory, parcel, ripeness

Introduction

Different methods have been applied to determine the wine grape quality and the optimum ripeness level (Bisson 2001). However, these methods are sometimes complex, time consuming and even expensive. In addition, some traditional ripeness indicators such as the acidity and sugar content are usually not sufficient to predict the harvest date (Failla et al. 2005), they are also not sufficient to highlight differences between terroirs. Complementary indicators need therefore to be introduced and developed.

Meanwhile, the grape tasting is acquiring more and more interest from vintners and winemakers since it represents a useful tool to assess the harvest date (Le Moigne et al. 2007). The techniques adapted to grape tasting are mainly based upon a personal experience. In literature it is possible to find some scientific contributions related to grape tasting but there is a little attention to the assessment of the relationships between grape sensory evaluation and chemical-physical characterisation. Moreover, the grape tasting could provide information about the grape texture which allows a complete characterisation of the fruit.

In addition to sensory analysis, mechanical measurements based on compression tests could be applied to define the grape texture (Bourne 2002). Sensory texture attributes and instrumental texture parameters were found to be related to each other when both were applied on other fruit like apple (Mehinagic et al. 2004). Texture analysis is a method widely applied to measure the quality of several fruit, their ripeness level and their aptitude to conservation and processing (Bourne 2002; Lana et al. 2005).

In literature we can find researches that analyzed the modifications of some grape texture properties (Robin et
al 1997). It is known that grape mechanical properties can influence the winemaking process; nevertheless in general, little attention was given to the wine grape texture analysis (Grotte et al. 2001; Letaief et al. 2007).

This work applied sensory and instrumental measurements to highlight the importance of the grape texture characteristics as an indicator of grape quality. It studied the evolution of the sensory descriptors and instrumental parameters during grape development and the relationship between them. It was also intended to highlight the parcel and seasonal effects on the grape texture properties whether analysed by sensory evaluation or mechanical tests.

Materials and methods

Sampling

Cabernet franc grapes were sampled from three parcels located in the Loire Valley: Chinon (P1), Bourgueil (P2) and Saint-Nicolas de Bourgueil (P3) during two harvest seasons 2005 (A) and 2006 (B). The three sites were pedoclimatically different (Table 1).

Parcel 1	**Parcel 2**	**Parcel 3**
Sandy calcareous	Sandy clay loam	Ancient alluvial sandy
Low slope (50-75m) 90cm soil depth which allows a deep rooting Moderate vigour potential and high aptitude to earliness Low soil hydric potential Sensitive to dry seasons	Low slope (50-75m) 70cm soil depth Allows a deep rooting and good drainage Important soil hydric potential High vigour potential and normal aptitude to earliness	Very low slope (<50m) Very deep soil but with a low drainage Very Low soil hydric potential Very sensitive to dry seasons with risk of stress Normal vigour potential and very high aptitude to earliness

The sampling was made weekly from véraison to harvest which corresponds to 10 sampling dates (form B to K) from August to October.
The samples consisted of 450 berries randomly hand picked from designated vines according to the sampling method described by Carbonneau et al. (1991). It consisted in picking bunch fragments in the midsection of the cane or the cordon excluding those in the first rank of the parcel.
Sub-samples were then randomly taken from the batch of 450 berries for sensory evaluation and texture instrumental measurement. They were composed respectively of 150 and 50 berries. Each berry was visually inspected for any skin damage. The berries were analysed the following day they were picked. Chemical-physical analysis was performed on the remaining berries.

Sensory analysis

A trained analytical sensory panel evaluated the grapes from all parcels and at each sampling date. The Jury consisted of regular members of the sensory panel of the laboratory. Twelve judges in 2005 and 16 in 2006 were trained weekly from May to the end of August. The training sessions took 1hour each. The purpose was to develop a common vocabulary among panellists, on specific attributes that respects the AFNOR recommendations (1995). Frozen Cabernet franc berries and other fruit with similar shapes were used for the training. Thirty descriptors were obtained to allow a complete characterisation of the berry, its skin and seeds (Table 2). Throughout the training, panellists were provided with feedback on scoring of attributes to ensure panel consistency.
The grape analysis sessions started in September and ended in October, after harvest. Each panellist evaluated five berries for each ripening stage and each parcel. The samples were scored for the intensity of attributes using an unstructured line scale anchored with the terms “very weak” and “very intense” (Le Moigne et al. 2008). The scores were then recorded and converted into a 10-point scale using Fizz software (Biosystèmes, France, 1999).

Analysed material	Attribute
Berry 1	Skin fading, elasticity, touch resistance, facility to detach the pedicel, odour intensity at the pedicel point, vegetal odour, fruity odour, jam odour, sweetness, acidity
Berry 2	Crunchiness
Berry 3	Firmness, juiciness, pulp gelatinousness
Berry 4	Aroma intensity during chewing, vegetal aroma, fruity aroma, jam aroma, skin thickness
Berry 5	Skin dilacerations, skin acidity, skin sourness, skin astringency
Seeds (one seed per attribute)	Aroma intensity, vegetal aroma, roasted aroma, seed sourness, seed astringency, seed hardness, seed cracking

Table 2 Grape sensory descriptors (Le Moigne et al. 2008)

Texture Profile Analysis

A universal testing machine (MTS, Synergie 200H) equipped with two-parallel plate geometry (MTS, Synergie 200H) and a 50N load cell was used. A double-compression was applied on the lateral side of the berries (Grotte et al. 2001) using a 25.4mm ∅ probe. The test speed was 50 mm min^{-1} until a deformation of 20% the berry height was reached. As summarised in Table 3, the test extracted a number of textural parameters from the resulting pressure versus deformation curve (Figure1).

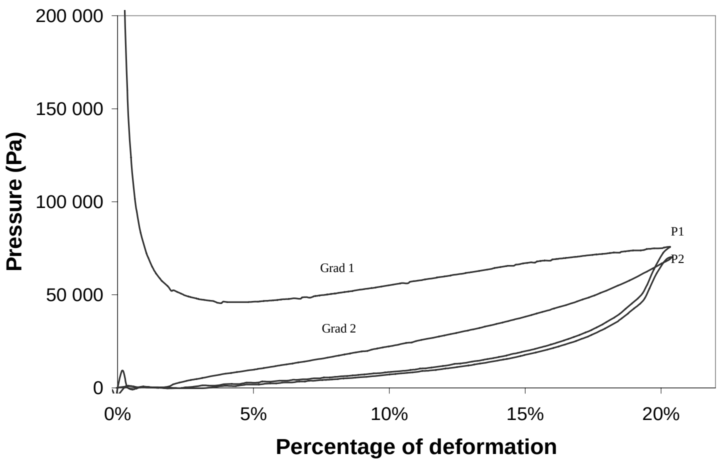

Figure 1 Pressure versus deformation curve related to the double-compression test

Parameter	Definition
P1 (Pa)	Berry hardness or Pressure corresponding to the first peak
P2 (Pa)	Pressure corresponding to the second Peak
W_{P1}(mJ)	Work related to the first compression
W_{P2}(mJ)	Work related to the second compression
Grad1(Pa/mm)	Slope of the first compression curve
Grad2 (Pa/mm)	Slope of the second compression curve
Cohesiveness (-) (Bourne 2002)	W_{P2}/ W_{P2}
Gumminess (Pa) (Bourne 2002)	P1∗(Cohesiveness)

Table 3 Parameters extracted from the Pressure-deformation curve

Statistical analysis

ANOVA with interactions and multidimensional analysis were carried out using Statgraphics Plus 5.0 software.

Results and discussion

Differences between the two harvest seasons were observed. The grapes indeed reached ripeness earlier in 2005 than in 2006. The 2005 harvest season was in fact one of the driest seasons in the last 30 years. The fresh winter temperatures and the low pluviometry accelerated the plant vegetative cycle. In contrast, the end of the 2006 summer was rainy which led to a slower ripening process if compared to 2005. These different climatic conditions influenced the hydric potential of the parcels which affected the ripeness kinetic and the grape quality.

Sensory analysis

The data concerning the 2005 harvest season were reported in a previous work (Le Moigne et al. 2008). It was shown that sensory analysis could give a considerable description of the ripening level and parcel type. The method succeeded in differentiating ripeness levels and parcels. However, the ripeness level effect dominated the parcel effect. The berries from the parcel 3 were less firm and sweeter than those sampled from parcels 1 and 2. Parcel 3 was in fact more sensitive to dryness due to its sandy soil which is favorable to an early ripeness. Grapes belonging to parcel 3 were more difficult to dilacerate. These grapes were indeed ripe earlier than the other grapes.
The representation of the axis 1 and 2 of the PCA related to the grape sensory evaluation in 2006 showed the ripeness level effect. Touch resistance, firmness, vegetal notes and astringency decreased during maturation (Figure 2). On the other hand, a representation of the axis 2 and 3 highlighted the parcel effect (Figure 3). The axis 2 discriminated the parcel 1 from the parcel 2 whilst the axis 3 discriminated the parcels 1 and 2 from the parcel 3.

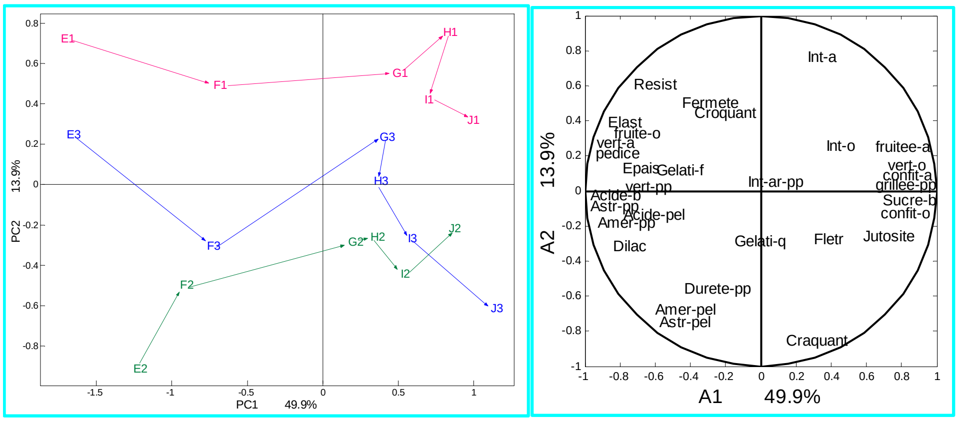

Figure 2 2006 PCA map on sensory data in the plane defined by principal component 1 and principal component 2.

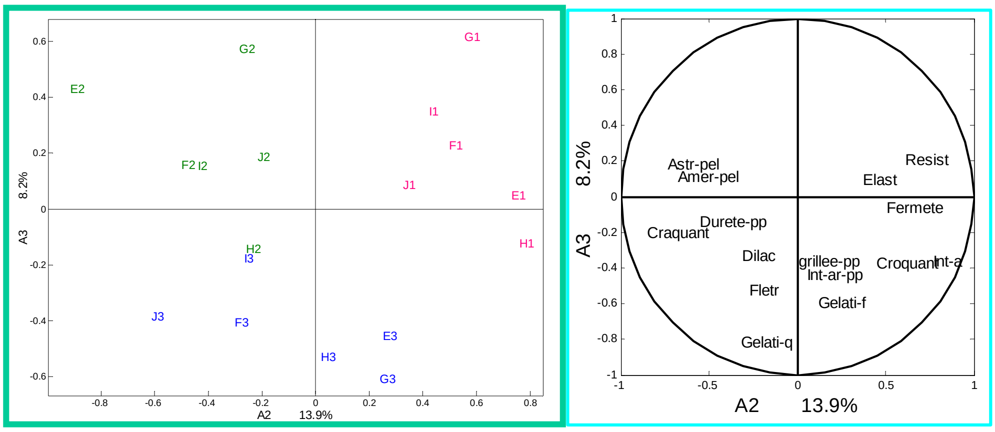

Figure 3 2006 PCA map on sensory data in the plane defined by principal component 2 and principal component 3.

The importance of the texture properties analyzed by sensory evaluation is highlighted by MFA analysis (Figure 4). The texture ripeness discriminated in fact the parcels more than the other three ripeness notions and a difference between harvest seasons could be observed.

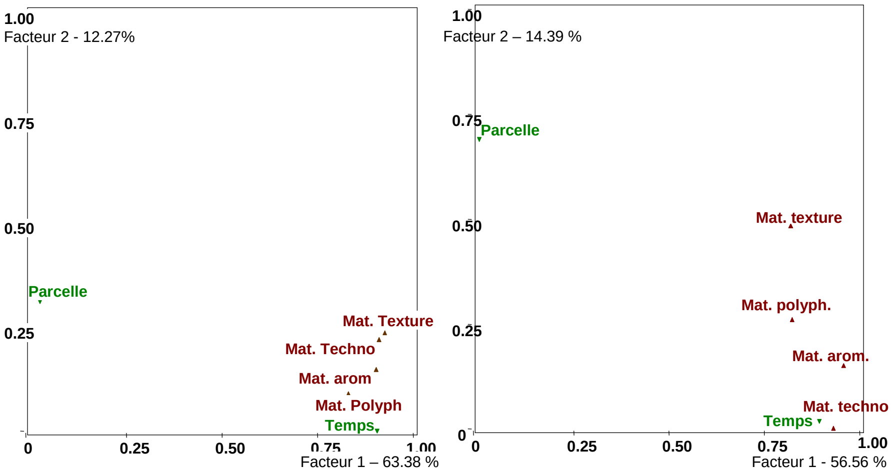

Figure 4 MFA representations of the texture, technological, aromatic, and phenolic ripeness notions, assessed by sensory evaluation and their effect on parcel differentiation. Left: 2005, right: 2006.

Texture Profile Analysis

The evolution of the grape texture parameters from véraison to harvest was investigated. In 2005, almost all the mechanical indices except the cohesiveness decreased from véraison to the 5^th sampling date and then were steady (Figure 5). The mechanical ripeness was reached later in 2006 than in 2005 due to the climatic conditions of the 2005 season.

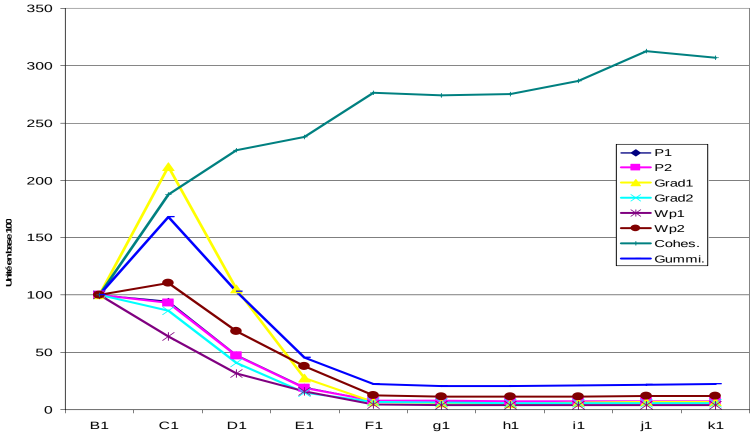

Figure 5 Evolution of the grape texture parameters from véraison to harvest corresponding to parcel 1 (2005)

The effects of the sampling date, the parcel type and their interactions were studied on the different compression parameters with an analysis of variance. There was evidence of a difference between the sampling dates until the 6^th date. The compression test allowed also discrimination between parcel types.

A multidimensional analysis applied on the last 5 sampling dates of 2005 showed that berries from parcel 1 were firmer than those from parcels 2 and 3. The gumminess and cohesiveness differentiated the parcel 3 from the others. Grapes belonging to parcel 3 were gummier and more cohesive. This could be explained by the sandy soil type of parcel 3. Such a soil has low hydric potential which could accelerate the ripeness.

In 2006, the parcel 1 was distinguished from parcels 2 and 3. The berries from parcel 1 were less cohesive and less gummy than those from parcels 2 and 3. The Parcel 3 was characterised by important cohesiveness and gumminess even in 2006 (Figure 6).

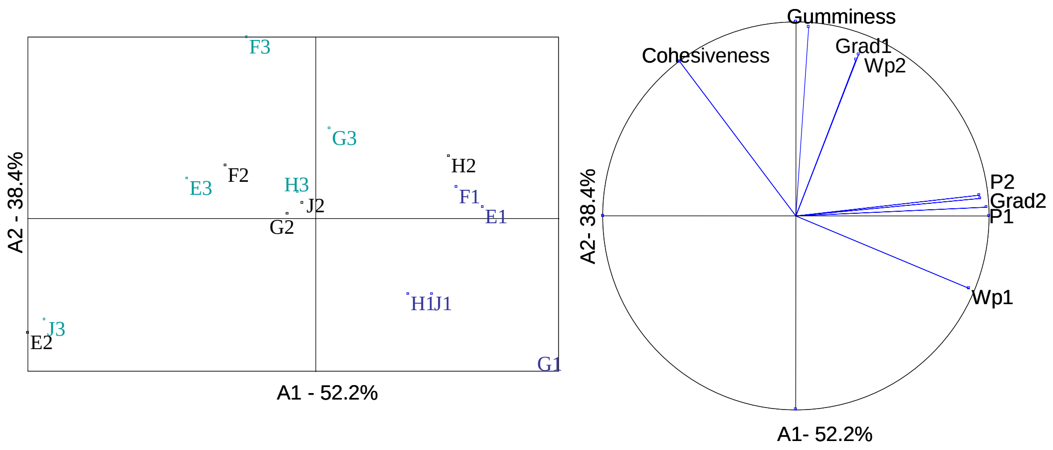

Figure 6 PCA applied on the compression test parameters corresponding to the 5 last sampling dates (2006)

Correlations between mechanical and sensory parameters

The correlation coefficients between the averaged sensory attributes related to texture and compression parameters were calculated in 2005 and 2006 (Table 4). In 2005, the parameters P1, P2, Grad2, Wp1 and cohesiveness were correlated with elasticity, touch resistance, facility to detach the pedicel, firmness and juiciness. No significant correlations were observed with Grad1. The best correlation coefficients for firmness and touch resistance were obtained with Wp1 (R=0.83 and R=0.82, respectively) and Grad2 (R=0.77 and R=0.81, respectively). Cohesiveness was rather correlated with elasticity and touch resistance. The descriptor skin dilaceration, which discriminated the three parcels, was correlated with Wp2 (R= 0.65) and gumminess (R=0.62). These results are consistent since some descriptors were directly linked with compression parameters (touch resistance, elasticity and firmness). For some other descriptors, the relationships found could be due to internal links (facility to detach the pedicel, dilaceration or juiciness). In 2006 only a correlation between the cohesiveness and the skin dilaceration was observed.

	Harvest Season	**Elasticity**	**Touch resistance**	**Facility to detach the pedicel**	**Crunchiness**	**Firmness**	**Juiciness**	**Dilaceration**
P1	2005	0,70	0,77	-0,78	0,69	0,78	-0,76	ns
	2006	ns	ns	ns	ns	ns	ns	ns
P2	2005	0,69	0,75	-0,78	0,69	0,78	-0,77	ns
	2006	ns	ns	ns	ns	ns	ns	ns
Grad1	2005	ns	ns	ns	ns	ns	ns	ns
	2006	ns	ns	ns	0,67	0,69	ns	ns
Grad2	2005	0,69	0,77	-0,81	0,65	0,80	-0,80	ns
	2006	ns	ns	ns	ns	ns	ns	ns
Wp1	2005	0,75	0,83	-0,79	0,70	0,81	-0,81	ns
	2006	ns	ns	ns	ns	ns	ns	ns
Wp2	2005	ns	ns	ns	ns	ns	ns	0,65
	2006	ns	ns	ns	ns	ns	ns	ns
Cohesiveness	2005	-0,73	-0,78	0,64	ns	-0,63	ns	ns
	2006	ns	ns	ns	ns	ns	ns	0,73
Gumminess	2005	ns	ns	ns	ns	ns	ns	0,63
	2006	ns	ns	ns	ns	ns	ns	ns

Table 4 Correlation coefficients between texture descriptors and compression parameters (2005 and 2006)

Conclusion

The compression test and the sensory evaluation allowed the discrimination between ripeness levels and parcel types. The influence of the parcel soil type and the harvest season were highlighted. High correlations were observed in 2005 between some sensory descriptors and texture parameters. From these results it is apparent that texture could become a new indicator to assess the grape ripeness, in addition to the indices commonly used by winemakers to make decisions concerning their winemaking process in relation with the terroir. However this work involved only one mechanical test and further tests should be developed on the berry, its skin and seeds for a complete description of the grape texture.

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