Chenin blanc table wines in South Africa

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A golden thread running through each of the best Chenin blanc table wines from South Africa is the passion and dedication of a winemaker.

I wish to thank every respondent interviewed for this dissertation.

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TABLE OF CONTENTS

Page

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

It is important for a wine producing country to maintain an increase in wine quality in order to continue to grow its international market share (Gishen, Iland, Dambergs, Esler, Francis, Kambouris, Johnstone and Høj, 2001). Emile Peynaud, previously professor at the Bordeaux Institute of Oenology, claims that there is only one possible strategy to use when competing in the global wine market and that is "… to produce wines that are better and better, whose quality is unquestionable and also unattainable by foreign producers" (Peynaud, 1987).

Chenin blanc represents almost 20% of all the wine grapes crushed in South Africa for the production of wine (see figure 1) and it is therefore important for South African wine producers to establish those viticultural and oenological practices that enhance the quality thereof.

The objective of this dissertation is to attempt to identify viticultural and oenological practices that contribute to the production of top quality drier styled Chenin blanc table wines in South Africa (i.e. wines with a residual sugar level less than 30g/l).

This section will discuss the problem statement, list the research objectives, explain the rationale and the significance and detail the delineations and limitations of the dissertation. The section will close with a brief overview of the chapters in the dissertation.

1.1 PROBLEM STATEMENT: THE EVOLUTION OF CHENIN BLANC IN SOUTH AFRICA

Chenin blanc historically forms the basis of white wine production in South Africa (Carstens, Burger and Kriel, 1981) and is used to produce every imaginable wine style (Marais, 2003).

More recently the variety has made a great amount of progress and there has been a recognisable improvement in the quality of Chenin blanc table wines from South Africa. The 21st century saw the workhorse variety of the industry emerge to be recognised internationally as a world class table wine (Fridjhon, 2006).

In a recent article in the New York Times, Eric Asimov (2007) stated that "… all who hold Chenin blanc dear should be soothed to learn how far the wines from South Africa have come in the last 20 years." Andrew Jefford (2002: 51) says in his book 'The New France' that "… internationally, the ancient bush vine Chenins of South Africa are beginning to create a climate of appreciation around the world." South African wine critic Michael Fridjhon claims that South African Chenin blanc took ownership of the variety from France and cites the consistently strong performance of South African Chenin blanc at the Rendez-vous de Fontevraud (previously the Rendez-vous de Chenin) as evidence of this (Fridjhon, 2006).

Examining the various viticultural and oenological practices employed by top Chenin blanc producers may help identify the practices that contributed most to the emergence of these new and improved wines of the Cape Chenin blanc renaissance.

1.2 RESEARCH OBJECTIVES

The aim of the dissertation is to look holistically at a representative sample of the best Chenin blanc table wines in South Africa and attempt to identify viticultural and oenological practices that contribute to the production of quality South African Chenin blanc table wines.

1.3 SIGNIFICANCE / RATIONALE: THE ECONOMIC OPPORTUNITY PRESENTED BY CHENIN BLANC TABLE WINES FOR THE SOUTH AFRICAN WINE INDUSTRY

Chenin blanc wines represent a large portion of the production and export of wine in South Africa. It is one of the less expensive noble varieties and the low price suggests that there may be scope for a price increase. The massive production and the low price create an opportunity for the South African wine industry to increase its revenue.

If the South African wine industry can improve the general quality of Chenin blanc table wine, it could potentially justify a price increase. In this regard, it is interesting to compare the cellar price of those Chenin blanc wines researched in this study to the average wholesale price of Chenin blanc wines in South Africa. The wines included in this study have a mean cellar price of R73.52 per 750 ml bottle and fifty percent of these wines have a cellar price of between R34.42 and R92.50. Compared to this, the average wholesale price of all Chenin blanc wines in South Africa sold in 750 ml bottles was only R19.92 in 2006 (South African Wine Industry Information and Systems [SAWIS], 2007a). Although it does not fall within the scope of this study to research the extent to which an increase in the quality of Chenin blanc wine will contribute to an increase in the price of Chenin blanc wines, the above simple comparison is an indication that the modest assumptions referred to hereafter can be achieved if the South African wine industry can make a concerted effort to improve the quality of Chenin blanc wine.

Consider the following:

- If one accepts that 3.3% of Chenin blanc wine made in South Africa is produced by **producing wholesalers** (see figure 5) and that 60% of this is used to produce good wine, then a R1.00 per bottle increase in the price of Chenin blanc wine will result in a R4.8 million increase in revenue (accepting 700 litres of wine per ton retrieval rate).
- If one accepts that 7.4% of Chenin blanc wine made in South Africa is produced by **private cellars** (see figure 5) and that all the grapes are used to produce good wine, then a R1.00 per bottle increase in the price of Chenin blanc wine will result in a R17.9 million increase in revenue.
- If one accepts that 89.3% of Chenin blanc wine made in South Africa is produced by **producer cellars** (see figure 5) and that 60% of this is used to produce good wine, then a R1.00 per bottle increase in the price of Chenin blanc wine will result in a R216.2 million increase in revenue.

The increase in the selling price will result in a recurring bonus for the wine industry every single year. If these cash flows are discounted at an appropriate rate, it becomes clear that the improvement in the overall quality of all Chenin blanc table wines from South Africa could result in a billion rand intangible asset for the South African wine industry.

Practices that promote Chenin blanc wine quality may therefore be of practical importance to local wine producers because it can be used to assist them to implement current best practices to improve South African Chenin blanc wine quality as a whole.

1.4 DELINEATIONS AND LIMITATIONS

The study does not intend to compare the viticultural and oenological practices employed in the production of South African Chenin blanc to practices used in other wine producing countries. It is believed that the unique growing conditions present in South Africa is different from other international wine producing areas and therefore it is not possible to determine the influence that foreign practices will have on wines produced in South Africa with reasonable certainty. Such a comparison would only be of academic and not of practical significance.

The study also does not intend to investigate viticultural and oenological practices employed by a representative sample of all South African Chenin blanc producers. Such an investigation would also only be of academic and not of practical significance. It is believed that it is more important to identify a representative sample of the top examples of the variety and attempt to identify practices that seem to promote Chenin blanc wine quality. As mentioned above, this information may be of practical importance to local wine producers as it can be used to assist them to implement current best practices to improve Chenin blanc wine quality.

1.5 CHAPTER OVERVIEWS

The **literature review** provides background on the concept of wine quality, the international distribution of Chenin blanc, statistics of Chenin blanc in South Africa and focus on the viticultural and oenological practices that influence the quality of Chenin blanc table wines in South Africa.

The **methodology** chapter outlines and motivates the methodology followed in the study and lists the steps that the dissertation will follow to identify viticultural and oenological practices that contribute to the production of quality Chenin blanc table wines in South Africa.

The **analysis of results** section contains the interpretation of the gathered data and presents the research findings and conclusions. It contains the list of the sample of wines that were investigated and considers the importance of all the various production practices that could influence the quality Chenin blanc table wines in South Africa.

The **conclusion** draws the final conclusions of the dissertation.

2. LITERATURE REVIEW

The literature review will introduce the concept of wine quality and continue with an extensive overview of literature investigating factors that influence the quality of Chenin blanc wines, grouped under the main topics of terroir, viticultural practices and oenology. The literature review then proceeds to investigate the prevalent viticultural and oenological practices as well as the influence of terroir in global well-known Chenin blanc producing wine regions and concludes with relevant statistics of Chenin blanc production in South Africa.

The main purpose of the literature review is to provide an academic overview of the most commonly researched aspects of Chenin blanc wine production believed to contribute to the production of quality Chenin blanc wines with which to compare the views of a selection of the top Chenin blanc producing winemakers in South Africa to.

2.1 THE CONCEPT OF WINE QUALITY

The term 'quality' in the context of wine is not easy to define because there is no clear consensus as to what constitutes wine quality (Gishen, Iland, Dambergs, Esler, Francis, Kambouris, Johnstone and Høj, 2001).

The sensory perception of humans is very complex and demonstrably highly variable among individuals (Francis, Høj, Dambergs, Gishen, Lopes and Pretorius, 2004). The evaluation of the overall quality of the wine by an individual requires the assessment off many aspects including the conformity of the wine to regional standards, the development, duration and complexity of aromas and the duration of the finish (Jackson, 2000). There is also often much disagreement as to which characteristics are desirable and undesirable for a particular wine style.

The international standards for quality management systems, with particular reference to the ISO9000 series, define quality as the "degree to which a set of inherent characteristics fulfils requirements." For most businesses this usually means that quality depends on the degree to which the requirements of consumers are fulfilled. Consumers of wine have been shown to display large variations in preference and can be split into groups displaying similar liking (Francis, Høj, Dambergs, Gishen, Lopes, Pretorius, Godden, Henschke, Herderich and Waters, 2004). This disproves any notion that there is an absolute measure of wine quality.

And yet the world of wine is constantly ranking wines. One of the most famous attempts to classify wines was drawn up by the Bordeaux Chamber of Commerce to help with the presentation of the wine of Bordeaux at the 1855 *Exposition Universelle* in Paris. The five-class classification reflected the prices fetched by the wines of various Medoc, Graves, Sauternes and Barsac châteaux (Penning-Rowsell, 1969). The classification system assumed that the price paid for a particular wine was an absolute measure of the quality thereof.

There are numerous regional, national and international wine competitions where panels of judges evaluate and classify wines according to its quality. And yet it is known that the human evaluation of wine can be unreliable. (Merrit, 1997)

Fortunately there are currently a number of objective measures of wine quality as a result of the correlation between measurable wine and grape characteristics and wine quality. These include the colour of grape or wine, the glucosyl-glucose (G-G) assay and the assessment of vineyard characteristics.

The colour of grapes and wine correlates well with red wine quality (Marais and October, 2005; Somers and Evans, 1974) and can be used to indicate the quality of specifically a red wine.

The glucosyl-glucose (G-G) assay is an indication of the flavour potential of grapes. It measures the secondary metabolites present as glycosides that are responsible for many wine sensory properties. Studies have shown that the flavour intensity and wine score have a strong relationship with the grape glycoside concentration. (Francis, Iland, Cynkar, Kwiatkowski, Williams, Armstrong, Botting, Gawel and Ryan, 1998)

The assessment of the characteristics of the vineyard can also indicate the potential quality of wine produced from those vines (Francis, Høj, Dambergs, Gishen, Lopes, Pretorius, Godden, Henschke, Herderich and Waters, 2004). The importance of uniform shoot length for the production of quality wine is discussed by Archer (2001b). Other characteristics that might be assessed in order to determine the quality of the wine includes: balance between grape yield and the canopy area, evenness of ripening, presence of growing tips after *véraison*, exposure to sun, disease and berry characteristics (Francis, Høj, Dambergs, Gishen, Lopes, Pretorius, Godden, Henschke, Herderich and Waters, 2004).

This dissertation recognises that there is a certain amount of disagreement as to what constitutes wine quality and that there will always be some diversity of opinion. However, the dissertation also adheres to the point of view that there is a continuum of wine quality that the majority of people can agree to.

2.2 FACTORS THAT INFLUENCE CHENIN BLANC TABLE WINE QUALITY

According to Peynaud (1987) the conditions that are required to obtain quality wines can be divided into natural factors or elements of innate quality as well as human intervention or acquired quality. This section will discuss how the terroir (innate quality) as well as viticultural and oenological factors (acquired quality) influence the quality of Chenin blanc table wines made in South Africa.

This section of the literature study focus mainly on scientific and selected semi-scientific studies published during or after 1980.

2.2.1 TERROIR

Carey, Archer and Saayman (2002) claims that terroir is a set of natural environmental factors that cannot be easily modified by a producer. The components of terroir listed include aspect, altitude, geology, soil type, effective soil depth, water supply, etc.

There are a number of studies that demonstrate that the interaction between the natural environment and vines have an influence on the nature and characteristics of wines.

Marais, Van Rooyen and Du Plessis (1981) aimed to identify flavour components produced during fermentation that could be used to identify the geographical origins of wines. Chenin blanc table wines were included in the study. The study concluded that regional classification was possible based on the concentration of only a few flavour components produced during fermentation. The components with the highest discriminatory value for Chenin blanc table wines were hexanol and 2-phenyl ethanol, both higher alcohols. The study provided proof that there is a quantifiable difference between wines produced from grapes grown in different localities or terroir.

Van Leeuwen, Friant, Choné, Tregoat, Koundouras and Dubourdieu (2004) demonstrated that soil, cultivar and climate had a significant effect on vine development and berry constitution. Climate had the greatest effect on vine development and berry constitution. The study demonstrated a strong relationship between water deficit before *véraison* and improved grape quality. This was caused by the reduction in shoot growth and berry size. The study concluded that the effects of climate and soil on fruit quality are likely mediated by the influence these two components of terroir have on vine water status.

Van Huyssteen (1989) claims that the capacity of soil to supply water for the longest possible period is the most important characteristic of the soil for growing vines. This is directly related to the soil depth and potential rooting volume.

Producers in South Africa that experience the effect of sea breezes often claim that its cooling effect results in quality grape production. Bonnardot, Carey, Planchon and Cautenet (2001) showed that the sea breeze from False Bay penetrates further than 100 km from the coast and peaks late in the afternoon. The sea air was cool (23°C) but the temperature increased rapidly as it progressed further inland (Bonnardot, Carey, Planchon and Cautenet, 2001). Dry and Botting (1993) found that wind decreased yield, shoot length and pruning weight compared to sheltered vines.

The impact of terroir on the sensory characteristics of wines is a well established concept (Guinart and Cliff, 1987) and it is therefore reasonable to expect different regional characteristics amongst the various Chenin blanc wines in South Africa.

To conclude, the influence of terroir is an acknowledged contributor to the characteristics of all wines and if understood and utilised correctly could have a positive influence on the quality of Chenin blanc wines from South Africa.

2.2.2 VITICULTURE

This section discusses the viticultural characteristics of Chenin blanc and review a number of the more important viticultural aspects that have an influence on wine quality and its characteristics, with a specific look at the influence these have on Chenin blanc wines.

Viticultural characteristics of Chenin blanc

Chenin blanc vines have a tendency to form water shoots and it is important to sucker in the spring to improve the airflow through the canopy and to prevent an excessive amount of pruning wounds with winter pruning. Chenin blanc vines are very fertile and care should be taken to prevent overproduction especially in young vines that have been trellised.

Bunches are pyramidal, have prevalent side bunches, a short, tough stem and are of medium to large size. The problem with Chenin blanc is that its compact bunches predispose it to develop either botrytis or grey rot. The formation of acetic acid together with these infections is also a risk. Leaves are medium-small and either whole or three-lobed. Berries have a thin skin without a great amount of epicuticular wax, are small, elongated and oval and relatively juicy. Grapes ripen during the early mid-season. (Orffer, 1979)

Viticultural progress contributing to improvement in wine quality in general

The viticultural progress made in South Africa contributed to a noticeable improvement in wine quality in general (Archer, 2001a). The main areas of improvement include progress in training and progress in viticulture itself (Archer, 2001a). Regarding viticulture, progress has been seen in the choice of terroir, changes in cultivar patterns, in farm planning and viticultural practices,

As mentioned in the section on the influence of terroir on wine quality, a greater understanding of the influence of soil and climate on vine performance makes it possible to make more informed viticultural decisions. This includes decisions on the selection of the appropriate rootstocks, scions and clones for a specific vineyard (Archer, 2001a).

Changes in the cultivar pattern, seen as an increase in the percentage of premium wine grape varieties being planted, could be cited as another indicator of the progress in viticultural practices in South Africa (Archer, 2001a).

In the past, little farm planning used to take place before a vineyard was established. Nowadays, with the progress in farm planning, new plantings are based on a scientific study of the soil type that occurs in the vineyard. This makes it possible to make a better selection of the rootstock to use, to make use of the correct soil preparation procedures before planting and to make better decisions about vine spacing and trellising systems (Archer, 2001a).

Changes in general viticultural practices have also seen producers beginning to manage individual blocks to emphasize relevant characteristics in order to produce the desired wine style. Improvements in trellising, pruning and water management practices also contributed to the improvement of the quality of the grapes (Archer, 2001a).

The effect of a number of the more important viticultural aspects that have an influence on wine quality and characteristics will now be discussed in more detail, with emphasis on the influence of these aspects on Chenin blanc. Vine age, clonal selection, choice of trellising system, vine spacing, row orientation, canopy management, fertilisation, irrigation, maturity indices and yield are amongst the wide range of viticultural practices that will be discussed in the rest of this section.

Vine age

According to Smart (1993) the accumulation of various plant stresses can result in the gradual devigoration of vines with age. In addition, soils can become impoverished over time due to the utilisation of nutrients. This combination of factors will cause the canopy of the vines to open up leading to improved leaf and fruit exposure resulting in better fruit quality. According to the author, higher carbohydrate reserves – often cited as the reason for the improved grape quality of older vines – does not hold correct.

The example cited by Smart (1993) concerns vines older than 30 years in the Barossa Valley, the source of Australia's most prestigious wine, Grange Hermitage. Eutypa dieback and nematode infestation over many years contributed to the reduction of the vigour of these vines. However, the author also cites examples of young vineyards that produce high quality grapes as a result of proper management that achieved vine balance and appropriate leaf and fruit exposure.

Smart's examples seem therefore to indicate that vine age could play a role in the improvement of fruit quality in certain instances but that it is not a necessary prerequisite. It is assumed that this conclusion is also applicable to Chenin blanc.

Clone

According to Mullins and Meredith (2001) clonal selection has become the most widely used procedure for the improvement of wine grapes. The existence of variations between clones of the same variety is firmly established.

According to Kriel and Visser (1993) differences amongst clones of the same variety can influence yields, sugar, acid and pH of the grapes, morphological characteristics for example the size of the grapes and the levels of aroma compounds found in the grapes.

According to Kriel and Visser (1993) it is also important to select plant material that is free of harmful viral diseases such as leaf roll because this will negatively influence yields, growth and the metabolism of the

vine. The elimination of virus and related diseases from plant material by means of heat therapy results in increased yields and improved grape quality if vines are in balance.

These references seem to indicate that the choice of a specific Chenin blanc clone could potentially have an effect on wine quality.

Trellising system

The trellising system determines, amongst other things, the effective leaf surface area for sunlight interception, production potential, microclimate, bud fertility, ease of production practices and resistance to wind and frost damage (Zeeman, 1981b). Vines should only be trained on a trellising system if shoot growth exceeds 45 cm in length and 8 mm in diameter in the second growth season (Zeeman, 1981b).

The majority (71%) of Chenin blanc vineyards in South Africa are not trellised and trained as bush vines. Three strand and Perold trellising systems are two of the more popular systems used to train Chenin blanc vines in South Africa. See figure 3 for the trellising systems used in Chenin blanc vineyards in South Africa.

Van Zyl and Van Huyssteen (1980a) compared the consumptive water use of Chenin blanc trained on four trellising systems, which were bush vines, the Perold system, the lengthened Perold system and the slanting trellis. The study showed that the bush vines had the highest evapotranspiration rate which was attributed to the higher air temperature, more air movement and less shading of the soil realised with this trellising system. Despite the high water consumption of bush vines, it yielded 50% less grapes compared to the trellised vines. The bush vines also had a higher incidence of botrytis cinerea rot compared to the trellised vines, although the mechanism involved in this was not clear. The study concluded that the Perold trellising system is the most attractive option to farmers with limited water supplies because of its low water consumption and relatively high yields.

Van Zyl and Van Huyssteen (1980b) also studied the effect of the four above-mentioned trellising systems on the micro-climate, grape composition and wine quality of Chenin blanc. There was significantly more air movement and higher bunch, air and soil temperatures recorded in the bush vines compared to the lengthened Perold and slanting trellising systems. Bush vines accumulated sugar slower compared to the other trellising systems and had lower malic acid concentrations at harvest.

The differences in the grape composition of the four trellising systems apparently did not have an influence on the quality of the wine. Wine quality did however show an inverse relationship with the incidence of botrytis rot and bush vines had the highest percentage of botrytis infection. The study concluded that the effect of the trellising system on the quality of the wines under the specific climatic and viticultural conditions observed in the study is predominately determined by the incidence of botrytis and not by the grape composition or the microclimate.

Archer (2001b) investigated the relationship between vine training practices and grape quality of two red and one wine grape variety. Although Chenin blanc was not specifically included in the investigation, the conclusion of the article referred to all wine types produced in South Africa.

The investigation showed that there are large differences in the chemical composition of grapes that ripened on shoots of different length. Shorter shoots (± 60 cm) tended to produce grapes with lower sugar concentrations, lower acid concentrations and a higher pH compared to shoots of normal length (± 120 cm). Longer shoots (> 200 cm) tended to produce grapes with lower sugar concentrations, higher acid concentrations and a higher pH compared to shoots of normal length (± 120 cm). The fruitiness on taste of the white grape variety was negatively influenced in either shorter or longer shoot lengths compared to shoots of normal length. The investigation concluded that vineyards with even shoot lengths are required for

the production of top quality wines under South African conditions. It claims that the main cause of uneven shoot lengths is poor training practices. The author suggested that 16 to 20 leaves per shoot are required to optimally ripen white grapes varieties under South African conditions.

This section reviewed the effect of trellising systems on Chenin blanc grapes in particular and that of vine training practices on grape quality in general. The literature reviewed seems to suggest that the choice of trellising system and training practices can affect wine quality.

Vine spacing

A number of factors influence the choice of vine spacing for a particular vineyard, including natural vigour, rootstock, irrigation, fertilisation, trellising system and others (Hunter, 1998).

Plant spacing has important consequences that need to be considered. Hunter (1998) investigated the effect of vine spacing and found that closer spaced vines have a slightly lower berry mass that corresponded to the decreased bunch water potential. Fertility in closer spaced vines were reduced and resulted in a decrease in yield per vine although the yield per hectare increased. The microclimate of closely spaced vines was more favourable to the occurrence of pests and disease. Relative humidity increased and light intensity and air flow decreased with closer vine spacing. Despite these observations, the study found that wine made from closely spaced vines was distinctly better than wine made of grapes from wider spaced vines.

The study concluded that if all parameters are considered, including land utilisation, yield, wine quality and labour intensity, it becomes clear that medium spaced vines consistently outperformed either very close or very wide vine spacing. However, wine quality is positively influenced by the close spacing of vines.

Row orientation

According to Smart (1973), row orientation influences the light interception and the amount of energy available for photosynthesis. An east–west row orientation intercepts considerably less light compared to a north-south row orientation. It is comparable to a reduction in the height of the vine.

Experiments on Chardonnay in Italy showed that an east-west row orientation decreased the vigour of the vines and the yield of vines. Soluble solids, pH and titratable acid were unaffected by the row orientation. (Intrieri, Silvestroni, Rebucci, Poni and Filippetti, 1997)

Studies on the effect of row orientation on wine quality are limited but it does seem to affect grapevine performance and therefore it is probable that it can also affect wine quality.

Canopy management

Excessive vineyard vigour is a common occurrence, especially in the New World, and results in a decrease in grape quality (Smart, Dick, Gravett and Fisher, 1990). Canopy management includes a range of techniques to alter the canopy microclimate to achieve a desired result, like for instance improving the quality of the grapes.

Smart, Dick, Gravett and Fisher (1990) presented optimal values for 21 performance indices and characteristics of grape canopies to improve grape yield and wine quality. These included canopy width (as thin as possible), shoot lengths (600 – 900 mm), yield-to-canopy surface area ratio (1 – 1.5 kg fruit/m^2 canopy surface), growing tip presence after véraison (nil), number of leaf layers (1 – 1.5), the proportion of exterior leaves (80 – 100%) and others. The paper gave evidence that canopy management techniques have a major effect on the grape composition and wine quality from vigorous vineyards.

Marais, Van Schalkwyk and October (2005) compared Chenin blanc wines made from small berries with those made from larger berries. Berry sizes were reduced by either pruning methods or moisture stress after berry set. Wine made from smaller Chenin blanc grapes tended to have a higher quality. The authors concluded that a possible explanation might be that smaller grapes may contain higher levels of flavours or flavour precursors.

The study also compared Chenin blanc wines made from berries that ripened under indirect sunlight compared to direct sunlight radiation and concluded that wines made from berries that ripened under indirect sunlight are of a higher quality and have higher levels of esters.

These studies seem to indicate that careful canopy management could have a positive impact on grapes in general and on Chenin blanc in particular.

Fertilisation

Conradie and Saayman (1989a and 1989b) investigated the effects of fertilisation on Chenin blanc vines. Nitrogen application to Chenin blanc vineyards increased yield and shoot growth. It was established that Chenin blanc vines need approximately 3.9 kg of nitrogen to produce one ton of grapes under South African conditions (Conradie, 1980). Soils with more than 1% organic material have high nitrogen holding capacity and nitrogen fertilisation can further be reduced or even be unnecessary. The application of phosphorus also increased yield and shoot growth. An annual application of 9 kg phosphorus per hectare is more than adequate for the production of quality grapes. Phosphorus deficiencies are rarely encountered. Potassium fertilisation also increased yield and shoot growth. Less than 45 kg potassium per hectare per year and a soil norm of 50 mg/kg was found to be appropriate.

No consistent relationship between nitrogen application and wine quality was found. The addition of nitrogen did however result in higher nitrogen levels in the grapes and in some cases in the higher occurrence of bunch rot. Phosphorus application had little effect on grape or wine composition. The application of potassium increased both the acidity and the pH of the must.

Irrigation

Myburgh (2006) studied the effects of the timing of irrigation of the vineyard on juice and wine quality parameters. Chenin blanc grapevines were included in the study. Additional irrigation after vériason resulted in a lower concentration of nitrogen in Chenin blanc grapes compared to a single irrigation at pea size. This suggests that irrigation during ripening causes juice dilution in Chenin blanc. The lower nitrogen concentration was still above levels that can cause stuck fermentations but suggests that irrigation during ripening can reduce the rate of fermentation of Chenin blanc wines. Irrigation did not significantly effect the concentrations of P, K, Ca or Mg in Chenin blanc grapes. Irrigation applied to Chenin blanc vineyards a week prior to harvest resulted in a reduction of the total titratable acid and Myburgh (2006) suggested that it is probably due to the dilution effect of the water. Irrigation three days prior to harvest caused an increase of the pH of the juice of Chenin blanc. Irrigation applied at vériason and either 21 or 28 days later caused a higher total titratable acid compared to a single irrigation at pea size. The author suggested that dry conditions lead to the breakdown of total titratable acid.

The guava flavour of Chenin blanc appeared to be relatively insensitive to irrigation applied during the ripening of Chenin blanc grapes. Irrigation closer to harvest resulted in slightly fuller wines but did not cause any negative impressions. The study concluded that irrigation applied during ripening did not have a significant effect on overall wine quality of Chenin blanc table wines.

Myburgh (2006) did however caution that the field trial was conducted on vineyards that grew on soils with good water availability and that the conclusion might not be valid for vines that grow on, for instance, sandy soil or on soils where physical limitations restrict root development.

Yield

According to Dunn, Martin, Whiting, Krstic and Clingeleffer (2001) it is clear that over cropping leads to delayed maturation and lower fruit quality. However the authors also claim that there are many instances were there is little or no benefit in reducing the yield of a vineyard. Sinton, Ough, Kissler and Kasimatis (1978) found that the intensity of good wine aromas declined as yield increased.

The notion of minimum yields per hectare cannot be taken into consideration without consideration for the exposed canopy surface area. The amount of grapes that a vineyard can ripen is essentially dependent on its exposed surface area (Smart and Robinson, 1991).

The normal way of regulating yield is by managing the number of buds in a vineyard (Van Schalkwyk, Hunter and Venter, 1995). Bunch removal might however be necessary on high-yielding vines to reduce the yield within limits believed to be necessary for the production of quality wine (Van Schalkwyk, Hunter and Venter, 1995). Other yield-regulating strategies include shoot thinning and mechanical thinning (Dunn, Martin, Whiting, Krstic and Clingeleffer, 2001).

Van Schalkwyk, Hunter and Venter (1995) studied the effect of bunch removal on grape composition and wine quality. Although Chenin blanc was not specifically included in the study, the conclusion of the article referred to all wine types produced in South Africa. The study concluded that there is no improvement in wine quality when grapes are removed at different phenological stadiums up to 19°B if the yield/growth relationship of the vine is in balance. The study indicated that bunch removal can only be recommended when vines are noticeably stressed.

Van Schalkwyk and De Villiers (1995) found that when bunches are removed prior to véraison, vines compensated by increases in berry set as well as in bunch and berry mass. This resulted in a lower reduction of yields. The study indicated that bunch removal at or after 14°B resulted in the maximum reduction of the harvest.

This section reviewed several yield-regulating strategies believed to positively influence the quality of wines produced from lower yielding vines.

Maturity indices

According to Van Schalkwyk and Archer (2000) both green and overripe grapes have a negative influence on the eventual wine quality. Determining when grapes have reached optimum ripeness for a specific wine style is therefore of critical importance.

In contrast to other wine producing countries, grapes in South Africa ripen as the temperature increases and this results in sugar ripeness being reached before other components such as phenolics and flavour reach optimum ripeness (Van Schalkwyk and Archer, 2000).

Du Plessis and Van Rooyen (1982) attempted to find reliable and applicable maturity indices for four varieties from South Africa including Chenin blanc. Degrees Balling have been extensively used in South Africa as the only indicator of grape maturity without taking into account other important and readily determinable grape parameters. The authors claim that the use of total soluble solids as the only grape maturity indicator has not always provided satisfactory results in the past.

Wine made from free run juice as well as from juice obtained after skin contact, was included in the study. A number of indices correlated significantly to indicate optimum grape maturity. The study suggested five maturity index values for Chenin blanc at maximum quality. See table 1 for the maturity index values for Chenin blanc at maximum wine quality.

Table 1: Maturity index values for Chenin blanc at maximum wine quality.

Maturity index	***Free run***	***Skin contact***
°B/pH	7.02	-
°B.pH	73.35	-
°B/TA	2.78	2.25
TA/pH	2.71	3.25
TA.pH	28.01	31.68

Source: Du Plessis and Van Rooyen (1982)

The study limited its discussion mostly to one index, °B/TA and claims that it is very suitable to replace °B as the main indicator of grape maturity. The study could only determine the stage of optimum grape maturity and concluded that it was not possible to predict the actual quality of the wine if chemical analyses are within normal parameters.

Ellis, Van Rooyen and Du Plessis (1985) demonstrated that it was not possible to predict optimum maturity of Chenin blanc from various maturity indices including °B, °B/total titratable acidity and °B.pH. The study concluded that it is very difficult to predict wine quality from analytical data although analytical data can in some instances give an indication of wine quality.

Cootes, Wall and Nettlebeck (1982) also found no correlation between sugar, acid and pH levels and wine quality within normal ranges. These results imply that it is not possible to predict optimum grape maturity and the timing of harvest using chemical analytical data alone.

Augustyn and Rapp (1982) studied the inherent grape aromas of Chenin blanc and how the concentration of a selected number of these components change during ripening. The study identified 29 volatile aroma components in Chenin blanc grapes. Although monoterpenoid components are responsible for the characteristics in the muscat group of varieties, the study found no terpenoid components in Chenin blanc grapes although other studies have identified the presence of terpenoid components in Chenin blanc grape leaves. Only a few esters were identified during the study, supporting the view that these components are formed during fermentation. The study also concluded that neither the stage of ripeness nor the locality in which the grape are grown has any significant effect on the concentration of the selected components in Chenin blanc grapes.

Marais, Van Schalkwyk and October (2005) studied the effect of ripeness on the quality of Chenin blanc table wines. The study concluded that Chenin blanc grapes reach optimum maturity between 21°B and 24°B. Chenin blanc grapes that were harvested at 24°B produced wines with higher levels of esters and wine quality compared to wines made from Chenin blanc grapes harvested at 21°B.

The effect of grape maturity on the production of volatile esters is pronounced. According to Houtman, Marais and Du Plessis (1980b) more mature grapes increased the formation of esters in the wine. Increased levels of sugar in the juice caused higher levels of formation of both ethyl and acetate esters.

Other yardsticks can be used to supplement chemical analysis in order to help decide when grapes have reached optimum ripeness. By tasting the grapes in the vineyard it is possible for experienced judges to determine when the grapes have reached flavourant ripeness. Additional observations that can also help to determine when grapes have reached optimum ripeness include the amount of browning of the pip and the ease with which the grape skins burst. (Van Schalkwyk and Archer, 2005)

The review of literature on maturity indices highlights the importance of achieving optimal grape ripeness at the time of harvesting on the quality of the wine. The review also seems to indicate that chemical analysis should be used in conjunction with other yardsticks to best determine the point in time where optimum grape ripeness has been achieved.

Harvesting method

The period of optimum ripeness in grapes is relatively short which necessitates fast harvesting methods. The two methods to harvest are manual or hand harvesting and mechanical harvesting. (Archer, 1981)

Wagener (1980) investigated the effect of mechanical harvesting on wines made from Chenin blanc grapes in South Africa. The study found no significant difference in the colour and quality of the wines made from mechanically harvested grapes held at 17°C for one hour with low matter other than grapes (MOG) compared to wines made from hand harvested grapes. High extraction fan speeds of the harvester ensured low MOG content. An increase in the MOG content, temperature and holding time caused an increase in the phenolic concentrations and a decrease in the quality of the Chenin blanc wines. The study concluded that Chenin blanc grapes can be mechanically harvested without negatively effecting the wine quality if holding times, temperature and MOG content are kept to a minimum.

Carnacini, Amati, Capella, Casalini Galassi and Riponi (1985) also found that for the majority of compounds present there is no significant difference in the composition of wines produced from hand or manual harvested grapes. The method of harvesting also did not result in a significant difference in the taste test.

Botrytis cinerea

Chenin blanc grapes are very susceptible to botrytis cinerea infection and the infection can lead to losses especially in irrigated vineyards (Carstens et al., 1981).

Ferreira and Marais (1987) studied the effect of rootstock, pruning method and crop load on the occurrence of botrytis cinerea infection on Chenin blanc grapes. Rootstock cultivar had a highly significant relationship with the occurrence of botrytis cinerea infection and the authors suggested that it could be attributed to the effect of the rootstock on vigour and bunch compactness. More vigour resulted in denser foliage that created a more favourable environment for botrytis cinerea. A higher incidence of botrytis cinerea infection occurred on spur-pruned vines compared to cane-pruned vines. The authors suggested that this could be attributed to the closer spacing of buds on spur-pruned vines which created denser foliage. Chenin blanc cultivated on 101-14 Mgt, 110 Richter and Ramsey had more compact bunches compared to 99 Richter and Jacquez. The first three rootstock also showed a higher incidence of botrytis cinerea infection when spur pruned. Chenin blanc grown on Jacquez displayed poor growth. The relationship between a number of vine parameters and the incidence of botrytis cinerea were studied but only bunch compactness had a significant influence.

Sivertsen, Dewey and Heymann (2005) investigated the relationship between the level of botrytis cinerea infection and sensory descriptive data in dessert wines. The study found that aromas of oak, toast and smoke were significantly positively correlated with the level of botrytis cinerea infection. A hot mouth feel or hotness also correlated significantly with the level of botrytis cinerea infection. One of the more distinctive aromas associated with botrytis cinerea infection is sotolon. It gives a wine a distinctive honey-like fragrance

in combination with other compounds formed during infection (Masuda, Okawa, Nishimura and Yunome, 1984). This seems to indicate that the presence of a percentage of botrytis cinerea infection could possibly contribute to the complexity of Chenin blanc table wines.
This section reviewed the occurrence of botrytis cinerea infection on Chenin blanc grapes and the sensory effect that the fungus has on wine.

Conclusion

In conclusion, this section on the viticultural practices contributing to wine quality, specifically to that of Chenin blanc wines, covered a wide range of viticultural practices and discussed the significance of relevant research and literature on the topic.

2.2.3 OENOLOGY

This section will discuss the second of the two factors influencing the acquired quality of Chenin blanc table wines in South Africa, namely oenological factors. The influence of pressing, skin contact, juice oxidation, settling, yeast nutrition, yeast strain, fermentation temperature, wood, blending and bottle age are amongst the topics reviewed.

Pressing

Free run juice is generally 550 – 650 litres per ton of grapes and the successive press fraction can amount to as much as an additional 200 litres per ton. Up to 20% of the retrieved juice could be influenced by skin contact either as a consequence of maceration or the recovery of light to heavy pressings. It is the heavy press fraction, the final 60 – 80 litres per ton, that can present problems and its inclusion is a matter of judgement. (Somers and Pocock, 1991)

Juice pressings have higher phenolics, mineral extract and pH and lower acidity (Terrier and Blouin, 1975). Grape varieties differ significantly in the amount of phenolic compounds that are released during maceration and pressing (Somers and Pocock, 1991). Some varieties, like Trebbiano show a rapid increase in phenolic concentration with maceration and pressing whilst others such as Palomino have minimal phenolics present in the free run juice or press fractions (Somers and Pocock, 1991).

Although a tasting panel could recognise a difference between wine made from free run juice and wine made from press juice (Riesling, Semillon and Chardonnay) the study found that wine made from free run juice was not clearly preferred (Somers and Pocock, 1991).

Skin contact

Deliberate skin contact prior to fermentation or *macération pelliculaire* is a technique that can be used by producers to enhance flavours. For some white grape varieties there is a preference for moderate rather than minimum skin contact due to the localisation of flavour compounds and their glycosidic precursors in grape skins (Somers and Pocock, 1991).

According to Marais and Rapp (1988) white grape varieties that are cultivated in warmer climates often lack characteristic aromas. They found that skin contact prior to fermentation extracts additional aroma compounds such as grape terpenes that may enhance the characteristics of a variety.

Baumes, Bayonove, Barillère, Samson and Cordonnier (1989) also investigated the effects of skin contact on the volatile compounds in wine including Chenin blanc. The study showed skin contact significantly increases most volatile compounds except volatile acidity.

Skin contact also resulted in the extraction of compounds that are detrimental to wine quality such as phenolics. The extraction of such compounds increased at higher temperatures and when longer contact times occurred. (Marais and Rapp, 1988)

Chenin blanc is considered to be a neutral variety and the research seems to indicate that the benefits of skin contact should be carefully weighed against the disadvantages thereof.

Juice oxidation

Schneider (1998) reviewed the use of juice hyperoxidation in the production of white wines. Flavonoids are found primarily in grape skins and their extraction depends on, amongst other things, the method of pressing and is enhanced by a higher temperature and the presence of sulphur dioxide. Flavonoids are protected from oxidation by enzymes with the addition of sulphur dioxide to the juice and through limited oxygen contact. The oxidation of flavonoids yields peroxide that is a strong oxidising agent. In white wine this leads to the development of bitterness, astringency, browning, aroma alterations and a reduction of the shelf life.

Hyperoxidation actively promotes the oxidation of phenols (especially flavonoids) in the juice. This leads to lower concentrations of phenolic compounds in the wine that can react with oxygen. Studies in France have shown that juice hyperoxidation does not result in aroma degradation in Chenin blanc. Other studies refer to less aroma and varietal character in hyperoxidised wines, depending on the cultivar. This decrease in aroma intensity of hyperoxidised wines compared to a reference at an early stage of aging may not hold true after some aging has occurred.

According to Van Rooyen and Tromp (1982) aeration during fermentation in Chenin blanc juices caused a significant reduction in the total fermentation time but a significant reduction in the aroma quality of the wine.

Van Wyk (1995) discussed the use of ascorbic acid in the production of white table wines. Ascorbic acid is a strong reducing agent and reacts with oxygen to prevent oxidation. It occurs naturally in grapes. Ascorbic acid prevents the oxidation of inherent grape and fermentation aromas. Wines made from oxidised juice tend to have lower fruit character. The guava character also tends to be reduced in wines made from oxidised juice. The use of ascorbic acid reduces the oxidation of sensitive phenolic compounds and increases the risk of pinking in the bottle. White wines that have been made highly reductively should be tested for pinking. Pinking can be prevented by the exclusion of oxygen and the use of fining agents that removes phenolic compounds such as PVPP or casein. Ascorbic acid should always be used in conjunction with SO_2 to prevent the formation of peroxide.

This section discussed the effects of juice oxidation on several aspects of Chenin blanc wine quality.

Settling

Natural settling at low temperatures together with the use of SO_2 and with or without the use of fining agents is the most traditional and widely used method of settling. Dynamic systems such as filtration, floatation and centrifugation to clarify the juice are becoming more prevalent due to its speed and efficiency. (Puig-Deu, López-Tamames, Buxaderas and Torre-Boronat, 1996)

Puig-Deu, López-Tamames, Buxaderas and Torre-Boronat (1996) investigated the influence of racking and fining procedures on the composition of white wine. The study found that juice filtration was more effective at clarifying juice although it resulted in the greatest reduction of volatile compounds in wines possibly due to retention in the filter or oxidation. It was also found that juice filtration resulted in lower phenolic content compared to settled juice, possibly due to oxidation. Juice fining usually produced wines with lower phenolic content compared to control samples. A further finding was that wine made from fined juice had a greater

loss of aroma compounds than wine made from juice that had not been fined. The study found that bentonite removed the most nitrogenous compounds and volatile substances while potassium caseinate had the least influence on aroma and removed more phenolic compounds that other fining agents.

Houtman, Marais and Du Plessis (1980b) studied the effect of a number of factors on the aroma composition of wines. The study made use of Chenin blanc grapes. The study showed that the presence of large quantities of sediment caused malodours, a decrease in ester formation and an increase in the formation of fusel alcohols. The presence of a small amount of sedimentation promoted a complete fermentation and ester formation.

Excessive clarification by means of filtration prior to fermentation have a negative effect on grape aroma compounds and the production of fermentation bouquet although an excessive amount of turbidity resulted in unacceptable high levels of high fusel alcohols (Houtman and Du Plessis, 1986).

The presence of air to a fermentation of slightly turbid settled juice decreased the production of esters (Houtman, Marais and Du Plessis, 1980b). This finding stresses the importance of reductive handling of the wine during fermentation.

According to Van Rooyen and Tromp (1982) lower grape solids in Chenin blanc juices significantly improved the aroma quality and the overall wine quality but brilliantly clear juice caused a lagging fermentation.
The addition of 1% to 2% juice lees prior to fermentation increased ester formation while additions of more than 5% juice lees decreased the formation of esters (Houtman, Marais and Du Plessis, 1980b).

According to Van Rooyen and Tromp (1982) the addition of bentonite in Chenin blanc juices caused a significant reduction in the total fermentation time but resulted in a slight reduction (though not significant) in the aroma quality and the overall wine quality.

Cold settling also reduces the population of ambient or wild yeast species in Chenin blanc juice. The extent of the removal depends on the particular yeast species. *Saccharomyces cerevisiae* is one of the most affected species (Mora and Mulet, 1991).

This section discussed the effect of various settling practices on the resulting wine, with specific focus on Chenin blanc wine.

Yeast nutrition

Yeast has a number of nutrient requirements apart from a carbon source such as glucose and fructose which includes assimilable nitrogen, phosphate, vitamins, minerals, long chain fatty acids and sterols (Lourens and Reid, 2002).

Grape juice often does not contain adequate levels of nitrogen and this can lead to the production of hydrogen sulphide as well as stuck fermentation problems (Lourens and Reid, 2002). According to Van Rooyen and Tromp (1982) the addition of assimilable nitrogen to the juice of Chenin blanc significantly improves the aroma quality and the overall wine quality and reduces the total fermentation time.

There are currently various nutritional supplements that producers can add to must to ensure a normal fermentation including di-ammonium phosphate, ammonia, inactivated yeast cells and others. The timing of the nutrient additions can influence the quality of the wine. (Lourens and Reid, 2002)

Yeast strain

Yeast makes an important contribution to the aromas found in wine. The fermentation of juice can either be conducted by the ambient or wild yeast present on grapes and in the winery or by inoculation with a commercial yeast strain (Lambrechts and Pretorius, 2000).

Reynolds, Edwards, Cliff, Thorngate and Marr (2001) evaluated the impact of ten yeast strains on the chemical composition and sensory characteristics. The study found significant differences in the aroma and flavour of Chenin blanc wines fermented with different yeast strains. Houtman and Du Plessis (1986) found that the yeast strain had an effect on the fermentation rate and the aroma compounds in Chenin blanc wines. This suggests that yeast selection is very important for the production of quality Chenin blanc wines.

Marais and Jolie (2005) studied the effect of the yeast strain on the quality of Chenin blanc table wines. A number of commercially available yeast strains were investigated based on the recommendations of winemakers and yeast manufacturers. The yeast strains tested include: N96, NT116 and VIN13 from Anchor Bio-Technologies and QA23 from Lallemand South Africa. VIN13 and NT116 produced wines that displayed the most fruitiness, the lowest levels of higher alcohols and the highest overall wine quality directly after fermentation. Wines fermented with N96 produced a fuller bodied wine compared to other strains included in the study.

The effect of the yeast strain on the quality of Chenin blanc wines was compared again after five months of lees contact. No statistical differences between the different yeast strains were observed but QA23 produced wine with the most pronounced lees character, the most body and the highest overall quality.
Van Rooyen, De Wet, Van Wyk and Tromp (1982) attempted to identify relationships between volatile compounds and the intensity of a guava flavour in Chenin blanc wines from South Africa. The study was deemed important because Chenin blanc wines that displays this characteristic is usually scored higher by sensory panels compared to wines that does not display it. The flavour is believed to originate during fermentation because it cannot be detected in Chenin blanc grapes.

The study could not find one single volatile compound in Chenin blanc wine from South Africa with a typical guava flavour. Several volatile compounds and their ratios did however correlate significantly with the intensity of the guava flavour in the wine. Of these, the concentration of ethyl butyrate, as well as its ratio relative to two other volatiles, had the most definite relationship with the organoleptic intensity of the guava flavour in Chenin blanc wine from South Africa. The authors suggested that the guava flavour in Chenin blanc wines could possibly be much more complex and involve many other compounds.

Houtman, Marais and Du Plessis (1980a, 1980b) investigated the influence of several juice factors on ester production in Chenin blanc table wines. They concluded that the factors that had the most marked influence on ester formation were grape maturity, sugar content, fermentation temperature and juice clarity. Yeast inoculation of 2.5% and 10% did not cause a significant difference in the ester concentrations of wines. According to Van Rooyen and Tromp (1982) lower fermentation temperatures (12°C), moderate grape solid levels (0.25%) and the addition of assimilable nitrogen lead to Chenin blanc wines with high levels of esters, low levels of higher alcohols and normal fermentation times.

Large scale wineries usually inoculate juice with a selected pure strain starter culture to insure a trouble free fermentation. But some wineries in South Africa allow juice to ferment spontaneously and then microbes found on the grape skins and on the surface of winery equipment participate in the fermentation. During spontaneous fermentations, different yeast dominates the fermentation over time to contribute to the character of the wine. It is usually the alcohol tolerant strains of *Saccharamyces* that complete the fermentation (Pretorius, Van der Westhuizen and Augustyn, 1999).

Whether or not spontaneous fermentation enhances the quality of wines depend on the nature of the yeast population that dominate the fermentation. There are a number of producers that feel that it does improve the quality of the wine. One of the main reasons cited is that the producers feel that spontaneous fermentation allows a greater diversity of strains to contribute to the fermentation that improves the complexity of the wine (Heald and Heald, 1995).

Jolly, Augustuyn and Pretorius (2003a) investigated the effect of four non-*Saccharomyces* and *Saccharomyces* combinations on fermentation and wine quality. Chenin blanc was included in the investigation. Five months after fermentation the non-*Saccharomyces* and *Saccharomyces* combinations were all judged to be of better quality compared to a reference fermented with VIN13. After 18 months only two non-*Saccharomyces* and *Saccharomyces* combinations were judged to be of better quality than the reference.

Candida pulcherrima can be a prominent non-*Saccharomyces* yeast species present in settled juice. Jolly, Augustuyn and Pretorius (2003b) investigated the use of this non-*Saccharomyces* in the production of Chenin blanc wine. The yeast could not ferment the juice to dryness on its own and was used in combination with a commercial wine yeast. The Chenin blanc wine produced by the combined fermentation was of a higher quality than the wine produced by *Saccharomyces cerevisiae* alone. Some of the combined fermented wines had a higher aroma note of guava.

This section discussed the importance of the choice of yeast strain used in particularly Chenin blanc wines and reviewed the results of various studies done on the topic.

Fermentation temperature

Temperature has a significant effect on the fermentation of grape juice. Fortunately, if the cellar is equipped with proper cooling equipment, producers have great control over it.

According to Houtman, Marais and Du Plessis (1980a) higher levels of esters were formed at a fermentation temperature of 15°C compared to 11°C in Chenin banc wines. According to Van Rooyen and Tromp (1982) higher fermentation temperatures (20°C compared to 12°C) in Chenin blanc juices increased the formation of unwanted higher alcohols and caused a marked change in the chemical profile of the wine. Lower fermentation temperatures caused a significant increase in the total fermentation time but resulted in significantly better wine and aroma quality.

Wood

Barrel storage of white wines results in their enrichment in several wood components that contribute to the intensity of a woody character (Chatonnet, Dubourdieu and Boidron, 1991).

Spillman, Pocock, Gawel and Sefton (1995) found that the aroma of white wine matured in oak barrels varies significantly from one barrel to the next. The study identified that the composition of the oak prior to coopering, heat treatment and microbial activity during maturation have a significant influence on the variation of aromas that are imparted from oak into wine. This indicates that the selection of the type of oak to ferment or age Chenin blanc wines in will have a significant influence on the nature and quality of the wine.

No method of temperature regulation exists for fermentation in the oak barrel and temperature peaks exceeding 25°C are often reached. The temperature of the surrounding cellar is the only external factor that helps to regulate the fermentation. However, the effect of the higher fermentation temperature is small and

only the concentration of higher alcohols is significantly increased (Chatonnet, Dubourdieu and Boidron, 1991).

This section discussed the various influences of wood on Chenin blanc wines.

Extended lees contact

Extended lees contact or *sur lies* maturation involves leaving wine in contact with either the fine or gross lees for a period of time after the completion of fermentation. The dead and dying yeast cells release nutrients and aromatics into the wine (Jackson, 1994).

Marais and Jolie (2005) studied the effect of lees contact on the quality of Chenin blanc table wines. Chenin blanc wines that aged on its lees for five months after fermentation, including wine treated with a commercial enzyme preparation to accelerate yeast autolysis, were compared to wines that received no lees contact. Chenin blanc wines that were aged on its lees and treated with enzymes produced wines of statistically better quality and had the most body and lees character.

Yeast is an important cause of volatile sulphur compounds because of their sulfite reductase activity. If the lees are not manipulated during extended contact a reductive smell can develop (Rankine, 1986).

Maturation of white wines on yeast biomass in barrels limits the development of reductive aromas. The presence of an oxidation catalyst (gallic acid) prevents the accumulation of undesirable reductive compounds. Barrels lose their oxidation properties with time and it is common for older barrels (> 2 years) to give rise to a reducing environment (Chatonnet, Dubourdieu and Boidron, 1991).

This section reviewed the effect of extended lees contact on especially Chenin blanc table wines.

Malolactic fermentation

Malolactic fermentation can significantly increase or decrease the quality of wine (Jackson, 2000). It can either occur spontaneously but can be induced with a starter culture if it is desired (Henick-Kling, Acree, Gavitt, Krieger and Laurent, 1992).

Beneficial effects of malolactic fermentation include acidity reduction, flavour modification and microbial stability. Undesirable affects of malolactic fermentation include sensory changes, colour change in red wines and amine formation. (Davis, Wibowo, Eschenbruch, Lee and Fleet, 1985)

Malolactic fermentation can contribute to wine quality depending on the grape variety. The process tends to enhance the quality of for instance Chardonnay. Malolactic fermentation can enhance the body of the wine and give a longer lasting aftertaste. Fruitiness is not destroyed by malolactic fermentation and some strains seem to enhance it. Vegetative aromas are generally reduced by malolactic fermentation. Typical malolactic fermentation aromas include buttery and yeasty. Malolactic fermentation can also give rise to oaky aromas in wines that did not spend time in oak barrels. (Henick-Kling, Acree, Gavitt, Krieger and Laurent, 1992)

The net benefit or disadvantage of malolactic fermentation depends on the viticultural region, grape variety, wine composition, winemaking practices and style objectives of the wine (Davis, Wibowo, Eschenbruch, Lee and Fleet, 1985).

Blending

Blending is an important winemaking practice and has a number of purposes (Rankine, 1989). A few producers feel that blending is important in the warmer Mediterranean climate found in South Africa to gain complexity, an all-round structure and balance (Sadie, 2006).

Singleton and Ough (1962) investigated the relationship between the complexity of flavour and the blending of wine. The study compared the ranking of two distinct wines and a 50-50 blend thereof. In about 20% of the cases a 50-50 blend of the two wines ranked higher than either of the two constituent wines. In no case was the blend rated more poorly than the lower ranked constituent wine.

This seems to indicate that blending with a percentage of another variety could possibly be used to improve the quality of Chenin blanc table wines in South Africa.

Fining agents

Fining is commonly used to stabilise wine against haze formation, to remove excessive bitter phenolics and to accelerate spontaneous clarification (Jackson, 2000).

Sims, Eastridge and Bates (1995) found that both PVPP and casein added pre- or post fermentation significantly reduced phenols, as well as the initial colour intensity and browning in white wines that were exposed to air. PVPP was considered to be more effective than casein in removing phenols and reducing the initial colour intensity. Gelatine was less effective than either PVPP or casein, possibly because it binds larger phenols. Gelatine additions to the must prior to fermentation can actually increase colour intensity. The study showed that the PVPP and casein treated wines had less harshness compared to a wine that did not receive any finings although the sensory changes were minimal.

Carnacini, Amati, Capella, Casalini Galassi and Riponi (1985) found that fining treatments did cause a decrease in the concentration of volatile compounds. The more volatile compounds showed the greater the decreases. The study did however also show that there was no significant difference in the taste test that was caused by fining agents.

Residual sugar adjustments

Consumers often ask how sweet a wine is which suggests that the level of sweetness in a table wine is an important consideration for the winemaker (Rankine, 1989).

Sweet table wines can be made in two ways. Grapes can be harvested with high levels of sugar and the fermentation process can be stopped so that the wine remains sweet. Alternatively, juice can be fermented to dryness and sweetened after stabilisation with either grape concentrate or sweet reserve. (Rankine, 1989)

Wilker, Dharmadhikari and Goin (2004) investigated the effect of three sweetening treatments on white wine aroma and composition. The flavour characteristics of the grape used in the study is similar to that of Chenin blanc. The study found that the choice of sweetening method could have a distinct impact on the aroma of the wine. Wines made by stopped fermentation had a fresher aroma and greater aroma intensity compared to wines made with the addition of juice to sweeten it. The different treatments only had minor effects on the composition of the wine.

Filtration

Filtration involves the physical removal of suspended particle matter. Filtration is a controversial issue and it is claimed that it can lead to an excessive loss of colour and that it makes wines taste thinner. (Riberéau-Gayon, Glories, Maujeanand and Dubourdieu, 2000)

Serrano and Paetzold (1994) studied the effect of different types of filtration on the chemical composition and organoleptic effects of white wine. The study found that although filtration removed small quantities of macromolecules, including aroma compounds, in addition to the suspended particle matter no significant difference was detected between filtered wines and the unfiltered control when tasted after a month.

Wines that have residual sugar are particularly sensitive to microbial spoilage. It is necessary to asses the risk of spoilage before deciding not to filter the wine.

Bottle Age

The aging of wine can significantly change the character thereof. According to Marais (2005) Chenin blanc rely on the presence of fermentation flavours that can disappear rapidly with aging to be replaced by a one dimensional maturation character. Therefore South African Chenin blanc tends to have a short shelf life. On the other hand, Chenin blanc wines from the Loire Valley in France are revered for their longevity (Halliday and Johnson, 1992).

Marais and Pool (1980) showed how the bottle maturation bouquet increased while the concentration of esters and the young wine bouquet decreased with time in Chenin blanc wine from South Africa. The maturation bouquet of Chenin blanc wines correlated significantly with an increase in the dimethyl sulphide concentration in the wine. This suggests that dimethyl sulphide makes an important contribution to the typical bottle maturation character of wine.

The study found that temperature has a marked influence on the increase of the maturation bouquet and the decrease of the young wine bouquet of Chenin blanc wine. Wines aged at 30°C for 12 months were over-aged and brown whereas wines stored at 0°C retained their original fruit bouquet, displayed practically no maturation bouquet and were judged to be of slightly improved quality compared to the initial product. A slight decrease in wine quality occurred consistently just after bottling.

Marais (2005) investigated the effect that a number of treatments have on the shelf life of Chenin blanc table wines from South Africa. Wines that received an extra addition of SO_2 (60 ppm free SO_2) displayed slightly less bottle age character and more fruit character compared to wines with normal levels of SO_2 (30 ppm free SO_2). Wines were also treated with pure phenols and commercial phenol preparations that were selected for their high anti-oxidant activities. The study found little evidence that these delayed bottle aging of Chenin blanc.

The addition of sodium hydroxide to increase the pH by 0.3 units resulted in the fruitiest wines with the least amount of bottle age character compared to all the other treatments. The author suggested that the hydrolysis of acetate esters occurs more rapidly at a low pH and this causes the decrease in fruit character and an increase in bottle age character. The author warned that high pH wines could oxidise more rapidly over a longer period compared to low pH wines due to unstable free SO_2.

The study also monitored the effect that a number of vineyard manipulations have on the formation of bottle age character in Chenin blanc wines. Wines made from smaller grapes tended to have more fruit character and less bottle age character compared to wines made from larger grapes. Wines made from grapes that

ripened under indirect sunlight and were harvested at a higher degree of ripeness (24°B compared to 21°B) displayed the best potential for a longer shelf life.

Conclusion

In conclusion, this section on the oenological practices contributing to wine quality, specifically to that of Chenin blanc wines, covered a wide range of oenological practices and discussed the significance of relevant research and literature on the topic.

2.2.4 CONCLUSION

Extensive studies by various research teams have shown that is there is a considerable number of factors that influence the quality of wine in general and wine made from Chenin blanc grapes in particular.

2.3 STYLISTIC DIFFERENCES

Wine is made in a wide variety of styles (Schuster, 2000) and this is even more applicable to Chenin blanc due to its exceptional versatility (Marais, 2003).

The style of Chenin blanc table wine depends on amongst other things the region of origin, yield and ripeness (Carstens, Burger and Kriel, 1981) to which could be added the use of oak, the inclusion of noble rot grapes or wine and the level of residual sugar (Eedes, 2007).

During the nineteen-sixties with the emergence of cold fermentation, a medium-dry style of Chenin blanc wines emerged known in the wine trade as “the Lieberstein revolution” named after the popular Stellenbosch Farmers’ Winery product (Robinson, 1986). This style of Chenin blanc has fresh acidity and sometimes a slight spritz but often only contains traces of varietal character (Robinson, 1986).

The first wooded Chenin blanc in South Africa was produced in 1994 by Walter Finlayson of Glen Carlou named Devereux (Hands and Hughes, 2001). Many other wine producers consequently started to experiment with oak fermentation and maturation for Chenin blanc wines and it is often these wines that triumph at tasting competitions.

The wide range of Chenin blanc wine styles produced present a challenge for competition tasting panels and a recent trend in judging Chenin blanc wines is to only compare wines that belong to a certain style. The aim of the Rendez-vous de Fontevraud for instance is not to be too prescriptive regarding the style of the wine, which might cause only the more powerful wines to perform well, but rather to distinguish the array of expressions that Chenin blanc has to offer (Robinson, 2006). The competition is designed to raise the profile and reputation of Chenin blanc by stressing the diversity of the cultivar (Budd, 2003). The fact that the competition distinguishes between nine different Chenin blanc wine styles illustrate the great diversity of wine styles that the cultivar can successfully produce. See table 2.

The diversity of Chenin blanc wine styles in South Africa is also indicated by the six recognised wine styles of the Chenin blanc Association. See table 3. Although there are still South African Chenin blanc wines made in a fresh and fruity style, there has more recently been a shift to a riper style of wine made with some degree of wood influence (Chenin blanc Association [CBA], c2004). More and more cooperative cellars are recognising that Chenin blanc grapes reach optimal ripeness at a slightly higher level of ripeness and encourage grape growers to harvest grapes riper (Naude, 2007). The levels of residual sugar as well as the inclusion of a small portion of wine made from noble rot grapes to impart botrytis character are other stylistic parameters that are still under discussion at the present moment (Eedes, 2007).

Table 2: Rendez-vous de Fontevraud's nine recognised categories.

Category 1	Sparkling wines- 100% Chenin Blanc
Category 2	Sparkling wines - 60% minimum Chenin
Category 3	Still wines - 100% Chenin fresh and fruity wine with ≤ 9g/litre
Category 4	Still wines - 100% Chenin full-bodied, structured wine with ≤ 9g/l sugar
Category 5	Still wines - 80% minimum Chenin fresh and fruity wine with ≤ 9g/l sugar
Category 6	Still wines - 80% minimum Chenin full-bodied, structured with ≤ 9g/l sugar
Category 7	Still wines- 80% minimum Chenin 9,1g/l – 30g/l sugar
Category 8	Still wines - 80% minimum Chenin 30,1g/l – 100g/l sugar
Category 9	Still wines - 80% minimum Chenin >100g/l sugar

Source: Robinson, 2006.

Table 3: The Chenin Blanc Association's six recognised styles.

Fresh & fruity	less than 9 g/l residual sugar
Rich & ripe – unwooded	less than 9 g/l residual sugar
Rich & ripe – wooded	less than 9 g/l residual sugar
Rich & ripe – slightly sweet	between 9 and 30 g/l residual sugar
Sweet	more than 30 g/l residual sugar
Sparkling	Tank fermented or Cap Classique

Source: CBA, c2004.

2.4 GLOBAL CHENIN BLANC DISTRIBUTION

This sub-section discusses a few of the better known wine growing regions in the world that produce Chenin blanc wines and the prevalent viticultural and oenological practices employed as well as the terroir of these regions.

2.4.1 THE LOIRE VALLEY

Chenin blanc wine production in France is concentrated in the central Loire. Chenin blanc has been cultivated there since at least 845 (Friedrich, 1996). The grape takes its name from Mont Chenin in southern Touraine (Friedrich, 1996). The Loire valley has approximately 8,900 ha cultivated with Chenin blanc.
Due to the northerly latitude of the central Loire valley, grapes ripen very slowly. The notion of vintage is very important because of the variation in rainfall and sunlight from one season to the next (Friedrich, 1996). The weather for a particular year plays a deciding factor in the style of wine that will be produced. Producers tend to produce more *moelleux* or sweet wines in warmer years if the weather allows grapes to ripen into autumn and more sparkling wine in cooler years (Wilson, 1998).

Chenin blanc still wines from the Loire Valley come in a range of sweetness categories: *sec* (less than 4 grams of residual sugar, can be up to 9 grams depending on the acidity), *demi-sec* (4 to 12 grams of residual sugar), *moelleux* (12 - 45 grams of residual sugar) and *doux* or *liquoreux* (more than 45 grams of residual sugar). Noble late harvest wines are not produced that frequently in the Loire due to the presence of less fog compared to for instance Sauternes in Bordeaux. (Friedrich, 1996)

A large percentage of grapes are cultivated by peasant farmers for whom vines only represent a portion of their total produce. This means that co-operatives or *négociants* control a large percentage of wine production in the Loire. There are currently an ever increasing number of growers or *vignerons* who produce, bottle and market their own wines (Voss, 1995).

The central Loire is divided into two provinces: Touraine and Anjou. Vouvray AOC is one of the better known appellations in Touraine. Preferred vineyard sites are situated on yellow tuffeau and chalk type soils. Montlouis AOC is situated across the river from Vouvray and also produces good Chenin blanc wines. Soils in Saumur are similar to Vouvray and Montlouis. Coteaux de Saumur AOC is an appellation within Saumur known for its sweet and semi-sweet Chenin blanc wines. (Wilson, 1998)

Vineyards in Anjou are situated on older schistose soils. Special appellations in Anjou include: Savennières AOC, Coteaux de l'Aubance AOC, Coteaux du Layon AOC, Bonnezeaux AOC, Quarts de Chaume AOC and Coteaux de la Loire AOC. Many of these areas are known for the sweeter style of Chenin blanc wines that they produce. (Wilson, 1998)

Vinification of Loire Chenin blanc is generally without sophistication. Partially clarified juice is fermented without the influence of oak followed by a limited degree of extended lees contact (Halliday and Johnson, 1992). Some producers allow skin contact prior to fermentation to extract flavours from grape skins (Friedrich, 1996). Old fashioned cellars have a reputation for adding too much sulphur to wine (Friedrich, 1996). Some of the appellations allow up to 20% Chardonnay or Sauvignon blanc to be blended in with Chenin blanc.

Chenin blanc is also used to produce sparkling wines in the Loire valley. Saumur is the largest producer of sparkling wine in France outside of Champagne. The sparkling wines are made by *méthod champenoise.* (Stevenson, 2003)

Recent developments in the Loire include the wider acceptance of harvesting in *tries*, successive harvest passages through the vineyard in order to pick the bunches when they are optimally ripe. This practice has resulted in a new generation of riper, more flavoursome Chenin blanc wines. Another development is the increasing popularity of organic and even biodynamic viticulture amongst certain vineyard owners. (Jefford, 2002)

2.4.2 UNITED STATES OF AMERICA

California has more Chenin blanc planted than the Loire in France (Robinson et al., 1994) but it is fast being uprooted (Patterson, 2006). It is primarily used for the production of sweet and lower classed wines and sometimes blended with other grapes like Colombar (Robinson et al., 1994). The variety is also cultivated in Washington State (Heald and Heald, 1991).

Clarksburg AVA in the Sacramento River Delta in California is known to produce more distinct Chenin blanc wines. The soils are fairly fertile and there is an abundance of water that promotes vigorous growth. This necessitates devigorating rootstock and severe pruning together with vertical shoot positioning. Winemaking procedures are generally minimalist: cold fermentation in stainless steel tanks without any malolactic fermentation and early bottling. Grapes are harvested relatively early in Clarksburg resulting in wines with alcohol levels of around 11%. Some producers make a richer style of wine with slightly higher alcohol levels. The range of Chenin blanc styles in Clarksburg include dry, off-dry and late harvest wines. (Patterson, 2006)

2.4.3 OTHER

Other wine producing countries that cultivate Chenin blanc include Australia where it is usually blended with other varieties. A few producers in New Zealand produce varietal labelled Chenin blanc wine. Chenin blanc is also cultivated in other parts of the Americas including Argentina, Chile, Mexico, Brazil and Uruguay. (Robinson et al., 1994)

2.4.4 CONCLUSION

This section discussed the production of Chenin blanc wines in other wine producing countries, mainly the Loire Valley in France and California in the United States of America. The prevalent viticultural and oenological practices were briefly discussed to put the practices followed in South Africa into perspective.

2.5 CHENIN BLANC IN SOUTH AFRICA

2.5.1 INTRODUCTION

More Chenin blanc are produced in South Africa than anywhere else in the world (Robinson, J et al. 1994). The grape currently forms the basis of white wine production in South Africa (Carstens, Burger and Kriel, 1981). It is an extremely versatile variety that is capable of producing high quality dry, semi-sweet and noble late harvest wines and also sparkling wine, sherry and rebate and distilling wine for brandy production (Marais, 2003).

Chenin blanc vines were imported into South Africa by Jan van Riebeeck but was known for many years simply as Steen and was thought to be unique to the Cape (Kench, Hands and Hughes, 1983). In 1963 Professor C.J. Orffer from the University of Stellenbosch established that the variety was in fact Chenin blanc (CBA, c2004).

Chenin blanc production in South Africa came to prominence in 1959 when Stellenbosch Farmers' Winery launched Lieberstein. This was a semi-sweet natural table wine produced mainly from Chenin blanc. Sales came to more than 31 million litres in 1964, making it the largest selling bottled wine in the world at the time (Orfer, 1979; Kench et al, 1983). It was during this decade that Chenin blanc became the most planted wine grape variety in South Africa (Carstens, Burger and Kriel, 1981).

2.5.2 STATISTICS OF CHENIN BLANC IN SOUTH AFRICA

Chenin blanc planted and tons crushed

Chenin blanc currently represents 18.7% of the total area planted to wine grapes in South Africa and 19.9% of the total tonnage of wine grapes crushed (South African Wine Industry Information and Systems [SAWIS], 2007a). See figure 1 for the total hectares and amount of tons crushed of the major white wine grape varieties in South Africa. In 2006 there were 19,122 hectares planted with Chenin blanc and in the 2006 harvest season 259,443 tons of the grape were crushed to make wine. (SAWIS, 2007a)

Distribution of Chenin blanc

More than 50% of all Chenin blanc in South Africa is harvested in Worcester and the Olifants River wine regions. Wine regions in Paarl, Malmesbury, Robertson and the Orange River each deliver approximately 10% of the annual Chenin blanc harvest. The remainder of the Chenin blanc harvest originate from Stellenbosch (5%) and the Klein Karoo (3%). See figure 2 for the distribution of Chenin blanc over the wine growing region in South Africa. (SAWIS, 2007a)

Trellis systems used in Chenin blanc vineyards

The majority of Chenin blanc vineyards in South Africa are not trellised (71%) but trained as bush vines. When trellised, the most popular trellising systems for Chenin blanc include one, two and three strand hedges and Perold and four strand extend Perold systems. See figure 3 for the trellising systems used in Chenin blanc vineyards in South Africa. (SAWIS, 2007a)

Irrigation of Chenin blanc vineyards

The majority (77%) of Chenin blanc vineyards in South Africa receive supplementary irrigation. Only 23% are dry land cultivated and receive no irrigation. See figure 4 for the irrigation systems in Chenin blanc vineyards in South Africa. (SAWIS, 2007a)

Producers of Chenin blanc

Chenin blanc wine production is concentrated in co-operative cellars that crush 89.3% of all the Chenin blanc grapes in South Africa. Private wine cellars crush 7.4% and producing wholesalers 3.3% of all the Chenin blanc grapes in South Africa (2006). See figure 5 for a chart depicting the producers of Chenin blanc in South Africa. (SAWIS, 2007a)

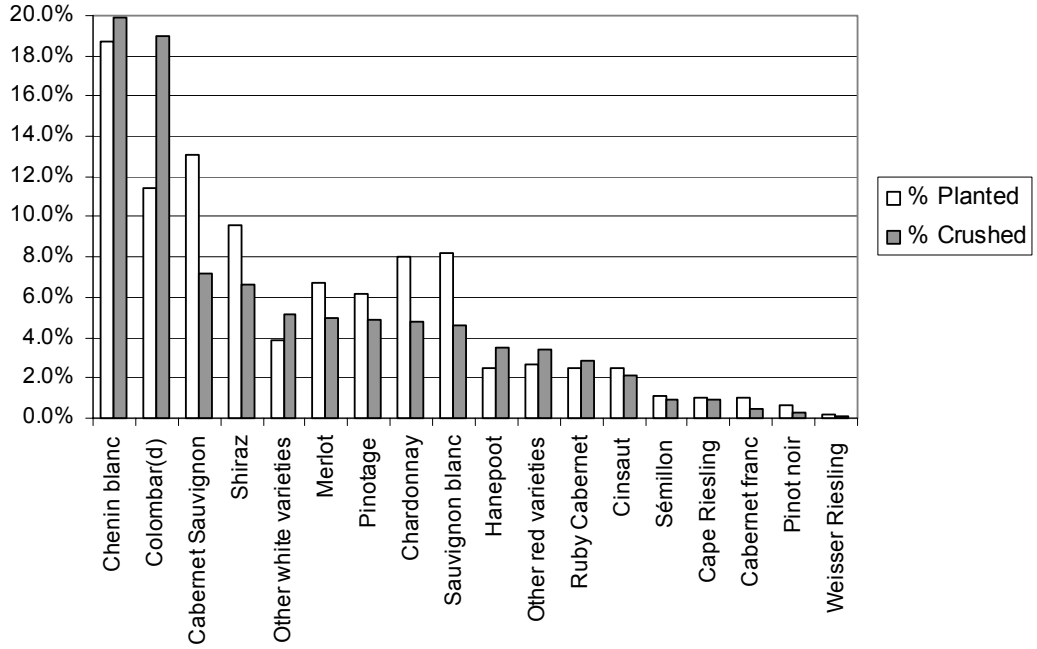
Chenin blanc exported

Chenin blanc wine is an important product for the export market and represents approximately 26% of the volume of all white and rosé wine exports. See figure 6 for the white and rosé wine exported from South Africa. (SAWIS, 2007a)

Price of Chenin blanc wine and grapes

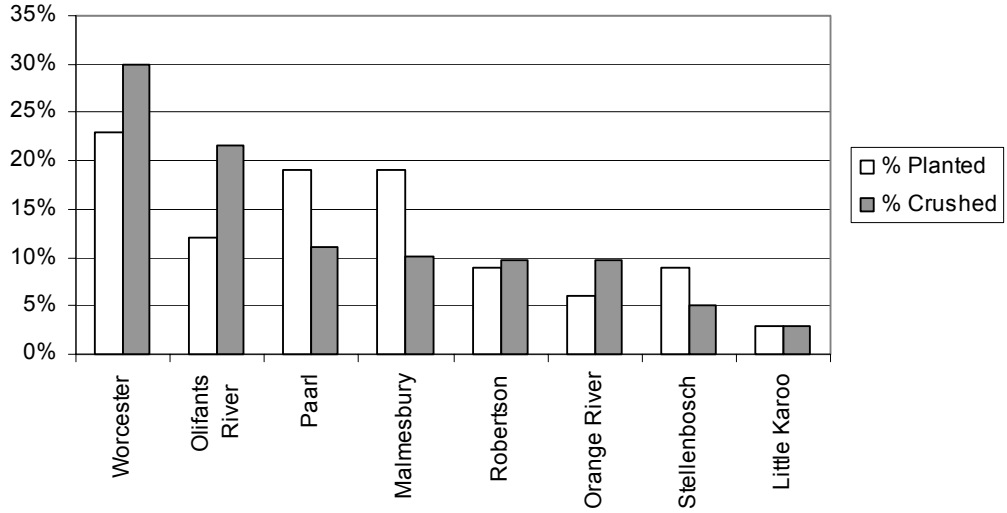
The average price paid for Chenin blanc grapes is considerably less than that paid for Chardonnay and Sauvignon blanc grapes. This holds true for Chenin blanc delivered by members to producer cellars as well as the sale of Chenin blanc to other private producers and producing wholesalers. Bulk wine prices for Chenin blanc wine is also less than those for Chardonnay and Sauvignon blanc wines. The price for Chenin blanc has been relatively stable over the last few years. See figures 7, 8 and 9 for the prices of Chenin blanc, Chardonnay and Sauvignon blanc grapes and wine sold in bulk. (SAWIS, 2007a)

Figure 1: Wine grape varieties in South Africa expressed as a percentage of the total area planted to wine grapes and as a percentage of the total wine grapes crushed (2006).



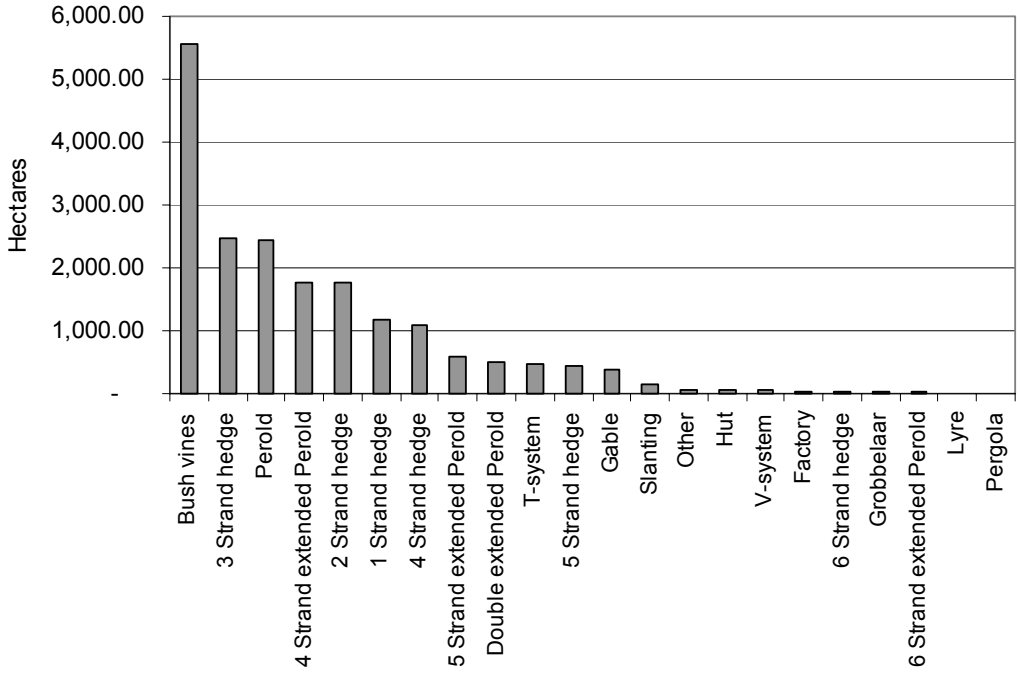
Source: SAWIS, 2007a – adapted

Figure 2: Percentage of Chenin blanc per region expressed as a percentage of the total area planted to Chenin blanc and as a percentage of the total Chenin blanc crushed (2006).



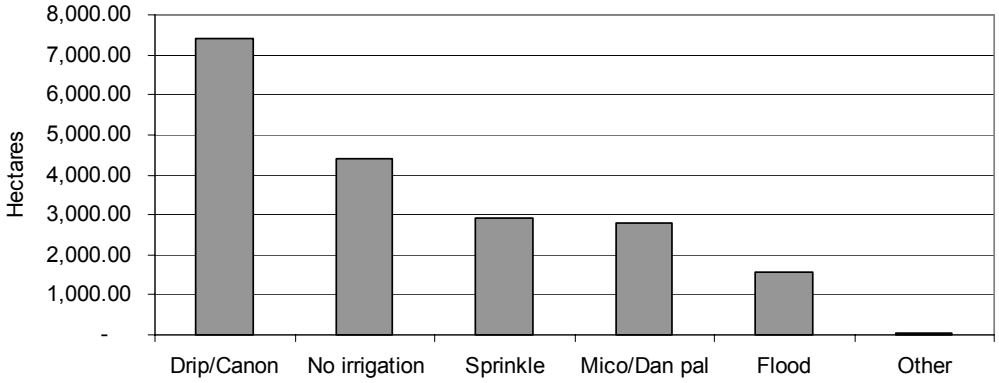
Source: SAWIS, 2007a - adapted

Figure 3: Trellising systems used in Chenin blanc vineyards in South Africa (2006).



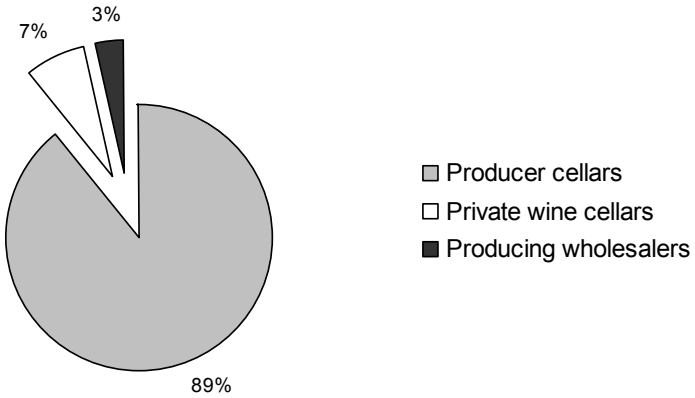
Source: SAWIS, 2007b – adapted

Figure 4: Irrigation systems in Chenin blanc vineyards in South Africa (2006).



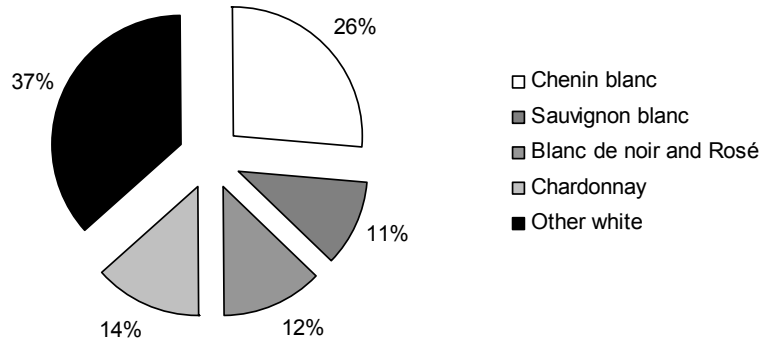
Source: SAWIS, 2007b – adapted

Figure 5: Producers of Chenin blanc in South Africa (2006).



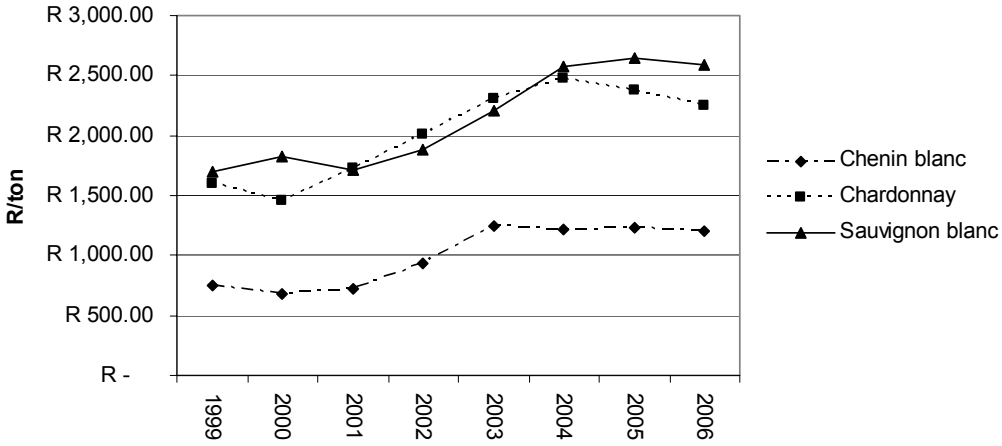
Source: SAWIS, 2007 - adapted

Figure 6: White and rosé wine exported during 2006 (litres).



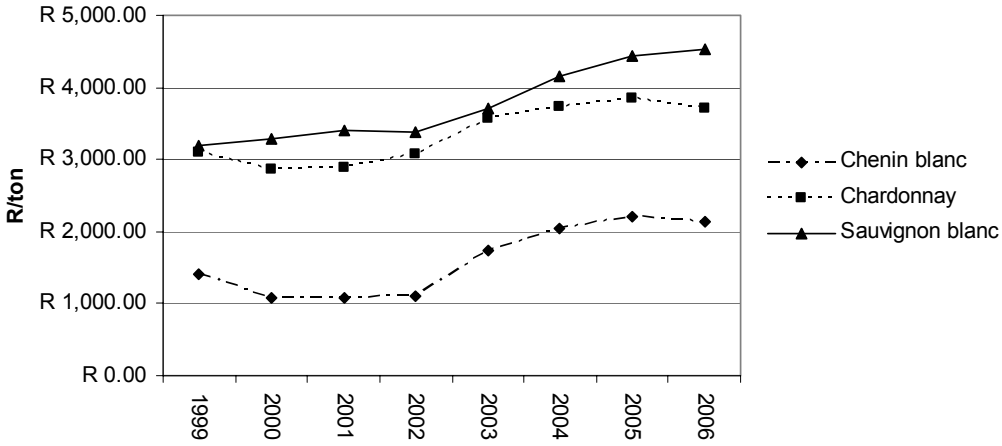
Source: SAWIS, 2007a – adapted

Figure 7: Prices of Chenin blanc, Chardonnay and Sauvignon blanc grapes delivered to producer cellars by members.



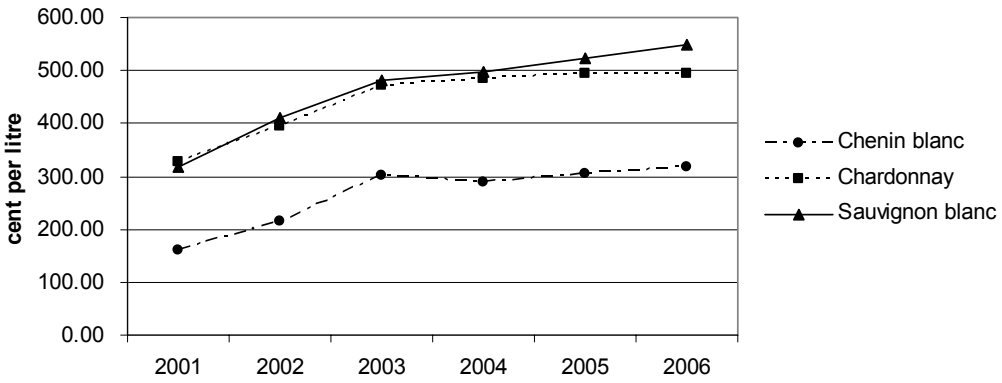
Source: SAWIS, 2007 - adapted

Figure 8: Prices of Chenin blanc, Chardonnay and Sauvignon blanc grapes excluding deliveries of members to producer cellars.



Source: SAWIS, 2007 - adapted

Figure 9: Prices of Chenin blanc, Chardonnay and Sauvignon blanc wine sold in bulk.



Source: SAWIS, 2007 - adapted

2.5.3 CONCLUSION

The section conveyed some of the relevant facts and figures of Chenin blanc production in South Africa.

2.6 CONCLUSION OF THE LITERATURE REVIEW

This chapter introduced the concept of wine quality as well as some of the difficulties of defining what exactly constitutes wine quality.

Factors that influence Chenin blanc wine quality were divided into terroir, viticulture and oenology and each section reviewed a number of the more important practices that have an influence on wine quality and its characteristics, with a specific look at the influence these have on Chenin blanc table wines in South Africa.

The production of Chenin blanc wines in other wine producing countries, mainly the Loire Valley in France and California in the United States of America, were discussed including a brief overview of the prevalent viticultural and oenological practices followed in these regions in order to put the practices followed in South Africa into perspective.

The chapter concluded with relevant statistics of Chenin blanc production in South Africa.

3. METHODOLOGY

The purpose of the dissertation is to identify viticultural and oenological practices that contribute to the production of quality Chenin blanc table wines in South Africa.

This chapter introduces and motivates the methodology that was used in the study and goes on to explain how the representative sample of top quality Chenin blanc table wines have been selected, the nature of the data that was collected, how data was gathered and how the data was analysed. The chapter also includes a section that explores data quality issues and a section on the ethics, privacy and confidentiality principles that were adhered to.

3.1 RESEARCH INSTRUMENTS

The study used semi-structured interviews to gather information on a representative sample of the best quality wooded and unwooded Chenin blanc table wines from South Africa and attempts to establish relationships between these wines and the viticultural and oenological practices employed in the production thereof.

It is believed that this approach allows a large number of production techniques to be evaluated simultaneously compared to the alternative approach of doing individual experiments on each of these practices.

The interview approach was furthermore chosen as it allows both quantitative and qualitative data to be gathered and allows the interviewer to explore in more detail those viticultural and oenological practices that the producer regards as important. It is believed that this flexibility should aid in gaining a better insight into the production of the wines being investigated. An alternative data gathering approach like for instance a self-administered questionnaire, would not have been able to provide the same degree of flexibility.

It is recognised that a correlation between viticultural and oenological practices and quality wines does not necessarily indicate causation. Therefore the study also asked producers to quantify the importance of the viticultural and oenological practices in relation to wine quality.

A high incidence of a particular viticultural and oenological practice in the sample of top quality wines combined with an indication from the wine producers that they believe that the particular practice does indeed influence wine quality will provide compelling evidence that a certain practice could indeed contribute to the production of quality Chenin blanc table wines in South Africa.

The practices that are ranked by the producers as the most critical quality factors could be used to direct future research on Chenin blanc.

Although research has been done on the influence of some of the viticultural and oenological practices on the quality of the Chenin blanc wines under investigation, this study could potentially provide empirical evidence that these practices are indeed critical for the production of quality wine.

By collecting data directly from individuals involved in the production of quality Chenin blanc wines, the study will utilise the collective experience and knowledge of a group of accomplished winemakers. This should ensure that the information gathered on the viticultural and oenological practices represents tried and tested methods.

The study followed the following steps:

1) Creation of a short-list that will be used to select the final sample of top quality Chenin blanc table wines from South Africa;
2) Selection of the best Chenin blanc table wines for inclusion into the study;
3) Construction of a questionnaire that would collect data on factors that might influence the quality of Chenin blanc table wines;
4) Conduct interviews lasting 45 minutes to one hour and thirty minutes with the producers of the wines;
5) Content analyses of the responses to the questionnaire to uncover points of commonalities;
6) Ranking of the relative importance of each viticultural and oenological practice.

3.2 SHORT LIST OF TOP QUALITY CHENIN BLANC TABLE WINES FROM SOUTH AFRICA

This section describes the process followed to create a short list of the best quality Chenin blanc wines that will be considered for inclusion into the study based on tasting results from a number of local and international wine competitions.

Rather than being absolute or universal, the assessment of quality by trained sensory panels at recognised wine competitions should give a useful measure of wine quality. Easy availability of these results makes it the preferred measure of wine quality for the purpose of this dissertation.

The following criteria for including wines in the study were considered:

- Wines that received at least a silver medal at either the 2005, 2006 or 2007 Veritas Awards.
- Wines that received at least three stars at either the 2005, 2006 or 2007 Wine Magazine Chenin blanc challenge.
- Wines that received a medal at either the 2005, 2006 or 2007 Trophy Wine Show.
- Wines that received at least a silver medal at either the 2004, 2005 or 2006 Michelangelo International Wine Awards.
- The winners of the South African Champion Chenin blanc trophy at the South African Young Wine Show in 2004, 2005 and 2006.
- Wines that were selected as *Grandes expressions de Chenin* at either the 2003 or 2004 *Rendez-vous de Chenin* or the 2006 *Rendez-vous de Fontevraud*.
- Wines that received a gold medal or trophy at the 2004, 2005 or 2006 International Wine and Spirit Competition.
- Wines that received a medal at the 2004, 2005 or 2006 International Wine Competition.
- Wines that received a medal at the 2005, 2006 or 2007 *Concours Mondial du vin Bruxelles*.
- Wines that received at medal at the 2005, 2006 or 2007 Decanter World Wine Awards.
- Wines from the 2004, 2005 and 2006 vintage that received more than 85 points in Wine Spectator.

Only the most recent competition results were considered as the South African wine industry operates in a rapidly changing environment where new top quality wines emerge every year. The use of older data might not have given a true reflection of the best quality Chenin blanc wines that are currently available from South Africa.

A strength of the approach of including wines that performed well in a number of different recognised wine competitions in the sample is that the data should, after analysis, provide insight into production practices that are essential to produce quality Chenin blanc wines across a wide range of wine styles. A possible

weakness of the approach is that it might not provide insights into the production of one particular style of wine that might be preferred by a specific judging panel.

The study risked overlooking wines that are not entered into wine competitions as it only considered wines that achieved a minimum accolade in competitions. This risk was addressed by including the top performing wines from a wide variety of wine competitions into which South African producers enter. This was done to ensure that as many top performing Chenin blanc table wines as possible are considered for inclusion into the study to finally arrive at a truly representative sample of the best South African Chenin blanc table wines.

3.3 REPRESENTATIVE SAMPLE OF TOP QUALITY CHENIN BLANC TABLE WINES FROM SOUTH AFRICA

This section describes the final selection procedure of the sample of top quality dry wooded and unwooded Chenin blanc table wines to represent the best quality Chenin blanc wines from South Africa.

The sampling technique did not aim to establish the top Chenin blanc table wines from South Africa. It only attempted to identify a representative sample of the best quality wines and therefore the list cannot be regarded as being complete.

On initial inspection of the medal winning Chenin blanc wines from South Africa it was found that wooded wines achieved higher ratings in general compared to the unwooded wines. This observation will be explored further in the body of the dissertation. It was therefore felt that more wooded wines should be included into the sample to better represent the nature of the best quality Chenin blanc table wines from South Africa. For a discussion dealing exclusively with the lighter styled unwooded Chenin blanc table wines from South Africa see appendix A.

The inclusion of an equal amount of wooded and unwooded wines would result in the inclusion of a number of unwooded versions of comparable lesser quality. This would distort the data collected and compromise its reliability. Therefore it was decided to include nine wooded and six unwooded or partially wooded Chenin blanc wines in the sample to be studied.

A bigger selection also created a risk that wines of lesser quality are included into the sample to be studied that could potentially affect the reliability of the data. This could potentially cause the incidence of a critical viticultural or oenological practice to be diluted.

A list was made of the best performing wooded as well as unwooded or lightly wooded wines in each competition from which the final nine wooded and six unwooded or lightly wooded wines were selected.

For a list of the fifteen wines selected for inclusion in the study see tables 4 and 5.

Table 4: The nine wooded wines that were selected for inclusion in this study together with their competition results.

Wooded Wines Selected	Competition Results
Bellingham 'The Maverick'	• Second best (cumulative) Chenin blanc wine in the 2005, 2006 and 2007 Wine Magazine Chenin blanc Challenge • Trophy in the 2005 Decanter World Wine Awards • Trophy in the 2006 Wine and Sprit competition
Cederberg V Generations	• Double gold in the 2007 Veritas Awards • 82 in the 2006 Trophy Wine Show • 4 stars in the 2007 Wine Magazine Chenin blanc Challenge
Fleur du Cap	• Double gold in the 2004 Veritas Awards • Silver in the 2007 International Wine Challenge • Selected as a grandes expression de Chenin in the Rendez-vouz de Fontevraud (previously Rendez-vouz de Chenin) • 84 in the 2006 Trophy Wine Show • 4 stars in the 2005 Wine Magazine Chenin blanc Challenge.
Forrester Meinert Chenin	• Top performing (cumulative) Chenin blanc wine in the 2005, 2006 and 2007 Wine Magazine Chenin blanc Challenge • Joint top performing (cumulative) Chenin blanc wine in the 2005, 2006 and 2007 Trophy Wine Show • Selected as a grandes expression de Chenin in the Rendez-vouz de Fontevraud (previously Rendez-vouz de Chenin) • Gold in the 2006 International Wine Challenge • Trophy in the 2007 Decanter World Wine Awards, gold in the 2006 Wine and Sprit competition.
Kanu wooded	• Selected as a grandes expression de Chenin in the Rendez-vouz de Fontevraud (previously Rendez-vouz de Chenin) • 82 in the 2005 Trophy Wine Show • 4 stars in the 2006 and 2007 Wine Magazine Chenin blanc Challenge
Rijk's Private Cellar	• Selected as a grandes expression de Chenin in the Rendez-vouz de Fontevraud (previously Rendez-vouz de Chenin) • 95 in the 2007 Trophy Wine Show • 4 stars in the 2005 Wine Magazine Chenin blanc Challenge
Rudera Robusto	• Selected as a grandes expression de Chenin in the Rendez-vouz de Fontevraud (previously Rendez-vouz de Chenin) • 4.5 stars in the 2005 Wine Magazine Chenin blanc Challenge

Wooded Wines Selected	Competition Results
Spier Private Collection	• Gold in the 2006 Veritas • Gold in the 2006 Concours mondial • 4.5 stars in the 2006 Wine Magazine Chenin blanc Challenge
Villiera Cellar Door	• Double gold in the 2004 Veritas Awards • Gold in the 2006 Veritas Awards • Selected as a grandes expression de Chenin in the Rendez-vouz de Fontevraud (previously Rendez-vouz de Chenin) • 4 stars in the 2005 Wine Magazine Chenin blanc Challenge

Table 5: The six unwooded or partially wooded wines that were selected for inclusion in this study together with their competition results.

Unwooded or Partially Wooded Wines Selected	Competition Results
Avondale	• Gold in the 2007 Veritas Awards • Silver in the 2006 Veritas Awards
Kleine Zalze Cellar Selection	• Top performing (cumulative) unwooded Chenin blanc wine in the 2005, 2006 and 2007 Wine Magazine Chenin blanc Challenge • Selected as a grandes expression de Chenin in the Rendez-vouz de Fontevraud (previously Rendez-vouz de Chenin) • Silver in the 2007 International Wine Challenge • Trophy in the 2005 Decanter World Wine Awards
Mulderbosch Steen-op-hout	• 90 in Wine Spectator • Second best (cumulative) unwooded or partially wooded Chenin blanc wine in the 2005, 2006 and 2007 Wine Magazine Chenin blanc Challenge
Perdeberg	• Selected as a grandes expression de Chenin in the Rendez-vouz de Fontevraud (previously Rendez-vouz de Chenin) • SA champion Chenin blanc in the 2005 South African young wine show • Gold in the 2006 Veritas Awards.
Raats	• 90+ in Wine Spectator • 4 stars in the 2005 and 2007 Wine Magazine Chenin blanc Challenge
Simonsig	• Double gold in the 2005 Veritas Awards • Selected as a grandes expression de Chenin in the Rendez-vouz de Fontevraud (previously Rendez-vouz de Chenin) • Gold in the 2006 International Wine Challenge • 87 in Wine Spectator

3.4 QUESTIONNAIRE AND INTERVIEWS

The questionnaire gathered data mostly on viticultural and oenological practices that influence the quality of wines identified during the literature study. It consisted of four sections: terroir, viticulture, oenology and general questions. For each of the practices producers were asked to quantify the relative importance thereof on a scale of one to a hundred. Appropriately worded probing questions were asked where necessary in order to further explore relevant aspects of the production process.

Interviews were conducted over approximately a two week period in July 2007. One of the producers preferred to fill in the questionnaire in his/her own time. One of the interviews was conducted telephonically.

3.5 DATA ANALYSIS

The study aimed to detect those production practices that have a high incidence in the sample of wines and are considered to be important for quality production by producers. These practices will be regarded as having a high likelihood for being important contributors to the quality of all Chenin blanc table wines in South Africa.

Due to the difficulty of defining quality wines (see the literature review) it was not possible to describe the population of quality Chenin blanc wines from South Africa with relative certainty. Because the population could not be defined exactly, the selection of the sample of wines that was studied was not random. Therefore care needs to be taken with generalisations to the population of all the top quality Chenin blanc wines in South Africa.

The results of the statistical analysis should be regarded as explanatory rather than confirmatory. Statistical methods were employed in order to transform the gathered data with the aim of extracting useful information and facilitating conclusions.

The quantitative data collected, i.e. yields per hectare, will be presented graphically as a boxplot. A boxplot is a convenient way of graphically depicting the five-number summary, which consists of the smallest observation, lower quartile, median, upper quartile, and largest observation. The spacing between the different parts of the boxplot indicates the variance and skew of the population. The boxplot also indicates outlaying or unusual observations. The numerical values of the minimum, maximum, lower quartile, upper quartile, median and mean will also be presented. Many of the categorical data, i.e. type of trellising system used, will be presented graphically as a bar chart.

The quantitative importance of the various viticultural and oenological practices will be categorised as unimportant, fairly important, important and very important according to the average values of the importance of the viticultural and oenological practices as determined by the respondents. Categorisation will depend on the specific quartile in which the average importance of a specific practice falls.

As the study is based on a relatively small sample of wines without the control of all the numerous additional factors that could possible influence the quality of wine, it is important not to overextend the significance of the findings. The main findings of the study could only possibly give an indication of practices that could potentially contribute to the production of quality Chenin blanc wine in South Africa. These findings will need to be examined further with more rigorous experimentation before it can be held as facts.

3.6 DATA QUALITY ISSUES

This section lists some of the factors that could potentially negatively influence the validity, completeness and accuracy of the collected data.

It is recognised that although the respondents may have been willing to partake in the interview, it is possible that they will not reveal all of the relevant details of the production process or that they may downplay a critical factor. Therefore all respondents were asked to sign a consent form to participate in the survey that promised confidentiality and anonymity because it was considered important in order to gain access to possibly sensitive information.

The respondents may also have attempted to give the most appropriate answer and this might influence the quality of the data negatively. At least the accuracy of certain quantitative data, for chemical analysis, could be verified from secondary sources.

This section listed the factors that could affect data quality and briefly discussed the data quality initiatives that were implemented to deal with those issues.

3.7 ETHICS, PRIVACY AND CONFIDENTIALITY

The biggest potential ethical concern of this study was the protection of the technical know-how of the producers of the wines included in the study. In order to address this problem all respondents completed a consent form to participate in the survey at the beginning of the interview. The consent form gave potential respondents written information to decide whether or not to participate in the interview.

The consent form stated that:

- The names of all the wines included in the survey will be revealed.
- Specific information, for instance the yeast strain used by a respondent, will be kept confidential.
- Specific information might be discussed in general, for instance that 80% of all respondents use a specific yeast strain.
- Every reasonable attempt will be made to ensure that the answers and opinions of the respondents, as well as the organisations that they are employed by, are referred to anonymously in the study.
- Every reasonable attempt will be made to ensure that the collected data is protected.

While the study has the potential to disclose sensitive information, all reasonable attempts have been made to ensure that the work adheres to general notions of ethics, privacy and confidentiality.

3.8 CONCLUSION OF THE METHODOLOGY

This section outlined and motivated the methodology followed in the study, the main areas of which were an explanation of the process followed to create a representative sample of top quality Chenin blanc table wines out of an initial short list, the nature of the data that was collected, how the data was gathered and what analyses were performed thereon. The section also stated any limitations of the study that might be caused by the data gathering method selected and concluded with a statement on the ethics, privacy and confidentiality practices that were adhered to in order to protect potentially sensitive information provided by the participants of the survey.

4. ANALYSIS OF RESULTS

4.1 INTRODUCTION

The following section will discuss the results of the survey of the following fifteen top Chenin blanc table wines that were included in the study. Refer to the previous section for details of the methodology followed in selecting this sample.

4.2 INTERPRETATION OF THE SURVEY DATA

For a table depicting the main headings of the survey data that will be discussed see table 6.

Table 6: Summary of the areas of analysis of the survey data.

Terroir	Viticulture	Oenology	General
Area	Clones	Grape temperature before crushing	Increase in quality of Chenin blanc wines from South Africa
Wind	Rootstock	Acid additions	Price point to style
Slope	Trellising system	Juice retrieval rate	The economic future of Chenin blanc
Soil characteristics	Vine spacing	Skin contact	
	Row orientation	Oxidation of juice	
	Vine age	Settling	
	Canopy management	Pre-fermentation fining agents	
	Sunlight exposure of grapes	Yeast nutrition	
	Fertiliser application	Yeast strain	
	Irrigation	Fermentation temperature	
	Yields	Oak maturation	
	Crop reduction	Malolactic fermentation	
	Maturity indices	Extended lees maturation	
	Harvesting at different levels of ripeness	Blending of Chenin blanc with other varieties	
	Bunch and grape selection	Post-fermentation fining agents	
	Botrytis cinerea	Residual sugar adjustments	
	Harvesting method	Filtration	
		Maturation	

4.2.1 TERROIR

Area

The producers of the wines included in the study are of the opinion that the area from where the grapes originate is very important for the production of quality Chenin blanc wines in South Africa. The wines included in the study originate from Stellenbosch (71.1%), Paarl (15.6%), Cederberg (6.7%) and Tulbagh (6.7%).

There are producers who feel that the terroir and also the area from where the grapes originate are much less important for the production of quality Chenin blanc wine than the influence that producers have. However, it does seem that the vast majority of the best quality Chenin blanc wines in South Africa originate from the coastal region.

The causative natural factor could either be the presence of the cool ocean breeze or possibly the absence of heavy irrigation schemes. Alternatively, the causative factor could be the production practices followed by producers. It is still uncertain exactly why a higher incidence of top quality Chenin blanc wine exists in the coastal region of South Africa when compared to other regions.

Wind

Although 93% of the wines included in the study are influenced by a wind or breeze the producers only regard it to be fairly important for the production of quality Chenin blanc wines in South Africa.

Some producers are of the opinion that a breeze is important for the production of quality Chenin blanc because it assists in keeping grapes dry and prevents an excessively high incidence of botrytis cinerea infection.

The high incidence of a breeze or a wind in the sample of wines makes it likely that the presence thereof improves the quality of Chenin blanc. However, the producers generally think that it is not critical and some are of the opinion that Chenin blanc is one of the least heat sensitive varieties among the better known white grapes.

Slope

The producers of the wines included in the study generally do not regard vineyards that grow on a slope to be important for the production of quality Chenin blanc wines. However 79% of the wines included in the study originate from vineyards that are situated on a slope and 21% originate from vineyards that are situated on flat ground.

There are producers who feel that vineyards that are situated on a slope are more exposed to cool breezes and have better drainage and that this contributes to the quality of the grapes. There are other producers who feel that the drainage of flat ground can be managed by installing drainage pipes and therefore a slope is not critically important.

The wines included in the study that originate from vineyards that are cultivated on a slope face south (32%), east (27%), south-west (17%), north-west (14%), north-east (5%), west (3%) and south-east (3%).

Although there is a high incidence of wines included in the study that originate from grapes that are cultivated on a slope with cool south and east orientations, the producers generally do not think that a slope is important for the production of quality Chenin blanc wines in South Africa.

Soil characteristics

The characteristics of the soil are regarded to be important for the production of quality Chenin blanc wines by the producers of the wines included in the study. A number of the producers are of the opinion that shale soil types produce the best quality Chenin blanc wine in South Africa. There are however producers who feel that quality Chenin blanc can be cultivated on a variety of different soil types. Some producers feel that alluvial soils do not promote quality Chenin blanc grapes.

The majority of soils have a medium clay content, high or medium water holding capacity, good drainage, are of medium fertility and have a medium effective depth. Not one of the wines included in the study originate from either very shallow soils or soil with poor drainage potential. For a bar chart depicting the characteristics of the soils of the vineyards from where the wines included in the study originate, see figures 10 to 14.

It seems that the soil characteristics can be important for the production of quality Chenin blanc wines in South Africa. However, because wine included in this study originate from vineyards with a range of soil characteristics it seems that the choice of soil type is not absolutely critical except for possibly avoiding very shallow soil and soil with poor drainage.

Figure 10: Clay content of the soil.

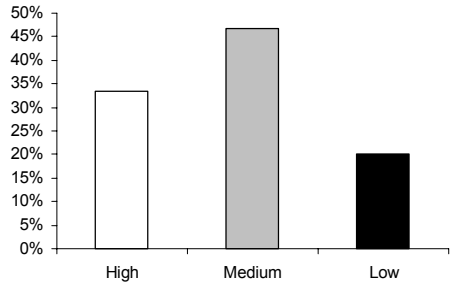


Figure 11: Water holding capacity of the soil.

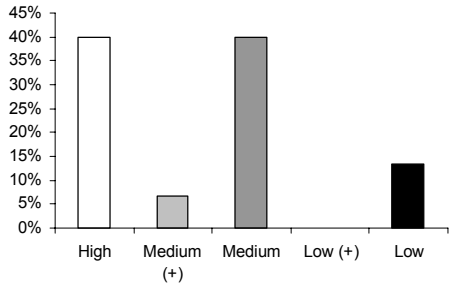


Figure 12: Drainage of the soil.

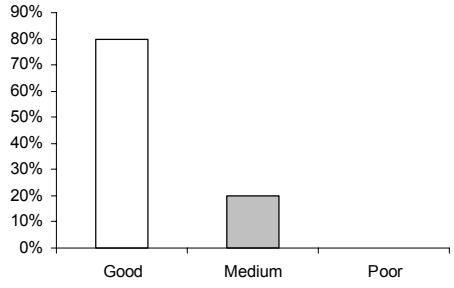


Figure 13: Fertility of the soil.

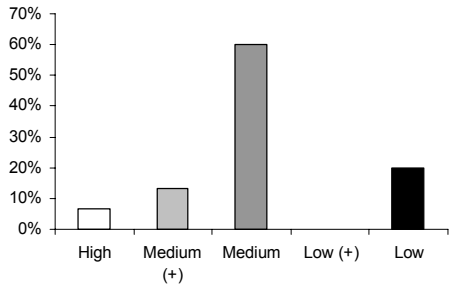
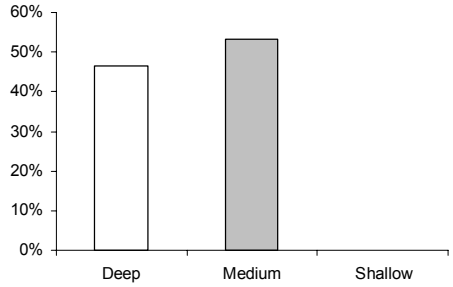


Figure 14: Effective depth of the soil.



Conclusion

Terroir is known to have an influence on both the character and the quality of wine. With regards to terroir related aspects of the selection of top quality Chenin blanc wines included in the study, the following practices seem to be regarded as most important for the production of quality Chenin blanc wines: the area from where the grapes originate and the characteristics of the soil.

For a high-level summary of the findings in the previous paragraphs with regards to viticultural practices, see table 7 below.

Table 7: High-level summary of findings related to terroir related aspects of the wines included in the study.

Terroir	High-level Analysis of Parameter	Relative Importance of Parameter for Quality According to Wine Producers
Area	Stellenbosch (71.1%)	Very important
Wind	Exposed to wind or breeze (93%)	Fairly important
Slope	South-facing slope (32%) and East-facing slope (27%)	Unimportant
Soil characteristics	Medium clay content High or medium water holding capacity Good drainage Medium fertility Medium effective depth (Wide variety of soil characteristics)	Important

4.2.2 VITICULTURE

Clones

Very few of the producers of the wines included in the study know the clone of Chenin blanc used in the production of their wine. Producers varied in their opinion about the relative importance of Chenin blanc clones but it is generally thought to be unimportant for the production of quality wines. Clones reported to be used for the production of the wines included in the study include: SN 1064, SN 1061 and SN 24.

Comments by producers include an observation that some of the older clones tend to be more compact and therefore susceptible to botrytis cinerea infection. Some of the older clones are thought to struggle to ripen grapes beyond 23°B and can therefore not be recommended. Some producers feel that because Chenin blanc does not have prominent inherent grape aromas the choice of clone is not critically important for the production of quality wines.

It does not seem that the choice of clone is particularly important for the production of quality Chenin blanc wines in South Africa.

Rootstock

Opinion about the relative importance of rootstock for the production of quality Chenin blanc varied but it is generally regarded to be unimportant. Wines included in the study originate from vines grafted on a range of rootstocks including: 99 Richter, 110 Richter, 101-14 Mgt, Ramsey and 140 Ruggeri. Some of the producers who used older vineyards do not know on what rootstock the vines are grafted.

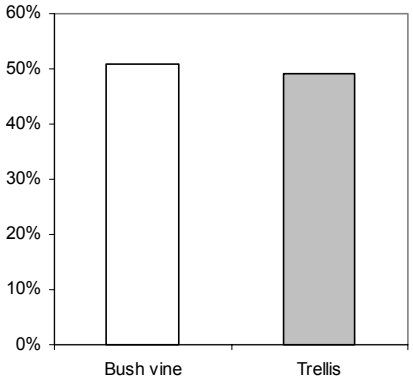
Some of the producers feel that it is important to match the growing conditions with the characteristics of the rootstock to ensure that vines are in balance. A few producers prefer 110 Richter for vineyards without irrigation due to its drought resistance although other producers feel that the strong growth of 99 Richter makes it the most suitable for dry conditions.

It seems that quality Chenin blanc can be produced on a range of different rootstock and therefore it does not seem likely that the choice of rootstock is absolutely critical for the production of quality wines.

Trellising system

Of the wine included in the study 51% originate from bush vine vineyards and 49% originates from trellised vineyards. See figure 15. The most popular trellising systems are the five-strand extended Perold system (22%).

Figure 15: Trellising systems of the wines included in the study.



Producers of Chenin blanc wine that originate form bush vines tend to think that it is very important for the production of quality wine. Some of these producers are of the opinion that bush vines have smaller, more concentrated berries and that vines achieve balance more easily.

There is however also producers who consider trellised vineyards important for the production of quality Chenin blanc. One of the main reasons cited for preferring a trellising system over bush vines is the cooling effect of positioning bunches away from the soil surface. Van Zyl and Van Huyssteen (1980b) confirmed that bush vines caused higher bunch temperatures. Another reason for preferring a trellising system over bush vines is that a trellising system allows more scope to manipulate the leaf canopy of the vine in order to achieve, for example, the desired morning sunlight exposure on bunches.

Some of the producers feel that one of the disadvantages of a trellising system is that inadequate pruning and canopy management practices can more easily lead to a decrease in wine quality compared to a bush vine. There are also examples where younger trellised Chenin blanc vineyards yield far too many bunches which necessitates severe crop reduction.

There was an example where a producer redeveloped an older bush vine vineyard into a trellising system and experienced an improvement in the quality of the grapes.

There are producers in the cooler Stellenbosch region who use grapes from both bush vines and trellised vineyards and claim that bush vines tend to produce better quality grapes in cooler years because it has a slightly warmer canopy microclimate and that trellised vineyards produce better quality grapes in warmer years because of its slightly cooler canopy microclimate. This seems to indicate that it is possible that trellised vineyards could produce better quality grapes in all of the warmer inland regions.

There are producers in the slightly drier areas that believe that bush vines produce better grapes in drier years. They feel that the slightly warmer canopy microclimate of the bush vine assists with ripening before the vine becomes stressed towards the end of the season when the soil moisture content rapidly depletes and this allows grapes to reach optimum maturity more easily.

Some of the producers who use grapes from both bush vines and trellised vineyards feel that the management of the vine and its canopy is more important than the specific trellising system.

The above observations seem to indicate that quality Chenin blanc wines can be produced from both bush vine and trellised vineyards. However, more detailed research is necessary to determine the exact effect of the trellising system on the quality and characteristics of Chenin blanc wines from South Africa.

Vine spacing

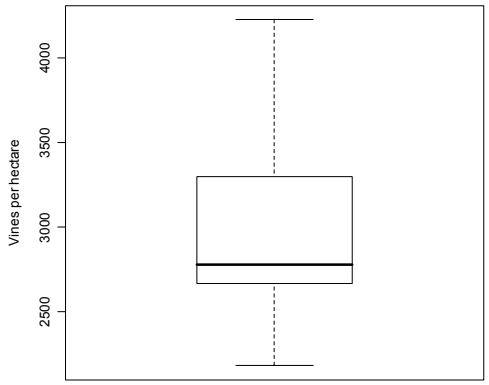
Wines included in the study originate from vineyards with varying plant densities. Half of the wines included in the study originate from vineyards that have vine densities between 2,667 and 3,294 vines per hectare. The mean and median vine spacing value of the vineyards included in the study are considered to be normal values for high to medium potential soils in South Africa (Zeeman, 1981a).

The following is a summary of the vine spacing of the vineyards from which the wines included in the study originate.

Table 8: Summary of statistics for vine spacing of vineyards from which the wines included in the study originate.

Statistical Parameter	Value (vines per hectare)
Minimum	2,179
Maximum	4,222
1st Quartile	2,667
3rd Quartile	3,294
Median	2,778
Mean	3,024

Figure 16: Boxplot of the vine spacing of vineyards from which the wines included in the study originate.



The majority of the producers of the wines included in the study do not think that vine spacing is important for Chenin blanc wine quality. A few producers thought that it was important that vine spacing accommodate the natural vigour of the vine on a particular vineyard site to ensure that vine growth is in balance. There are producers who are of the opinion that slightly closer vine spacing could possibly lead to a slight improvement in wine quality.

Row orientation

Wines included in the study originate from vineyards with north-south, east-west and north-east/south-west row orientations. Producers generally feel that row orientation is not important for the production of quality Chenin blanc wines in South Africa. This seems to indicate that a specific row orientation is not critically important for the production of quality Chenin blanc wine in South Africa.

A number of producers actually prefer warmer row orientations like north-south or north-east/south-west especially for riper styled barrel fermented wines. There are producers of unwooded Chenin blanc who are of the opinion that cooler east-west orientations could possibly be beneficial for the production of better quality wines. Many producers feel that row orientation is even less important for bush vines as it does not impact on sunlight interception to the same degree as for trellised vines. Some producers feel that the row orientation, specifically for trellised grapes, should be parallel to the prevailing wind direction to promote ventilation through the vineyard.

Wines included in this study originate from almost every row orientation and it seems that a specific row orientation is not important for the production of quality Chenin blanc wine from South Africa.

Vine age

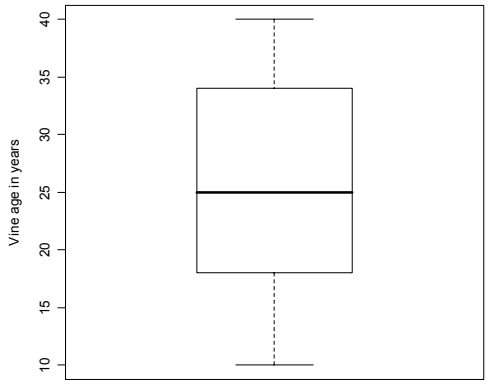
A few of the respondents were not absolutely sure of the exact age of the vines and this compromises the accuracy of the data. It is nevertheless clear that the majority of the wines included in this study originate from more mature vineyards. The producers generally consider the age of the vines to be relatively important for the production of quality Chenin blanc wines.

The following is a summary of the age of the vineyards from which the wines included in the study originate.

Table 9: Summary of statistics for the vine age of the vineyards from which the wines included in the study originate.

Statistical Parameter	Value (years)
Minimum	10.00
Maximum	40.00
1st Quartile	18.00
3rd Quartile	34.00
Median	25.00
Mean	25.16

Figure 17: Boxplot of the vine age of the vineyards from which the wines included in the study originate.



A number of the producers stated that they find that older vines are more in balance compared to younger vines. Younger Chenin blanc vines tend to have a heavy crop load that decreases with age. Some producers feel that a Chenin blanc vine needs approximately ten years to reach a stage where the vines are in balance. Older blocks give fuller and more flavoursome wines compared to the light and fruity style of wines from younger blocks. One producer feels that they do not produce one of their best wines from older (> 25 years) vineyard blocks.

The age of the vines seem to be important for the production of quality Chenin blanc wines but it does not seem to be a particularly strong causative factor. Many of the producers feel that the lower yields and the less vigorous growth of older vines cause them to produce better quality grapes and these characteristics are more important than the age itself. There are wines included in the study that have been winning medals since the first few harvests of the vineyard. This seems to indicate that older vines assist with the production of quality Chenin blanc wines from South Africa but is not absolutely critical.

Canopy management

Almost all of the producers practice canopy management on Chenin blanc vineyards. The survey shows that 93% of the producers practice suckering, 80% tipping or topping and 33% leaf removal on the vineyards from which the grapes for the wines included in the study originate. Canopy management was generally regarded by the producers to be very important for the production of quality Chenin blanc wines.

There are very old vineyards with low vigour that are already bearing very low yields where producers feel that it is not necessary to practice canopy management. Some of the producers in windy areas are careful not to sucker too vigorously otherwise a wind storm later in the season could cause vines to yield too few grapes.

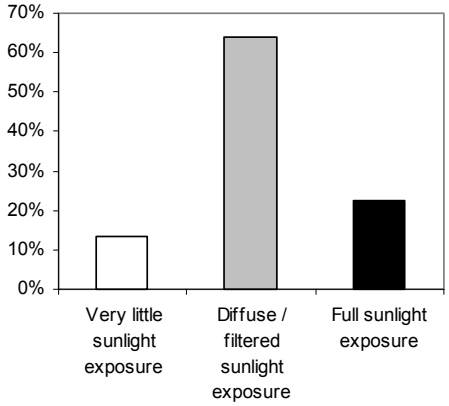
Some of the producers feel that canopy management is generally not practiced on Chenin blanc vineyards in South Africa as a result of the low price of the grapes.

The above observations seem to indicate that especially suckering and tipping and topping are canopy management practices that promote the quality of Chenin blanc wine.

Sunlight exposure of grapes

The majority of the wines included in the study originate from grapes that are exposed to diffuse or filtered sunlight. This corresponds with the recommendation of the study by Marais, Van Schalkwyk and October (2005) which showed that Chenin blanc wines made from shaded grapes have higher levels of esters and are of higher quality. The wines in the study were not subject to oak maturation. The amount of sunlight exposure was generally considered to be very important for the production of quality Chenin blanc wines in South Africa. And yet, wines included in the study originate from grapes with varying degrees of sunlight exposure. For a summary of the amount of sunlight exposure to which bunches are subjected to see figure 18.

Figure 18: Sunlight exposure of grapes of the wines included in the study.



There are producers who feel that Chenin blanc is the least sensitive to heat of all the major noble white varieties in South Africa and that full sunlight exposure produce the best quality wines. Some of these producers feel that sunlight exposure assists with the ripening of grapes, particularly where irrigation is not available where there is a risk that water stress will cause the stomata to close that will inhibit sugar accumulation and ripening towards the end of the season.

The observation that a number of the wines included in the study originate from grapes that received very little sunlight exposure as well as full sunlight exposure seem to indicate that the amount of sunlight exposure, within reasonable limits, is not absolutely critical for the production of quality Chenin blanc wines in South Africa. It is possible that the amount of sunlight exposure is more important in influencing the style of the wine rather than its quality.

However, more detailed research is necessary to determine the exact effect of sunlight exposure on the quality and characteristics of Chenin blanc wines from South Africa.

Fertiliser application

The application of fertilisers to Chenin blanc vineyards varied. The majority of the producers (67%) did occasionally apply fertilisers to the vineyards from which the wines included in the study originate. Opinions about the importance of fertilisers for the production of quality Chenin blanc wine in South Africa varied

among the producers of the wines included in the study but is was generally regarded as either only fairly important or unimportant.

Levels of fertiliser application are generally low, often only replacing the nitrogen utilised by the cover crops. Almost all of the producers only apply fertilisers after the assessment of the soil and plant material nutrition content or at least the vine growth. A few producers claim that older vines sometimes need nitrogen additions to support its growth. Some of the producers who apply nitrogen claim that it is important to ensure that shoot lengths reach the required length otherwise the vine will struggle to ripen its crop. Many of the producers indicated that the management of the vigour of the vine was more important than the application of fertilisers itself.

A few of the producers who do not apply any fertilisers to the vineyards prefer to manage soil nitrogen content with cover crops. These producers are generally concerned about excessive vigour that can cause a decrease in grape quality and an increase in the incidence of disease.

Due to the high incidence of fertiliser application in the study, it seems that the application of a limited amount of fertiliser to vineyards does not result in a significant deterioration of wine quality and may even promote it.

Irrigation

Of the wines included in the study, 86% of the vineyards from which the grapes originate receive supplementary irrigation and only 14% are dryland cultivated. Irrigation is generally considered by the producers to be very important for the production of quality Chenin blanc wine in South Africa.

Irrigation is generally applied only once with vériason. A few producers also irrigate if a heat wave occurs or if the vine shows signs of stress towards the end of the season. These producers feel that the vine should not suffer towards the end of the season as the soil water potential becomes very low otherwise ripening will be retarded. There are also a few producers who irrigate throughout the season depending on the soil water potential measurements.

Irrigation is applied by overhead, drip and micro sprinklers, which suggest that the method of irrigation is not critically important for the production for quality Chenin blanc wines.

It seems that supplementary irrigation is important for the production of quality Chenin blanc wines under South African conditions. Most of the wines included in the study receive supplementary irrigation and producers generally feel that irrigation is important for the production of quality Chenin blanc wine.

Yields

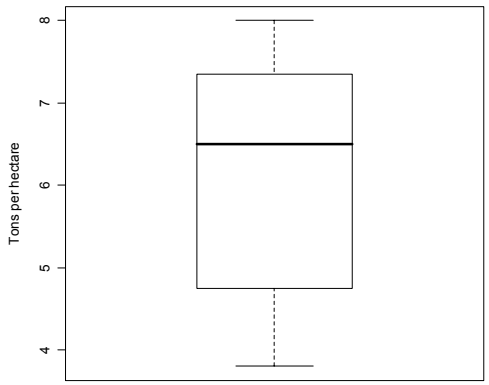
Producers of the wines included in the study generally regard the yield to be of critical importance for the production of quality Chenin blanc wine in South Africa. The 259,443 tons of Chenin blanc produced in 2006 from 19,122 hectares (SAWIS, 2007a) translates to a national mean yield of 13.6 tons per hectare. The mean of the vineyards from which the wines included in the study originate is considerably less than this.

The following is a summary of the yield of the vineyards from which the wines included in the study originate.

Table 10: Summary of statistics for the yield of the vineyards from which the wines included in the study originate.

Statistical Parameter	Value (tons per hectare)
Minimum	3.8
Maximum	8.0
1st Quartile	4.8
3rd Quartile	7.4
Median	6.5
Mean	6.1

Figure 19: Boxplot of the yield of the vineyards from which the wines included in the study originate.



Yields on the bush vine vineyards tend to be lower, possibly due to the smaller effective canopy. The older vines also generally tend to yield less, possibly due to reduced fertility.

Wines included in the study originate from low yielding vineyards. The producers of these wines generally considered yield to be very important for the production of quality wine. This seems to indicate that low yields promote the quality of Chenin blanc wine in South Africa.

Crop reduction

Approximately half of the producers of the wines included in the study practices' crop reduction. Producers who do not practice crop reduction generally feel that their vines are already in balance and that natural yields are low enough to ensure the production of quality wine.

Methods used to ensure low yields are short pruning of bearers, often leaving only one eye per bearer. Many of the producers practice green harvesting. A number of producers feel that it is particularly important that bunches on very short or thin shoots are removed early to prevent uneven ripening of grapes. This is in line with recommendations by Archer (2001). Some producers also ensure that very early or late bunches are removed with green cropping to ensure even ripening of the grapes.

The low price of Chenin blanc is cited as the main reason why the majority of Chenin blanc grape growers in South Africa do not practice any from of crop reduction.

It seems that crop reduction is important for the production of quality wine if the vines are not in balance. Younger vines tend to be fertile and require crop reduction while the practice becomes less important as the vine ages and naturally reduces its yield.

Maturity indices

The majority of the producers of wine included in the study indicated that the decision to harvest is a very important step in the production of quality Chenin blanc wine in South Africa. Most of the producers are of the opinion that fully ripe grapes are a prerequisite for quality Chenin blanc wines. The importance of ripe grapes was also confirmed by Marais, Van Schalkwyk and October (2005).

Most of the producers consider the chemical analysis when deciding when to harvest, especially the total dissolved solids (°Balling), but it would seem that most producers regard this information as supplementary. Some producers will only start to consider harvesting once the grapes reach 22°B. For an approximation of the distribution of the sugar level of the grapes at harvest see figure 20. The alcohol content of the wines was converted to degrees balling using the factor 0.57% alcohol per degree Balling. The sugar levels of the grapes at the time of harvest are generally high. The boxplot indicates that the wooded wines are generally picked slightly riper than the unwooded and lightly wooded wines. The producers of wooded Chenin blanc generally indicated that they prefer to pick as ripe as possible.

The following is a summary of the ripeness levels at time of harvest of the wooded and unwooded wines included in this study.

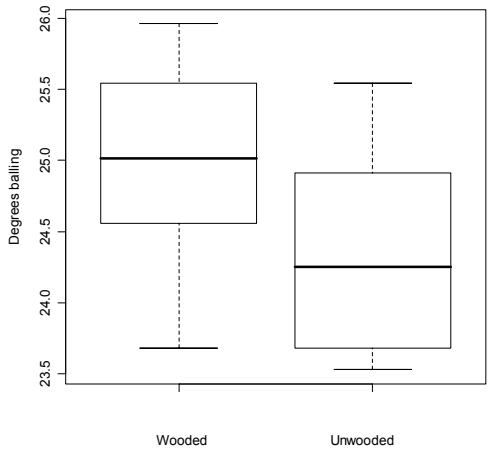
Table 11: Summary of statistics for the ripeness levels of wooded wines included in the study.

Statistical Parameter	Value (°B)
Minimum	23.68
Maximum	25.96
1st Quartile	24.56
3rd Quartile	25.52
Median	25.02
Mean	24.96

Table 12: Summary of statistics for the ripeness levels of unwooded and lightly wooded wines included in the study.

Statistical Parameter	Value (°B)
Minimum	23.53
Maximum	25.54
1st Quartile	23.81
3rd Quartile	24.76
Median	24.26
Mean	24.36

Figure 20: Boxplot of the ripeness levels of unwooded and lightly wooded wines included in the study.



The taste of the grapes seems to be the most important indicator of the stage of ripeness. Most producers will delay harvesting until they are convinced that the grapes have achieved the desired flavour profile.

Many producers monitor the gradual change of the skin colour from green and aim to harvest only when grapes display a golden colour. Some of the producers also evaluate the amount of browning of the pips. A golden skin colour and brown pips indicate optimum ripeness.

The health of the grapes and the incidence of botrytis cinerea can also influence the timing of the harvest. Historic data and experience with a particular vineyard also plays an role.

The state of the vineyard is very important for most of the producers when deciding when to harvest the grapes. Vineyards tend to struggle towards the end of the season as a result of producers' preference for ripe grapes in general. If a visual inspection of the vineyard indicates that the vines are losing leaves and are under stress, the producers may well decide that sugar accumulation and ripening are progressing too slowly or have stopped and based on this, decide to proceed with the harvest.

According to many of the producers, the possibility of rain is often a deciding factor in determining the exact timing of the harvest. It is possible that the dilution of the sugar in grapes and the consequent delay in ripening caused by rain can increase the risk of an unacceptably high incidence of disease on the grapes. Therefore producers tend to harvest before a rain storm given that the grapes have reached an acceptable level of ripeness.

According to some producers there is a definite stage of ripening after which quality starts to deteriorate. It seems to be a stylistic decision and that these producers prefer not to have a very high incidence of botrytis cinerea infection.

Harvesting at different levels of ripeness

Of the producers of wines included in the study, 47% harvest lots of grapes at different ripeness levels. The importance of harvesting at different ripeness levels differed among the producers, but it was generally regarded to be unimportant for the production of quality Chenin blanc wine in South Africa. A number of the producers who do not harvest at different ripeness levels feel that riper grapes produce better wines. Most of the producers that harvest at different ripeness levels feel that it contributes to the complexity and the balance of the wine.

Some of the producers that harvest at different ripeness levels specifically include a portion of earlier picked grapes and others a portion of riper picked or even botrytis cinerea infected grapes. Producers claim that the earlier picked lots of grapes give more lime and citrus character and that the riper picked lots of grapes give more tropical and peach character. The higher acid levels of earlier picked lots of grapes contribute to the crispness of the wine and can also be used to slightly lower the alcohol level.

It seems that harvesting at different levels of ripeness is not important for the production of quality Chenin blanc in South Africa.

Bunch and grape selection

The producers of the wines included in the study generally regard bunch selection to be important for the production of quality Chenin blanc wines. Only 7% of the producers do not practice bunch selection. The severity of bunch and grape selection practices varies between the producers.

Many producers focus their bunch selection efforts in the vineyard. Some of the producers send their best trained harvest personnel through the vineyard to remove any damaged or rot infected bunches from the vineyard. There are producers who make use of bunch selection to separate botrytis cinerea infected bunches to vinify separately in order to allow them to have noble late harvest wine as a blending component. Only a few producers make use of a sorting table at the cellar. The selection of individual grapes is not common.

Some of the producers also consider the heterogeneity of the vineyard when they harvest. Patches of the vineyard with either too little or too much foliage growth are harvested separately in order to ensure uniform ripeness of grapes.

It seems that producers tend to regard bunch selection more important in years with high disease incidence.

The high incidence of bunch selection (93%) together with an indication from the producers that it is a relatively important practice seems to indicate that bunch selection is necessary for the production of quality Chenin blanc wines in South Africa.

Botrytis cinerea

Chenin blanc is sensitive to botrytis cinerea infection due to cultivar characteristics like its compact bunches (Orffer, 1979). The practice of harvesting grapes at optimal ripeness seems to have resulted in a greater amount of time for botrytis cinerea symptoms to develop on grapes used in the production of top quality Chenin blanc wines.

Producers who include a portion of botrytis cinerea infected grapes or wine generally feel that it is very important for the production of quality Chenin blanc wines while producers who do not include a portion of botrytis cinerea infected grapes or wine generally feel that it is not important at all. In general the inclusion of a portion of botrytis cinerea infected grapes or wine is regarded to be fairly important.

The majority of producers (73%) allow botrytis cinerea infected grapes into the fermentation tank or alternatively blend in noble late harvest wine into the wine prior to bottling. Portions vary from very little botrytis infected grapes up to approximately 5% of the grapes. Motivation for the practice includes the natural enrichment that the infection causes, improving mouthfeel and enhancing the complexity of the nose of the wine.

There are also producers that questioned the inclusion of botrytis cinerea infected grapes as a quality factor for Chenin blanc wines. These producers argue that botrytis cinerea infected grapes do not contribute to the classic aromas of Chenin blanc and its inclusion should therefore be minimised.

The study seems to indicate that it is possible to produce quality Chenin blanc wine in South Africa with and without the addition of botrytis cinerea character. Botrytis cinerea does seem to be important for the production of certain styles of Chenin blanc wine.

Harvesting method

Almost all if the wines included in the study are made entirely from manually harvested grapes. Most of the producers regard manual harvesting of grapes to be critical for the production of quality Chenin blanc wines.

Producers of Chenin blanc in areas with a very low incidence of disease are of the opinion that the machine harvesting of healthy grapes does not significantly influence wine quality.

Studies by Wagener (1980) indicated that machine harvesting of Chenin blanc grapes do not negatively effect wine quality. The wines made in the study had a lower alcohol level (approximately 12.5%) compared to the wines included in the study. It is possible that the higher disease incidence of the riper grapes used in the production if the wines included in the study could necessitate bunch selection by experienced personnel in the vineyard in order to produce better quality wines.

There is a high incidence of manual harvesting of grapes in the wines included in the study and an indication by producers that manual harvesting is important for the production of quality Chenin blanc wine. This seems to indicate that manual harvesting of Chenin grapes is required for the production of quality wines. It seems to be particularly important in areas with some degree of disease incidence because the manual harvesting of grapes allows some form of bunch selection.

Conclusion

With regard to viticultural practices of the selection of top quality Chenin blanc producers included in the study, the following practices seem to be regarded as most important for the production of quality Chenin blanc wines: proper canopy management, supplementary irrigation, yield management (crop reduction), determining the optimal ripeness, manual harvesting and the amount of sunlight exposure of the grape bunches

For a high-level summary of the findings in the previous paragraphs with regards to viticultural practices, see table 13 below.

Table 13: High-level summary of findings related to viticultural practices of the wines included in the study.

Viticulture	High-level Analysis of Parameter	Relative Importance of Parameter for Quality According to Wine Producers
Clones	Mostly unknown	Unimportant
Rootstock	None	Unimportant
Trellising system	Bush vine (51%) and trellised (49%)	Fairly Important
Vine spacing	Mean of 3,024 vines per hectare	Unimportant

Viticulture	High-level Analysis of Parameter	Relative Importance of Parameter for Quality According to Wine Producers
Row orientation	Varied	Unimportant
Vine age	Mean of 25.16 years	Fairly Important
Canopy management	Suckering (93%), Tipping / Topping (88%)	Very Important
Sunlight exposure of grapes	Varied	Very important
Fertiliser application	Varied	Fairly Important / Unimportant
Irrigation	86% receive supplementary irrigation	Very Important
Yields	Mean of 6.1 tons per hectare	Very Important
Crop reduction	Approx. half practice crop reduction	Very important, especially for younger vines
Maturity indices	Varied	Very Important
Harvesting at different levels of ripeness	47% of producers	Unimportant
Bunch and grape selection	93% of producers	Important
Botrytis cinerea	73% of producers include infected grapes of wine	Fairly Important / Unimportant
Harvesting method	Manual harvesting	Very Important

4.2.3 OENOLOGY

Grape temperature before crushing

The producers of the wines included in the study consider cool grapes before crushing to be either very important or important for the production of quality Chenin blanc in South Africa. Some of the producers claim that although it is important to crush Chenin blanc grapes cool, it is less important than for instance with Sauvignon blanc because Chenin blanc has less inherent grape flavours that can potentially oxidise.

The majority (80%) of the wines included in the study are produced from cool grapes. The method employed to ensure cool grapes prior to crushing includes harvesting in the early morning or even at night when grapes are cool (53.3%) and making use of cold storage (26.7%).

Producers whose setup does not always allow for cool grapes prior to crushing, tend to limit skin contact to prevent the extraction of an excessive amount of phenolic compounds.

Most of the producers use a mash cooler although some producers feel that the action can result in excessive oxygen uptake as well as damage to the grapes.

The high incidence of cool grapes prior to crushing as well as a feeling amongst most of the producers that the practice is important seems to indicate that the practice is relatively important for the production of quality Chenin blanc wine in South Africa. There is however a few producers (20%) who do not attempt to crunch cool grapes and still manage to produce quality Chenin blanc wine. This seems to indicate that the practice is not absolutely critical.

Acid additions

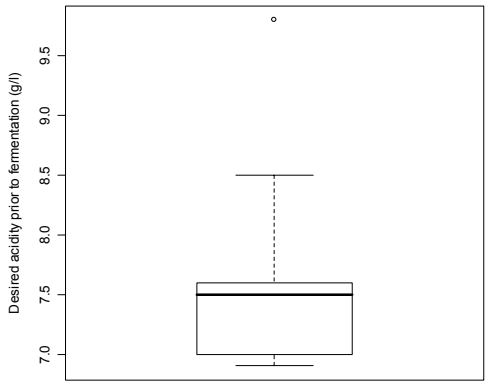
Producers generally regard acid adjustment to be fairly important for the production of quality Chenin blanc wine. Only two producers of the wines included in the study rarely have to adjust acid levels prior to fermentation. These wines are made from very old vines (>30 years) that have high enough levels of natural acid due to the low yields. Most of the producers prefer to adjust the acidity as early as possible in the production process.

The following is a summary of the desired level of acidity of the juice prior to fermentation of the wines included in the study.

Table 14: Summary of statistics for the desired level of acidity of the juice prior to fermentation of the wines included in the study.

Statistical Parameter	Value (g/l tartaric)
Minimum	6.90
Maximum	9.80
1st Quartile	7.00
3rd Quartile	7.60
Median	7.50
Mean	7.63

Figure 21: Boxplot of the desired level of acidity of the juice prior to fermentation of the wines included in the study.



The acidity level of the juice of fifty percent of the wines included in the study is adjusted to between 7.0 g/l and 7.6 g/l. A few producers feel that the inclusion of a higher press juice fraction will necessitate a higher acid adjustment due to the higher rate of precipitation of tartaric acid. Some of the producers only make acid adjustments after considering the sugar to acid levels and the pH of the juice.

Juice retrieval rate

The producers of the wines included in the study vary in their opinion about the importance of the juice retrieval rate but generally consider it to be either important or very important. Juice extraction rates are generally low and the majority of producers of the wines included in the study essentially only use free run juice. Not one of the producers made use of a portion of hard pressed juice. Fifty percent of the wines included in the study have a juice retrieval rate of between 551.5 litres and 675.0 litres per ton of grapes. A

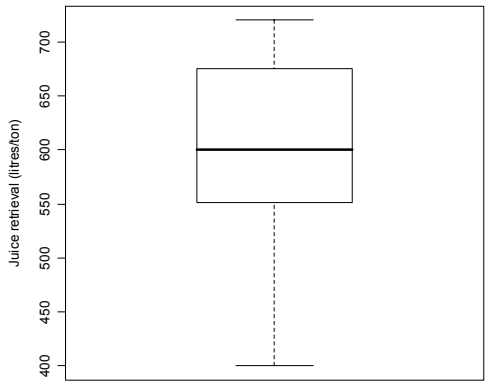
few producers even employ whole bunch pressing on a portion of the grapes that allows for the retrieval of juice with very little skin contact.

The following is a summary of the juice retrieval rates of the wines included in the study.

Table 15: Summary of statistics of the juice retrieval rates of the wines included in the study.

Statistical Parameter	Value (litres per ton of grapes)
Minimum	400.0
Maximum	720.0
1st Quartile	551.5
3rd Quartile	675.0
Median	600.0
Mean	602.9

Figure 22: Boxplot of the juice retrieval rates of the wines included in the study.



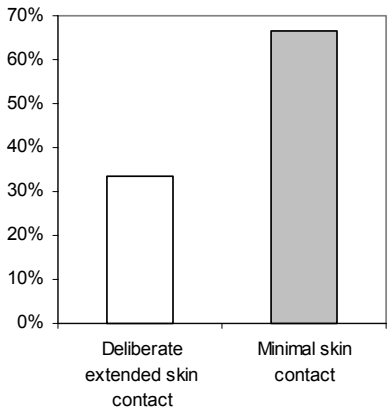
Some of the producers claim that pressing of grapes assist with the release of the botrytis cinerea or noble late harvest character, raisin character as well as inherent grape flavours. A few producers of barrel fermented wines aim for slightly elevated levels of phenolics in the must. Other producers feel that free run juice produce a more elegant wine. Producers that practice skin contact generally limit the inclusion of a press fraction because they are concerned about the extraction of an excessive amount of phenolic compounds.

Decisions regarding the pressing of grapes seem to be important for the production of quality Chenin blanc wines in South Africa. Although a few producers have relatively high juice retrieval rates, it seems that the majority of the producers of the wines included in the study only make use of free run and lightly pressed juice for the production of their top quality Chenin blanc wines.

Skin contact

The sample of wines included in this study contains both wines that receive no deliberate extended skin contact (67%) and wines that do receive deliberate skin contact (33%). For a bar chart depicting the number of wines made with and without skin contact see figure 23. This observation together with the general indication by the producers that skin contact or the limitation thereof is a fairly important practice indicates that the influence of the practice on the quality of Chenin blanc wine is not yet established.

Figure 23: Skin contact of the wines included in the study.



The majority of producers do not practice any deliberate extended skin contact. A number of these producers also make use of whole bunch pressing on some lots of grapes. Producers of Chenin blanc wine that do not allow skin contact claim that the skins of Chenin blanc grapes do not contain enough flavour compounds that can be extracted to justify the potential extraction of phenolic compounds.

The setup of some producers does not always make it possible for them to crush cool grapes. They claim that extended skin contact at these elevated temperatures will result in the extraction of an excessive amount of phenolic compounds that will negatively impact wine quality. As a result of this it was important for these producers to allow the least amount of skin contact and they reported that experience has taught them that they produce their best wines from batches of grapes that received the least amount of skin contact.

There are a few producers, of both wooded and unwooded wines, who practice extended skin contact. The temperature at which skin contact was practiced was consistently cool, approximately 10 - 15°C, in order to limit the extraction of phenolic compounds as well as oxidation. Skin contact times ranged from 3 to 24 hours. Producers who allow extended skin contact insist that even though Chenin blanc is considered to be a relatively neutral grape with limited amounts of inherent grape character it does not mean that the skin of the grape contains no flavour compounds or precursors thereof. These producers feel that extended skin contact results in more flavoursome wines with better maturation potential.

Some of the producers who allow extended skin contact only use the free run juice and possibly a delicately pressed portion. This is done in an effort to limit the release of harsh phenolic compounds.

Some of the producers who allow skin contact and also include a portion of botrytis cinerea infected grape claim that the practice is important because it aids with the extraction of the raisin character of the infected grapes that they consider to be important for wine quality.

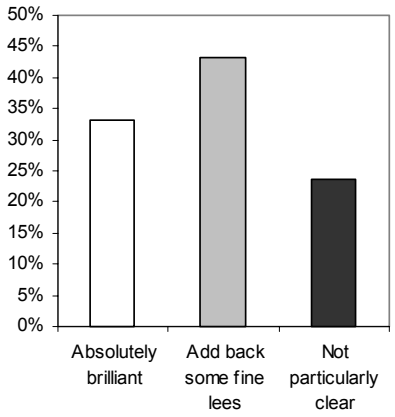
Opinions about the impact of extended skin contact on the quality of Chenin blanc wines varied among the producers included in the study. Quality wines were produced form both juice that received extended skin contact as well as from juice that received no extended skin contact. Additional knowledge is required about the exact effect of extended skin contact on the quality and characteristics of Chenin blanc wines from South Africa.

Settling

The producers of the wines included in the study generally regard the clarity of the juice to be very important or important for the production of quality Chenin blanc wines. The majority of the wines included in the study are made from brilliant juice to which some fine lees have been added (43%). This seems to be in line with

recommendations from previous studies. See the literature review. The remaining wines are made from absolutely brilliant juice (33%) and not particularly clear juice (24%). For a bar chart displaying the clarity of the juice see figure 24. The settling time varied from 18 – 48 hours. The majority of the wines were settled either overnight or for two days.

Figure 24: Juice clarity of the wines included in the study.



All of the unwooded wines included in the study are made from either brilliant juice (67%) or brilliant juice to which some fine lees have been added (33%). The lightly wooded wines included in the study are made from brilliant juice (22%), brilliant juice to which some fine lees have been added (60%) and not particularly clear juice (18%). The wooded wines included in the study are made from brilliant juice (26%), brilliant juice to which some fine lees have been added (41%) and not particularly clear juice (33%). All of the portions made from turbid juice is fermented in oak barrels.

Although the producers of the wines included in the study generally regard the clarity if the juice to be important for the production of quality Chenin blanc wines, wines included in the study are made from juice with varying degrees of clarity. This seems to indicate that the clarity of the juice, within normal limits, may affect the style of the wine more than it does the quality thereof. The exceptions may possibly be for unwooded wines that seem to have a high incidence of brilliantly clear juice and possibly for lightly wooded wines that seem to have a high incidence of juice to which some fine lees have been added.

Pre-fermentation fining agents

The addition of pre-fermentation fining agents is generally regarded by the producers of the wines included in the study not to be either important or excessively detrimental to the production of quality Chenin blanc wines.

Pre-fermentation fining agents used in the wines included in the study are as follows:

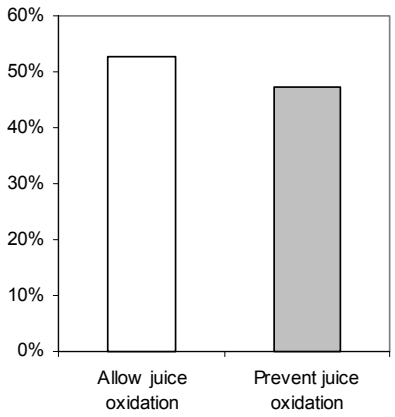
- bentonite in the presence of botrytis cinerea infection to eliminate laccase enzymes,
- PVPP or a gelatine and silica sol combination to remove phenolic compounds,
- gelatine to ensure a more compact lees.

It seems that pre-fermentation fining agents do not have a critical influence on the quality of Chenin blanc wine from South Africa although a number of producers claim that any additive to a wine has the potential to negatively influence the quality thereof.

Oxidation of juice

There is no clear preference for the amount of oxidation of Chenin blanc juice prior to fermentation. 53% of the wines included in the study are made from juice that was allowed some oxidation and 47% of the wines included in the study are made from reductively held juice. For a bar chart depicting the number of wine included in the study made with and without some degree of juice oxidation see figure 25. The producers varied in their opinion about the influence of juice oxidation on the quality of Chenin blanc wine but generally thought that is was fairly important.

Figure 25: Juice oxidation of the wines included in the study.



Ascorbic acid additions are made to the juice of three wines and inert gas is used on the juice of five wines to prevent juice oxidation.

Many of the producers recognise the benefits of allowing some oxidation of the juice although there is no incidence were a producer deliberately hyperoxidise the must. A few producers only add SO_2 after crushing and even only after settling. Producers who allow a degree of juice oxidation seem to feel that the aromas of Chenin blanc wine is not diminished if the juice undergoes slight oxidation prior to fermentation. These producers seem to favour a degree of juice oxidation due to the oxidation and precipitation of phenolic compounds that makes the wines less sensitive to oxidative browning and pinking. There are producers who indicated that they consider it important to allow some degree of juice oxidation in the presence of botrytis cinerea infection in order to limit possible oxidation once fermentation is complete due to the presence of laccase enzymes.

It seems that the influence of juice oxidation of Chenin blanc on the quality of the wine under South African conditions is still unresolved among producers. Quality wines are made from juice that is allowed some degree of oxidation as well as juice that is held very reductively. It is possible that juice oxidation is more important in determining the style of the wine than its quality. Additional knowledge is required about the exact effect of juice oxidation on the quality and characteristics of Chenin blanc wines from South Africa.

Yeast nutrition

Yeast nutrition was added to the juice of all of the wines included in the study. Producers of the wines included in the study generally regard proper yeast nutrition to be important for the production of quality Chenin blanc wines. A number of the producers feel that because Chenin blanc wines rely on yeast produced fermentation flavours it is very important to ensure healthy yeasts by means of proper yeast nutrition. Producers are generally very wary of hydrogen sulphide production and administer additional yeast nutrition to prevent its formation.

Liquid ammonia is the most popular yeast nutrition and added to the must of 67% of the wines included in the study. Anchorferm (containing inactive yeasts, magnesium sulphate and thiamine) is added to 47% of the musts, Fermaid K (containing DAP, inactive yeasts, magnesium sulphate, thiamine, folic acid, niacin and calcium pantothenate) is added to 27% of the musts, Nutrivin (containing ammonium sulphate, di-ammonium phosphate and inactive yeasts) and plain di-ammonium phosphate are both added to 13% of the musts and Go-ferm (inactive yeasts) is added to 7% of the musts.

Some of the producers who ferment turbid juice feel that it already contains a reasonable amount of yeast nutrition although they still supplemented with additional nutrients.

The high incidence of additional yeast nutrition added to the juice of the wines included in the study together with an indication from most of the producers that it is important seem to indicate that proper yeast nutrition is a prerequisite for the production of quality Chenin blanc wine from South Africa. The study did not determine whether wine quality is affected differently by the different yeast nutrition supplements.

Yeast strain

The importance of the choice of yeast strain varied among the producers of the wines included in the study but a number if the producers feel that it is important to very important for the production of quality wine.

Spontaneous fermentations are the most popular choice (39%) for fermenting the wooded wines included in the study. Other popular yeast strains for wooded wines include Anchor VIN7 (18%) and Lallemand CY3079 (11%). For a bar chart depicting the yeast strains used to ferment the wooded wines included in the study see figure 26.

The majority (59%) of the unwooded and lightly wooded wines included in the study is fermented with Anchor VIN7. Anchor VIN13 is the second most popular (22%) yeast strain for unwooded and lightly wooded wines. For a bar chart depicting the yeast strains used to ferment the unwooded and lightly wooded wines included in the study see figure 27.

There are producers who feel that spontaneous yeasts fermentations release more grape derived flavour compounds that are chemically bound to sugar to enhance the intensely of the wine's flavour. Three producers combine different yeast strains in the same fermentation vessel and are of the opinion that this practice also allows for the liberation of a greater amount of flavours during fermentation. The impact of these practices on the quality of Chenin blanc wines from South Africa need to be investigated further.

Figure 26: Yeast strains of the wines included in the study (wooded wines).

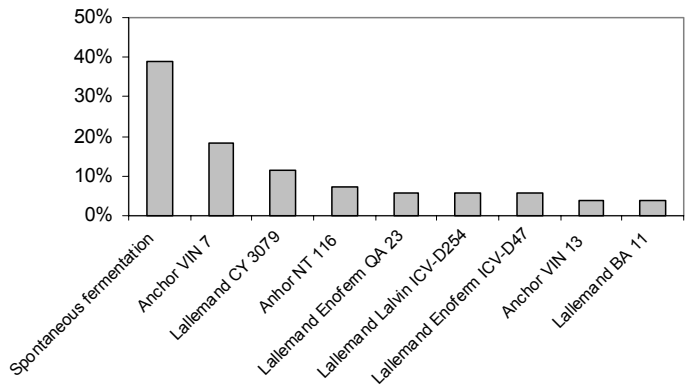
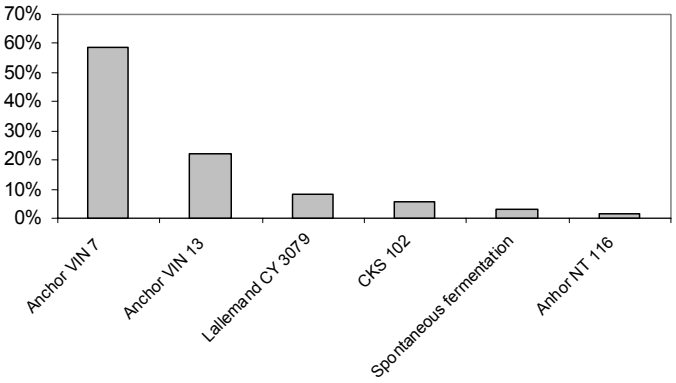


Figure 27: Yeast strains of the wines included in the study (unwooded and lightly wooded wines).



Only two wines are fermented with one single yeast strain. Apart from the four wines that are solely fermented with ambient yeasts, four wines are fermented with three different yeast strains and five wines are fermented with two different yeast strains. The high incidence of combining more than one yeast strain could indicate that the practice enhances the quality of Chenin blanc wines.

There are producers who experimented with *Candida* fermentations in the past and they reported favourable results. Also see Jolly, Augustuyn and Pretorius (2003b). The availability of the yeast currently seems to be a problem.

Interesting observations by producers include examples where a stuck fermentation that was reinoculated seemed to have enhanced the formation of flavours and the quality of the batch of wine. Further investigations are necessary before any conclusions can be made regarding the effect that reinoculated stuck fermentations have on the quality of Chenin blanc wines from South Africa.

Although producers generally feel that the choice of yeast strain is important for the production of quality wine, the sample of wines included in the study are fermented with a range of different yeast strains. This confirms that the choice of yeast strain is not critical for the production of quality Chenin blanc wine from South Africa. A possible exception may be for unwooded wines that have a high incidence of wines fermented with Anchor VIN7.

Fermentation temperature

The producers of the unwooded wines included in the study generally consider the fermentation temperature to be very important for the production of quality Chenin blanc wines. The producers of the barrel fermented wines varied in their opinion regarding the importance of fermentation temperature but three producers rated its importance as less than 50 on the scale of zero to one hundred.

Fermentation temperatures of the wines included in the study varied but the tank fermented portions are generally fermented cooler than the barrel fermented portions of wine.

The following is a summary of the fermentation temperatures of both tank fermented and barrel fermented portions of the wines included in the study.

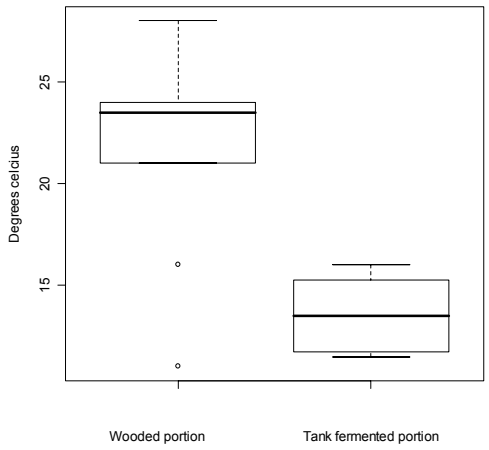
Table 16: Summary of the fermentation temperatures of the barrel fermented portions included in the study.

Statistical Parameter	Value (°C)
Minimum	11.0
Maximum	28.0
1st Quartile	21.3
3rd Quartile	25.0
Median	23.5
Mean	21.9

Table 17: Summary of the fermentation temperatures of the tank fermented portions included in the study.

Statistical Parameter	Value (°C)
Minimum	11.5
Maximum	16.0
1st Quartile	11.9
3rd Quartile	15.1
Median	13.5
Mean	13.6

Figure 28: Boxplot of the fermentation temperatures of the wines included in the study.



There are producers who claim that a fermentation temperature shock regime causes yeasts to produce more ester compounds that improve the overall quality of Chenin blanc wines. The regime consists of lowering the fermentation temperature three times during the duration of the fermentation and allowing it to return to a normal white wine fermentation temperature. The impact of this practice on the quality of Chenin blanc wines from South Africa needs to be investigated further.

It seems that a cool fermentation temperature is required for the production of quality tank fermented Chenin blanc wines. The barrel fermented wines seem to be capable of producing quality wines at both cold (11°C) and warmer (28°C) fermentation temperatures indicating that fermentation temperature may be more important in determining wine style rather than wine quality. It needs to be stated that most of the producers that have cooling facilities available to cool oak barrels make use of it. Studies on the effect of fermentation temperature on Chenin blanc wine quality in the past focussed on unwooded wines and it may be necessary to also investigate the effect of fermentation temperature on the quality of barrel fermented wines.

Oak maturation

During the initial inspection of the best performing South African Chenin blanc wines at various recognised wine competitions, it was found that wooded examples of the grape achieved higher ratings in general compared to unwooded examples. For instance, only one of the fourteen top performing wines at the 2007 Wine Magazine Chenin blanc Challenge did not receive any wood contact. A possible explanation for this observation could be that due its relative neutrality, Chenin blanc wines depend on both the oxidative character that develops and the aromatic oak compounds extracted during barrel fermentation to enhance its complexity. Some of the producers agree that oak maturation enhances the quality of Chenin blanc. Other producers feel that the more likely explanation for the observation is that only the best Chenin blanc vineyards are selected for barrel maturation. Thus the causative factor for the better quality of many of the wooded Chenin blanc wines compared to unwooded wines is not necessarily the oak itself but the better quality of the grapes used to make the wooded wines.

Five of the barrel fermented Chenin blanc wines included in the study also contain a portion of unwooded wine that varies between 5% to 25% of the total volume. Three of the unwooded Chenin blanc wines included in the study contain a portion of wooded wine that varies between 10% to 20% of the total volume.

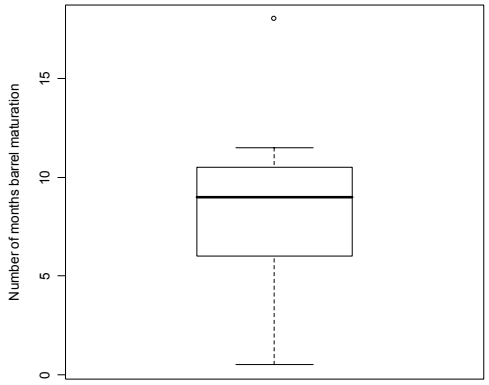
The numbers of months that the barrel fermented portions spend in oak varies from a few weeks to 18 months with a median of nine months. One of the lightly wooded wines only contains a portion of wine that was only fermented in the barrels.

The following is a summary of the barrel maturation period of the wines included in the study.

Table 18: Summary of the barrel maturation period of the wines included in the study.

Statistical Parameter	Value (months)
Minimum	0.5
Maximum	18.0
1st Quartile	6.5
3rd Quartile	10.3
Median	9.0
Mean	8.5

Figure 29: Boxplot of the barrel maturation period of the wines included in the study.



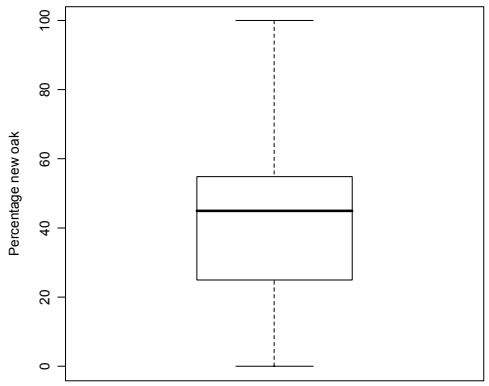
The percentage of new oak used in the oak matured portions of wine varies from 0% to 100% with a median of 45%.

The following is a summary of the percentage of new oak barrels used to mature the barrel fermented portions of wine.

Table 19: Summary of the percentage of new oak barrels used to mature the wines included in the study.

Statistical Parameter	Value
Minimum	0.0%
Maximum	100.0%
1st Quartile	27.5%
3rd Quartile	52.5%
Median	45.0%
Mean	43.8%

Figure 30: Boxplot of the percentage of new oak barrels used to mature the wines included in the study.



The origin of the oak matured portions for the wines included in the study is French (84%), Hungarian (13%) and American (3%).

Malolactic fermentation

Only one of the wines included in the study contains a portion of the wine that undergoes malolactic fermentation. Not one of the unwooded or slightly wooded wines included in the study undergoes malolactic fermentation. The majority if the producers are of the opinion that it is critical for the production of quality Chenin blanc wine to discourage the process.

Producers indicated that they do not allow malolactic fermentation in an effort to preserve the fruit and the fresh character of the wine. The producer that allows malolactic fermentation only allows a portion of the wine to undergo the process in an attempt to produce a wine that is distinguishable from Chardonnay. This producer is of the opinion that malolactic fermentation improves the palate and contributes to the complexity of the wine.

It seems that quality Chenin blanc wine is generally made in South Africa without undergoing malolactic fermentation. The finding that one of the top quality barrel fermented Chenin blanc wines in South Africa contains a portion of wine that underwent malolactic fermentation may provide motivation for more producers to experiment with the process. There do seem to be good reasons to only allow a portion of the wine to

undergo the process. Unfortunately the inclusion of a percentage of wine that contains malolactic fermentation bacteria to a wine that did not undergo the process renders it more susceptible to spoilage and it could necessitate greater clarification and manipulation that could negatively affect wine quality. Additional knowledge is required about the exact effect of malolactic fermentation on the quality and characteristics of barrel fermented Chenin blanc wines from South Africa.

Extended lees maturation

Every single wine included in the study underwent extended less maturation. Almost all of the producers surveyed in this study maintain that lees maturation is very important for the production of quality Chenin blanc wines in South Africa. This observation reaffirmed research by Marais and Jolly (2005).

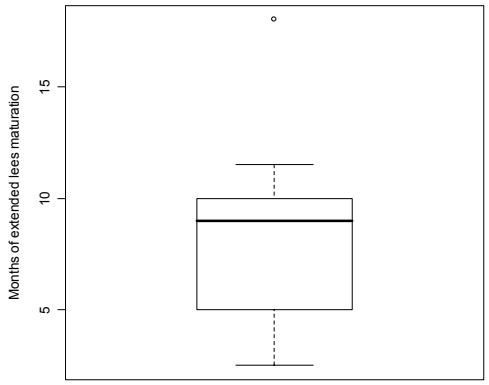
The duration of the extended lees maturation for the wooded wines usually corresponded with the barrel maturation period. There appears to be a tendency among the producers of the unwooded wines to aim for the longest possible extended lees maturation time.

The following is a summary of the duration of lees maturation of the wines included in the study.

Table 20: Summary of the duration of the extended lees contact of the wines included in the study.

Statistical Parameter	Value (months)
Minimum	2.5
Maximum	18.0
1st Quartile	5.0
3rd Quartile	10.0
Median	9.0
Mean	8.1

Figure 31: Boxplot of the duration of the extended lees contact of the wines included in the study.



Yeast manipulation practices to prevent the development reductive aromas differed. A number of producers follow a *battonage* regime whereby lees are stirred every two weeks for an initial period progressing to a monthly stirring of the lees. Other producers do not wish to expose the wine in the barrel to oxygen and preferred to roll the barrels in order to achieve blending of the wine and lees. The rolling of barrels was particularly important for the producers of unwooded Chenin blanc wines who blend in a portion of barrel fermented wine. Many of the producers of wooded wines say that the development of reductive aromas in barrels is a rare occurrence. There are producers who are not even particularly concerned about the development of a slight reductive character and claims that it adds to the uniqueness of their wine.

A number of producers of unwooded wines prefer to age the wine on its gross lees and not on its fine lees. They are not particularly concerned about the development of reductive aromas. These producers generally evaluate the wines on a regular basis to check for the formation of undesirable sulphur odours in which case they would circulate the wine in the tank in an attempt to dissipate any reductive characters.

Not one producer included in the study makes use of commercial enzymes to accelerate yeast cell autolysis on a regular basis. Some producers claim to have experimented with these enzymes but found that it did not measurably improve the quality of the wine.

It seems that extended lees contact is critically important for the production of quality Chenin blanc wine in South Africa.

Blending of Chenin blanc with other varieties

Many producers of the wines included in the study are of the opinion that blending in wine made from another variety is not very important for the production of quality Chenin blanc wines in South Africa. Producers who blend in a percentage of another grape variety into their Chenin blanc wine feel that it increases flavour subtlety and complexity. 40% of the wines included in the study contains a percentage of another grape variety. These producers feel that the aromas found in wine made from other varieties add an extra dimension to Chenin blanc and improve its quality.

Varieties blended into the wines included in the study include Viognier, Sauvignon blanc and Colombar. The portions varied from 1% or 2% up to 5% of the total wine volume. Viognier contributes a floral character and Sauvignon blanc increase the freshness of Chenin blanc. Some producers occasionally add the spend lees of Sauvignon blanc wine to Chenin blanc. Early picked, cold fermented Colombar produce a wine low in alcohol, high in acid and rich in the guava character and is said to contribute to the complexity and freshness of unwooded Chenin blanc.

No published research was found that investigated the effect on wine quality of blending another variety into a Chenin blanc wine. Research to establish which grape varieties best enhance the quality of Chenin blanc should be vary valuable to the South African wine industry.

Post-fermentation fining agents

The producers of the wines included in the study in general do not prefer to add fining agents to Chenin blanc wines, except for the addition of bentonite to ensure protein stability. However producers also recognised the need to sometimes make use of fining agents to correct wine faults if they occurred.

Post-fermentation fining agents (except bentonite) used in the wines included in the study are as follows:

- PVPP prior to bottling if it is indicated by a positive pinking test result. Producers who allow a degree of juice oxidation prior to fermentation claimed that pinking was very rarely an issue,
- either milk, casein or PVPP to remove hints of brown and prevent oxidative browning,
- PVPP to remove any harsh oak phenolics,
- gelatine to ensure compact lees,
- isinglass to improve the brilliance of the wine.

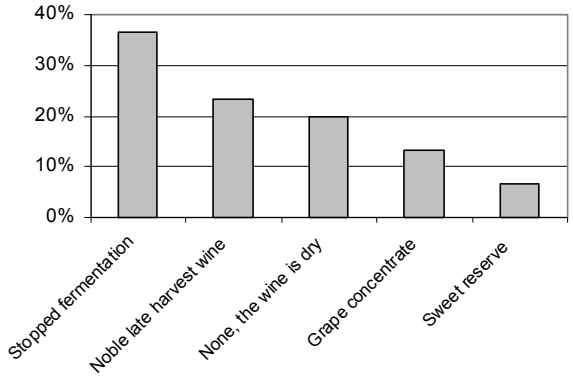
Seven of the wines included in the study do not contain any post-fermentation fining agents (except bentonite). These producers are of the opinion that fining agents cannot correct deficiencies present in the wine and that any additional treatment negatively influence the quality of the wine.

The study contains both wines that did receive a fining after fermentation as well as wines that did not receive any fining agents after fermentation (except bentonite) possibly indicating that the addition of post-fermentation fining agents is neither critical nor excessively detrimental to Chenin blanc wine quality. The addition of post-fermentation fining agents is another practice where there are strong and divergent opinions regarding the benefits and disadvantages thereof.

Residual sugar adjustments

The adjustment of residual sugar is considered to be important by the majority of the producers of the wines included in the study. Many of the wines included in the study have slightly elevated levels of residual sugar. The mean value of the residual sugar level is 5.9 g/l and 50% have a residual sugar level of between 3.4 g/l and 8.1 g/l. For a summary of the method of residual sugar adjustments by producers of the wines included in the study see figure 32.

Figure 32: Methods used to adjust the residual sugar level in the wine included in the study.



The majority of the producers of the wines included in the study preferred to regulate the residual sugar levels of the wine by arresting fermentation. Producers that make unwooded tank fermented wine have the possibility of arresting fermentation by cooling the juice and racking the wine of its lees to achieve the desired residual sugar. Producers of barrel fermented wines, especially where natural fermentations are used, often have a few barrels with incomplete fermentations. Some of the producers feel that the high levels of ripeness of the grapes of especially the riper wooded style of Chenin blanc predisposes the wine to a high alcohol level and consequently to stuck fermentations. The inclusion of these sweeter barrels into the final blend can be used to adjust the residual sugar of the wine.

Approximately a quarter of the producers of the wines included in the study make a batch of Chenin blanc noble late harvest wine that they use to adjust the residual sugar of the wine prior to bottling. Some producers also feel that the high level of acidity of the noble late harvest wines complements Chenin blanc and adds to its quality.

Other methods of sweetening used by the producers of the wines included in the study are the addition of grape concentrate and sweet reserve.

The majority of the producers of the wines included in the study adjust the residual sugar of their wines and are of the opinion that residual sugar adjustments are important for the production of quality Chenin blanc wines. This suggests that a slightly elevated level of residual sugar can possibly improve the quality of Chenin blanc wine from South Africa. But the residual sugar of approximately 20% of the wines included in the study is not adjusted. This seems to indicate that residual sugar is not absolutely critical for the production of quality Chenin blanc wines and could possibly only be important with regard to the style of the wine.

Filtration

All of the wines included in the study are filtered. Some of the producers have experimented with unfiltered wines but encountered microbial stability problems. Producers generally regard filtration to be important for the production of quality Chenin blanc wines although many attempt to minimise the number of times that the wines are filtered.

Of the wines included in the study, two wines are filtered three times, nine wines are filtered twice and four wines are only filtered once.

Most of the producers are of the opinion that the elevated level of residual sugar in many of the modern Chenin blanc wines make them susceptible to microbial instability and therefore it is important to ensure very low levels of microbes in the wine at the time of bottling. Some producers claim that although filtration may be detrimental to the quality of the wine immediately after the procedure it is more beneficial for the quality if the wine over a longer period.

The high incidence of filtration as well as an indication by the producers of the wines that filtration ensures the quality of the wines seem to indicate that the practice is important, especially for wine that contains elevated levels of residual sugar.

Maturation

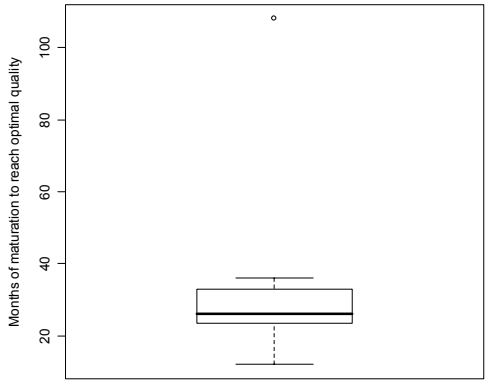
Producers of the wines included in the study generally regard some degree of maturation to be important for the quality of Chenin blanc wines. The producers were asked how many months of maturation after harvest is necessary for their wines to reach optimum quality. Although the opinions of the producers are likely to be very subjective it is still useful to get some indication of the aging ability of the top Chenin blanc wines from South Africa.

The following is a summary of the number of months of maturation that the producers feel is necessary for the wines to reach optimal quality.

Table 21: Summary of the number of months of maturation after harvest that the producers feel is necessary for the wines to reach optimal quality.

Statistical Parameter	Value (months)
Minimum	12.0
Maximum	108.0
1st Quartile	23.5
3rd Quartile	33.0
Median	26.0
Mean	31.3

Figure 33: Boxplot of the number of months of maturation after harvest that the producers feel is necessary for the wines to reach optimal quality.



Most of the producers are of the opinion that Chenin blanc wines that only rely on the esters and guava character produced during fermentation do not age beyond one year. These are usually wines made from early picked grapes with alcohol levels around 12.5%. A few producers are of the opinion that it is the noble late harvest and barrel fermented components of the wines that contribute the most after two to three years after which proper bottle maturation characters start to develop.

Some of the producers highlighted the following practices that may improve the aging ability of Chenin blanc:

- Wine made in a more oxidative style is more stable and age better than wines made highly reductively
- Extended lees contact that contributes to the amino acid concentration of the wine
- Inclusion of a portion of botrytis cinerea infected grapes or wine
- Inclusion of a portion of raisined grapes
- Increasing the residual sugar level

It seems that the quality of Chenin blanc from South Africa does benefit from some degree of maturation. The majority of the producers of the wines included in the study do believe that Chenin blanc can age and improve with time.

Conclusion

With regards to oenological practices of the selection of top quality Chenin blanc producers included in the study, the following practices seem to be regarded as most important for the production of quality Chenin blanc wines: extended less contact, bottle ageing, low juice retrieval rates, clarity of the juice prior to fermentation, crushing of cool grapes and the choice of yeast strain.

For a high-level summary of the findings in the previous paragraphs with regards to viticultural practices, see table 22 below.

Table 22: High-level summary of findings related to oenological practices of the wines included in the study.

Oenology	High-level Analysis of Parameter	Relative Importance of Parameter for Quality According to Wine Producers
Grape temperature before crushing	80% made from cool grapes	Very Important / Important
Acid additions	Mean of 7.63 g/l	Fairly Important
Juice retrieval rate	Mean of 602.9 litres per ton of grapes (mainly free run and lightly pressed juice)	Very Important / Important
Skin contact	67% received no deliberate extended skin contact	Fairly Important
Oxidation of juice	53% undergo some oxidation and 47% are made reductively	Fairly Important
Settling	43% made from brilliant juice to which some fine lees have been added	Very Important / Important
Pre-fermentation fining agents	Varied, preferred not to use fining agents	Unimportant
Yeast nutrition	100%	Important
Yeast strain	39% undergo spontaneous fermentations	Very Important / Important
Fermentation temperature	Mean of 21.9°C for wooded portions and 13.9°C for unwooded portions	Important
Barrel maturation	Use mainly France oak, median of 45% new oak, median of nine months in barrel	Stylistic decision
Extended lees maturation	Median of nine months	Very Important
Malolactic fermentation	Very low incidence	Unimportant
Blending of Chenin blanc with other varieties	40% is blended with another variety	Unimportant
Post-fermentation fining agents	Varied, preferred not to use fining agents	Fairly Important
Residual sugar adjustments	Mean value of 5.9 g/l	Important
Filtration	All of the wines are filtered	Important
Maturation	Median value of 26 months	Very Important

4.2.4 CHEMICAL COMPOSITION

The summary of the chemical analysis of the wines relate to wines from the 2006 vintage, although the data of three of the wines are from the 2005 vintage.

This summary gives an indication of the values of the most important chemical parameters of a sample of top quality Chenin blanc wines from South Africa. The selection of the sample of wines that were studied was not random and therefore care needs to be taken with generalisations to the population of all the top quality Chenin blanc wines in South Africa.

The chemical analysis of the wooded wines differed from that of the unwooded and lightly wooded wines. The alcohol, residual sugar, sugar free extract and the total acid of the wooded wines tend to have higher values compared to the unwooded and lightly wooded wines. It is interesting to note that the wooded wines tended to be sweeter with higher levels of acidity compared to the unwooded and lightly wooded wines. The higher alcohol and sugar free extract levels are expected due to the riper picked grapes and the contribution of oak to extraction levels.

The pH and volatile acid of the wooded wine tended to have lower values compared to the unwooded and lightly wooded wines. Both the higher pH and slightly higher volatile acid levels in unwooded wines are unexpected and need to be investigated further before any definite conclusions can be made.

The total SO_2 levels are slightly higher in the wooded wines and the free SO_2 levels are higher in the unwooded and lightly wooded wines. These values are expected due to the higher rate of oxidation of wines matured in barrels.

The chemical analysis of the sample of top quality Chenin blanc wines is summarised to provide other South African Chenin blanc producers a general indication of the parameters which to strive for in order to produce good quality Chenin blanc wines. For a five-number summary of the chemical analysis data of the wines included in the study see table 23. For boxplots of the alcohol, total acid, pH, residual sugar, volatile acid, sugar free extract, total SO_2 and free SO_2 levels of the wines included in the study see figures 34 – 41.

Table 23: Five-number summary of the chemical analysis data of the wines included in the study.

	Minimum	Maximum	1st Quartile	3rd Quartile	Median	Mean
Alcohol (volume %)						
Wooded	13.32	14.80	14.00	14.56	14.37	14.19
Unwooded and lightly wooded	13.41	14.56	13.57	14.11	13.82	13.89
Total acid (g/l tartaric)						
Wooded	5.40	7.40	6.25	7.00	6.62	6.56
Unwooded and lightly wooded	5.45	6.70	5.97	6.58	6.30	6.21
pH						
Wooded	2.97	3.53	3.23	3.37	3.27	3.29
Unwooded and lightly wooded	3.14	3.65	3.37	3.53	3.46	3.43
Residual sugar (g/l)						
Wooded	2.84	11.70	4.60	10.33	7.00	7.13
Unwooded and lightly wooded	2.20	8.10	3.50	5.28	4.50	4.67
Volatile acid (g/l)						
Wooded	0.33	0.65	0.47	0.59	0.56	0.52
Unwooded and lightly wooded	0.45	0.72	0.49	0.67	0.56	0.58
Sugar free extract (g/l)						
Wooded	18.14	25.40	20.29	23.68	22.05	21.91
Unwooded and lightly wooded	19.10	25.20	19.57	23.08	20.80	21.48
Total SO_2 (mg/l)						
Wooded	118.00	140.00	121.00	132.80	125.00	127.20
Unwooded and lightly wooded	96.00	148.00	113.20	134.80	121.00	122.70
Free SO_2 (mg/l)						
Wooded	27.00	47.00	30.50	41.50	33.00	35.67
Unwooded and lightly wooded	30.00	64.00	39.50	49.75	48.00	46.17

* The volatile acidity data of four wines, sugar free extract data of five wines and total and free SO_2 data of three wines were not available.

Figure 34: Alcohol of the wines included in the study.

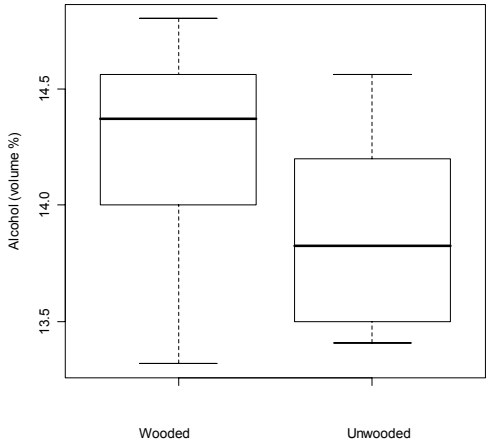


Figure 35: Total acid of the wines included in the study.

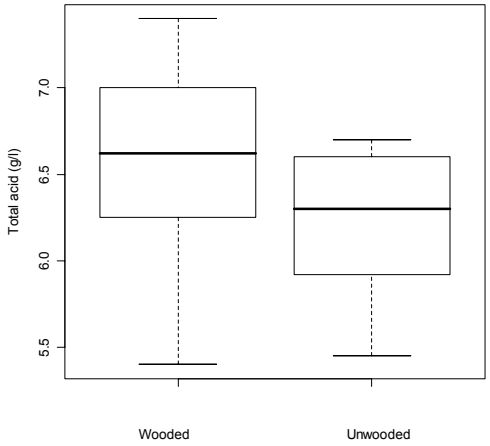


Figure 36: pH of the wines included in the study.

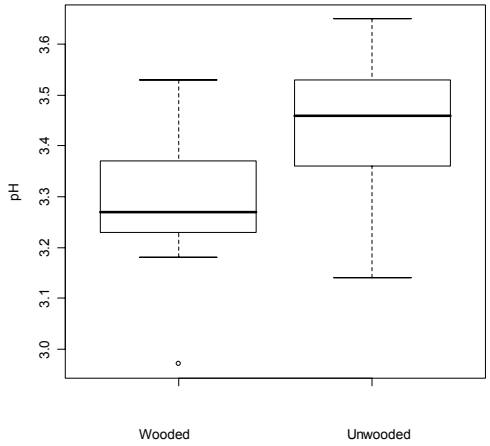


Figure 37: Residual sugar of the wines included in the study.

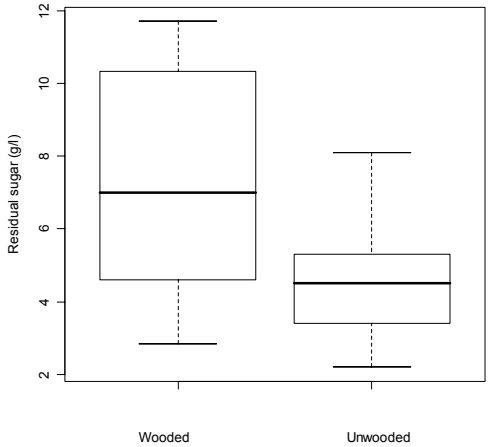


Figure 38: Volatile acid of the wines included in the study.

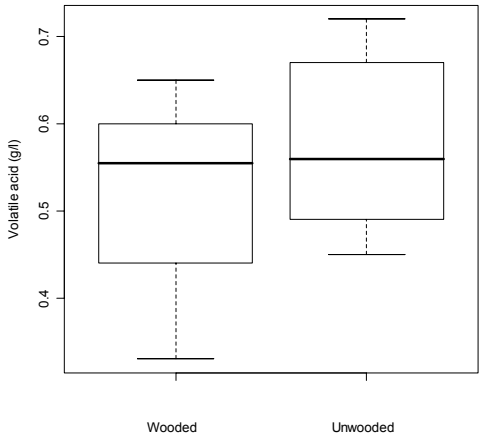


Figure 39: Sugar free extract of the wines included in the study.

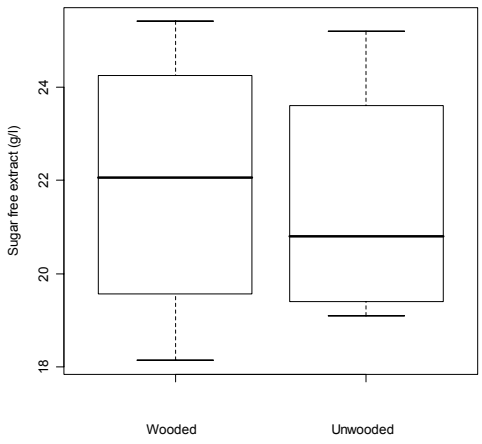


Figure 40: Total SO_2 of the wines included in the study.

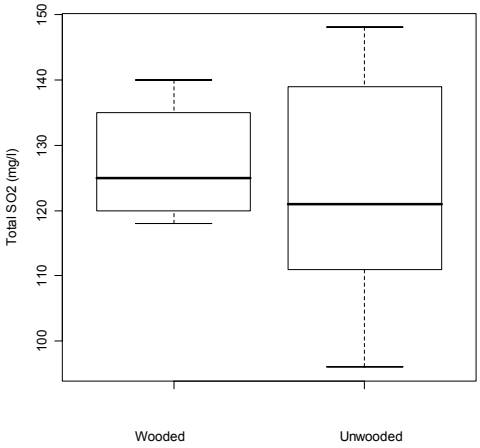
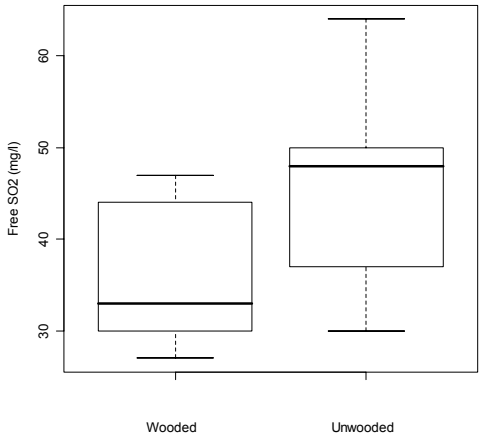


Figure 41: Free SO_2 of the wines included in the study.



4.2.5 GENERAL

Increase in the quality of Chenin blanc wines from South Africa

The producers of the wines included in the study were asked to comment on the factors that contributed to the steady increase in the quality of Chenin blanc table wines in South Africa over the past two decades.

There are some producers who feel that when South Africa was reintroduced into the international community in the early 1990's the international wine market valued a unique wine from South Africa. Chenin blanc represented South Africa's unique selling point because the country is the biggest producer of the variety in the world

There was a realisation in the middle 1990's that Chenin blanc produce better quality wine when it is harvested riper. During the 1992/3 harvest a few riper styled wines emerged that provided evidence that ripe grapes have more potential than the fresh and green style of Chenin blanc wines that were made prior to that time.

Many winemakers became aware of the quality of the grapes produced by especially very old Chenin blanc bush vines and realised that many of these grapes get blended away in large batches of bulk wines. Producers of top Chenin blanc wine started to focus on implementing better vineyard practices and lowered the yields in an effort to improve grape quality. Some winemakers started to specialise in Chenin blanc and concentrated their winemaking efforts to produce the best possible quality Chenin blanc wine.

Other factors that contributed to the improvement of the quality of Chenin blanc wines cited include the wider use of barrel fermentation and aging of Chenin blanc wines, the advent and the wider use of cold fermentation allowed more controlled fermentations and a better understanding of the consequences of residual sugar adjustments.

Producers seem to think that there were a number of factors that interacted to contribute to the steady increase in the quality of Chenin blanc wine over the past two decades. Many of these factors are possibly still relevant today and will hopefully continue to enhance the quality of Chenin blanc wines in South Africa

Regional characteristics

This section will look into the differences of the sensory characteristics of Chenin blanc wines between different wine producing regions in South Africa. It represents a summary of the data collected when the respondents were asked how the Chenin blanc wines from their region differ from Chenin blanc wines from other regions in South Africa.

It is however important to note that this section does not attempt to make generalised statements about the analytical analysis of Chenin blanc wines from different regions as this is known to be influenced more by winemaking techniques than by environmental influences (Guinart and Cliff, 1987).

Most of the respondents have strong opinions about the merits of Chenin blanc wines produced from the various regions and none of the respondents hesitated in describing their views of the characteristics of the wines of various origins. This seems to indicate that strong regional characteristics and styles certainly exist.

A number of respondents feel that wines that originate from the coastal region are generally produced from lower yielding vineyards which results in more complexity compared to wines originating from the irrigated regions further inland.

Respondents are of the opinion that Chenin blanc wines from especially the cooler coastal wards can display hints of mineral character typical of classic Loire examples.

Chenin blanc wines from Stellenbosch are often characterised by the presence of a botrytis character as well as honey – indicative of a very ripe style of wine. Other aromas that prevail in Stellenbosch Chenin blanc wines include guava, melon and papaya. These Chenin blanc wines tend to have more finesse than those from warmer regions. There are respondents who feel that the Stellenbosch area produces distinctly better Chenin blanc wines compared to cooler wards, like for instance Constantia and Elgin, because the variety is so well suited to warmer growing conditions.

Respondents feel that Chenin blanc wines from Paarl are characterised by its good quality and intensity. Aromas tend to be ripe with passion fruit which is cited as a characteristic with high discriminatory value for wines from this region.

Respondents commented that Chenin blanc wines from Tulbagh are characterised by very ripe aromas on the palate, particularly dried apricot, with a fuller mouthfeel compared to wine from other regions.

Chenin blanc wines from the Cederberg is considered to be characterised by a stronger presence of citrus and lime characters. Chenin blanc wines from this ward tend to have clean and distinct aromas.

There is a general feeling that the warmer inland irrigated wine producing regions tend to produce more fresh and fruity styled Chenin blanc wines. Explanations cited include the generally high yields of inland areas that result in the delayed ripening of grapes. This increases the likelihood that grapes will start to rot and forces the grape grower to pick before the grapes are optimally ripe.

Wines from the warmer inland irrigated wine producing regions are typified by a heavy reliance on the esters produced during fermentation for character and they do not age much longer than a couple of months in the bottle. One respondent coined the term “flowery” for Chenin blanc wines made from these high yielding vineyards. A number of respondents feel that the wines from these regions are comparatively thin, with less concentration compared to wines from the coastal region. These comments are justified by work done by Rankine, Fornachon, Boehm and Cellier (1971) who suggested that wines from warmer irrigated regions are

generally of a somewhat lower quality than those made from grapes of the same variety grown without irrigation in a cooler region.

From the above discussion it does seem that there are distinguishable features between Chenin blanc wines originating from different wine producing regions in South Africa although the extent to which they are always significant has not been established. The established concept of the Wine of Origin system as well as renewed interest in the response of the vine to natural terroir units (Carey, Archer, Saayman, 2002) will hopefully ensure that wines from different regions remain distinguishable from one another rather than moving towards a universal style of Chenin blanc wine.

Price point to style

Producers feel that lower priced Chenin blanc wines often lack the specific cultivar characteristics and rely heavily on fermentation esters. These wines tend not to age well beyond eight to twelve months. The South African entry level Chenin blanc market accepts a crisp and flowery wine style while the export entry level Chenin blanc market prefers a more fruit driven wine style. The sugar free extract levels for less expensive Chenin blanc wine tend to be less than 18 g/l.

Premium wines have more concentrated flavours, a fuller mouthfeel, balance, a long mid-palate and longevity. More expensive Chenin blanc wines often contain a portion of barrel fermented wine. The sugar free extract levels for more expensive Chenin blanc wine tend to be more than 20 g/l.

A theme that came up during many interviews was that producers felt that Chenin blanc offered more quality at specific price points compared to any other white cultivar wine made in South Africa.

The economic future of Chenin blanc

The majority of the producers that were interviewed are of the opinion that the number of hectares of Chenin blanc in South Africa will increase into the future or at least stabilise. There are producers who are of the opinion that the uprooting of Chenin blanc vineyards will continue due to the poor quality of many of the vineyards although there could be an increase in the planting of Chenin blanc vineyards aimed at premium quality grapes.

There are producers who feel that it is becoming too uneconomical to produce Chenin blanc because of the low price of the wines and they cannot see the hectares increasing in the near future. On the other hand a few of the smaller producers of Chenin blanc wines included in the study have currently established additional vineyards.

Some of the producers feel that the global wine market is saturated with wines made from popular grape varieties like for instance Cabernet Sauvignon, Shiraz and Chardonnay. They feel that the demand for wines made from more unique grape varieties considered most suitable for a specific wine producing area will experience an increase in demand in the future. For South Africa this includes Chenin blanc and Pinotage wines. Although the Loire is considered to be the historic home of Chenin blanc wines, the area does not market its wines as Chenin blanc but as for instance Vouvray AOC or Savennières AOC.

There are producers who claim that the price of Chenin blanc will depend on the quality of the wines and the price will only increase if the general quality of Chenin blanc wines increase. Some producers are of the opinion that the current uprooting of Chenin blanc vineyards will limit the supply of the grape into the future and ultimately cause the price to increase.

There are producers who feel that because of Chenin blanc's dominance of a number of high quality and lower price market segments in Europe it will continue to be a very important variety for the South African wine industry. Other producers feel that the versatility of Chenin blanc will ensure that it remains an important variety in South Africa.

4.3 CONCLUSION OF THE ANALYSIS OF RESULTS

This study clearly indicates that there are numerous factors that ultimately determine the quality of wines. Although the study attempted to investigate all of the important factors that influence wine quality it is likely that there are factors that influence wine quality that we are not yet aware of.

There is often disagreement as to what practice actually ensure the best quality wines like for instance with regard to the method of trellising and the application of extended skin contact. Producers also varied considerable as to the amount of juice oxidation they allow prior to fermentation. It would seem that these practices possibly influence the style of the wine more than it does the quality thereof.

The study found that although some practices have a high incidence in the sample of quality Chenin blanc wines that were studied, like for instance the fact that the majority of the wines originate from older vineyards as well as the high incidence of botrytis cinerea infection, it is still possible to produce quality wines in the absence of that specific factor. This indicates that the factor is possibly not a strong causative factor for the production of quality wine and therefore not absolutely critical.

The more important factors identified to improve the quality of Chenin blanc wine in South Africa include the use of extended lees contact, low yields, harvesting grapes at optimal ripeness, practicing canopy management and supplementary irrigation.

No data was collected regarding the personality traits of the winemakers producing the wines included in the study. It became apparent however, that a common characteristic of the respondents is that they make a conscious effort to ensure that every viticultural and oenological practice followed contribute to the superiority of the end product. It seems therefore that a dedicated winemaker is a prerequisite for the production of quality Chenin blanc wine in South Africa.

5. CONCLUSION

South Africa is a major producer of Chenin blanc wines and an improvement in the overall quality of all Chenin blanc wines in South Africa could result in a valuable intangible asset for the South African wine industry.

South African Chenin blanc recently made a great amount of progress that saw the workhorse variety of the industry emerge to be recognised internationally as a world class table wine.

The literature study revealed a large number of factors that can influence the quality of wine in general and Chenin blanc specifically. The quality of the wine was shown to involve a complex interaction of natural, viticultural and oenological factors.

The area from where the grapes originate proved to be the most critical terroir aspect for the production of quality Chenin blanc wines in South Africa. There is a very high incidence of coastal area wines.

Low yields, harvesting at the correct level of ripeness and intensive canopy management proved to be the most critical viticultural aspects for the production of quality Chenin blanc wines in South Africa.

Extended lees maturation was found to be the single most important oenological practice for the production of quality Chenin blanc wines in South Africa. The producers of top quality unwooded wines aimed for the longest possible extended lees maturation period.

The influence of some of the factors on the quality of Chenin blanc wine from South Africa remain unresolved like for instance the effect of the amount of sunlight exposure on bunches, deliberate extended skin contact, blending with other varieties and juice oxidation. Additional knowledge is required regarding the effect that these practices have on the quality of Chenin blanc wines in South Africa.

The study provided a summary of the chemical composition of the top quality Chenin blanc wines in South Africa that could be useful to both wine producers and wine tasters. The comparison of the chemical composition of wooded Chenin blanc wines with unwooded and lightly wooded wines showed a clear difference between the two wine styles.

Producers of Chenin blanc table wines in South Africa should focus on the important practices identified in this study to hopefully improve the quality of all wines made from the variety.

6. REFERENCES

Archer, E. 1981. Rypwording en oesmetodes, J. & Deist, J. ed. Wingerdbou in Suid-Afrika. Cape Town, SA: CTP Boekdrukkers, 463 – 476.

Archer, E. 2001a. Viticultural Progress in South Africa. Wynboer, July. Available from: <http://www.wynboer.co.za/recentarticles/0701progress.php3> [Accessed: June 2007]

Archer, E. 2001b. The relationship between vine training practices and grape quality. Wynboer Tegnies, August. Available from: <http://www.wynboer.co.za/recentarticles/0801vinetrain.php3> [Accessed: June 2007]

Asimov, E. 2007. South Africa's Trove of an Elusive Grape. New York Times, 7 March. Available from: <http://www.nytimes.com/2007/03/07/dining/reviews/07wine.html> [Accessed: June 2007]

Augustyn, O.P.H. and Rapp, A. 1982. Aroma components of Vitis vinifera L. cv. Chenin blanc grapes and their changes during maturation. South African journal of oenology and viticulture, Volume 3, number 2, 47 – 51.

Baumes, R.L. Bayonove, C.L., Barillère, J.M., Samson, A. and Cordonnier, R.E. 1989. La macération pelliculaire dans la vinification en blanc – Incidence sur la composante volatile des vins. Vitis 28, 31 – 48.

Bonnardot, V., Carey, V., Planchon, O. and Cautenet, S. 2001. Sea breeze mechanism and observations of its effects in the Stellenbosch wine producing area. Wynboer Tegnies, October. Available from: <http://www.wynboer.co.za/recentarticles/1001sea.php3> [Accessed: June 2007]

Budd, J. 2003. Loire Rendez-Vous lauds SA Chenin. Decanter. Available from: <http://www.decanter.com/news/46053.html> [Accessed: June 2007]

Carey, V.A., Archer, E., Saayman, D. 2002. Natural terroir units: What are they? How can they help the wine farmer? Wynboer Tegnies, February. Available from: <http://www.wynboer.co.za/recentarticles/0202terroir.php3> [Accessed: June 2007]

Carnacini, A., Amati, A., Capella, P., Casalini, A., Galassi, S. and Riponi. C. 1985. Influence of harvesting techniques, grape crushing and wine treatments on the volatile components of white wines. Vitis 24, 257 – 267.

Carstens, W.J., Burger, J.D. & Kriel, G.le R. 1981. Cultivarbeleid, cultivareienskappe en plantverbetering in Burger, J. & Deist, J. ed. Wingerdbou in Suid-Afrika. Cape Town, SA: CTP Boekdrukkers, 67 – 120.

Chatonnet, P., Dubourdieu, D. and Boidron, J.N. 1991. Effect of fermentation and maturation in oak barrels on the composition and quality of white wines. Australian and New Zealand wine industry journal, February, 73 – 84.

Chenin blanc Association. c2004. Available from: <http://www.chenin.co.za> [Accessed: June 2007]

Conradie, W.J. 1980. Seasonal uptake of nutrients by Chenin blanc in sand culture. South African journal of oenology and viticulture, Volume 1, number 1, 59 – 65.

Conradie, W.J. and Saayman, D. 1989a. Effects of long-term nitrogen, phosphorus and potassium fertilization on Chenin blanc vines. I. Nutrient demand and vine performance. American journal of oenology and viticulture, Volume 40, number 2, 85 – 90.

Conradie, W.J. and Saayman, D. 1989b. Effects of long-term nitrogen, phosphorus and potassium fertilization on Chenin blanc vines. II. Leaf analysis and grape composition. American journal of oenology and viticulture, Volume 40, number 2, 91 – 98.

Cootes, R.L., Wall, P.J. and Nettlebeck, R.J. 1982. Grape quality assessment, Yalumba Wines, PO Box 10, Angaston, South Australia 5353, 39 - 56.

Davis, C.R., Wibowo, D., Eschenbruch, R., Lee, T.H and Fleet, G.H. 1985. Practical implications of malolactic fermentation: A review. American journal of oenology and viticulture, Volume 36, number 4, 290 – 301.

Dry, P.R. and Botting, D.G. 1993. The effect of wind on the performance of Cabernet Franc grapevines. I. Shoot growth and fruit yield components. Australian and New Zealand wine industry journal, November, 347 – 352.

Du Plessis, C.S. and van Rooyen, P.C. 1982. Grape maturity and wine equality. South African journal of oenology and viticulture, Volume 3, number 2, 41 – 45.

Dunn, G.M., Martin, S.R., Whiting, J.R., Krstic, M.P. and Clingeleffer, P.R.. 2001. Yield targets: how do we hit them and how important are they? In: Blair, R.J., Williams, P.J. and Høj, P.B. ed. Proceedings of the eleventh Australian wine industry technical conference, October 2001, Adelaide, 61 – 67.

Eedes, C. 2007. FNB Private Clients Wine Magazine Chenin Blanc Challenge. Wine Magazine. Available from: <http://www.winemag.co.za/content/online/ratings/singlepage.asp?in=1011> [Accessed: June 2007]

Ellis, L.P., van Rooyen, P.C. and du Plessis, C.S. 1985. Interactions between grape maturity indices and the quality and composition of Chenin blanc and Colombar wines from different localities. South African journal of oenology and viticulture, Volume 6, number 2, 45 – 50.

Ferreira, J.H.S. & Marais, P.G. 1987. Effect of rootstock cultivar, pruning method and crop load on Botrytis cinerea rot of Vitis vinifera cv. Chenin blanc grapes. South African journal of oenology and viticulture, Volume 8, number 2, 41 – 44.

Francis, I.L., Høj, P.B., Dambergs, R.G., Gishen, M., Lopes, M.A.de B., Pretorius, I.S., Godden, P.W., Henschke, P.A., Herderich, M.J. and Waters, E.J. 2004. Objective measures of grape quality – are they achievable. In: Blair, R.J., Williams, P.J. and Pretorius, I.S. ed. Proceedings of the twelfth Australian wine industry technical conference, July 2004, Melbourne, 85 – 89.

Francis, I.L., Iland, P.G., Cynkar, W.U., Kwiatkowski, M., Williams, P.J., Armstrong, H., Botting, D.G., Gawel, R. and Ryan, C. 1998. Assessing wine quality with G-G assay. In: Blair, R.J., Sas, A.N., Hayes, P.F. and Høj, P.B. ed. Proceedings of the tenth Australian wine industry technical conference, August 1998, Sydney, 104 – 108.

Fridjhon, M. 2006. Which has achieved more – Pinotage or Chenin blanc? In Wine Magazine, December.

Friedrich, J. 1996. The wine and food guide to the Loire. New York: Henry Holt & Company.

Gishen, M., Iland, P.G., Dambergs, R.G., Esler, M.B., Francis, I.L., Kambouris, A., Johnstone, R.S. and Høj, P.B. 2001. Objective measures of grape and wine quality. In: Blair, R.J., Williams, P.J. and Høj, P.B. ed. Proceedings of the eleventh Australian wine industry technical conference, October 2001, Adelaide, 188 – 194.

Guinart, Z.X. and Cliff, M. 1987. Descriptive analysis of Pinot noir wines from Carneros, Napa and Sonoma. American journal of oenology and viticulture, Volume 38, 211 – 215.

Halliday, J and Johnson, H. 1992. The Art and Science of Wine. First edition. Great Britain: Mitchell Beazley.

Hands, P. and Hughes, D. 2001. New world of wine from the Cape of Good Hope. Somerset West, SA: Stephen Phillips.

Henick-Kling, T., Acree, T., Gavitt, B.K., Krieger, S.A. and Laurent, M.H. 1992. Sensory aspects of malolactic fermentation. In: Stockley, C.S., Johnstone, R.S., Leske, P.A. and Lee, T.H. ed. Proceedings of the eighth Australian wine industry technical conference, October 1992, Melbourne, 148 – 152.

Houtman, A.C. and du Plessis, C.S. 1986. The effect of grape cultivar and yeast strain on fermentation rate and concentration of volatile components in wine. South African journal of oenology and viticulture, Volume 7, number 1, 14 – 20.

Houtman, A.C., Marais, J. and du Plessis, C.S. 1980a. The possibilities of applying present-day knowledge of wine aroma components: Influence of several juice factors on fermentation rate and ester production during fermentation. South African journal of oenology and viticulture, Volume 1, number 1, 27 – 33.

Houtman, A.C., Marais, J and du Plessis, C.S. 1980b. Factors affecting the reproducibility of fermentation of grape juice and of the aroma composition of wines. I. Grape maturity, sugar, inoculum concentration, aeration, juice turbidity and ergosterol. Vitis 19, 37 – 54.

Heald, E. and Heald, R. 1991. Chenin blanc: Stylistic similarities. Practical winery and vineyard, January/February, 23 – 26.

Heald, E. and Heald, R. 1995. Yeast: should you inoculate. Practical winery and vineyard, May/June, 11 – 16.

Hunter, J.J. 1998. Plant spacing implications for grafted grapevine II. Soil, water, plant water relations, canopy physiology, vegetative and reproductive characteristics, grape composition, wine quality and labour input. South African journal of oenology and viticulture, Volume 19, number 2, 35 – 51.

Intrieri, C., Silvestroni, O., Rebucci, B., Poni, S. and Filippetti, I. 1997. How row orientation and trellising affect growth, yield, quality and dry matter partitioning in Chardonnay vines. Practical winery and vineyard, September/October, 7 – 9.

Jackson, R.S. 2000. Wine Science. Second edition. San Diego, California: Academic Press

Jefford, A. 2002. The New France. London: Mitchell Beazley.

Jolly, N.P., Augustuyn, O.P.H and Pretorius, I.S. 2003a. The effect of non-Saccharomyces yeast on fermentation and wine quality. South African journal of oenology and viticulture, Volume 24, number 2, 55 – 62.

Jolly, N.P., Augustuyn, O.P.H and Pretorius, I.S. 2003b. The use of Candida pulcherrima in combination with Saccharomyces cerevisiae for the production of Chenin blanc wine. South African journal of oenology and viticulture, Volume 24, number 2, 63 – 69.

Kench, J., Hands, P. & Hughes, D. 1983. The complete book of South African wine. Cape Town C. Struik Publishers.

Kriel, G.J.le R. And Visser, C.P. 1993. Die invloed van plantmateriaal op druifsamestelling en kwaliteit. Wynboer Tegnies, January, 12 – 14.

Lambrechts, M.G. and Pretorius, I.S. 2000. Yeast and its importance to wine aroma – a review. South African journal of oenology and viticulture, Volume 21, Special issue, 97 – 129.

Lourens, K. and Reid, G. 2002. Effect of fermentation and maturation in oak barrels on the composition and quality of white wines. Australian and New Zealand grapegrower and winemaker, Annual technical issue, 50 – 54.

Marais, J. 2003. Overview of Chenin blanc research. Wynboer, December. Available from: <http://www.wynboer.co.za/recentarticles/1203chenin.php3> [Accessed: June 2007]

Marais, J. 2005. Can the shelf life of Chenin blanc wine be enhanced. Wynboer Tegnies, October. Available from: <http://www.wynboer.co.za/recentarticles/200510-chenin.php3> [Accessed: June 2007]

Marais, J. and Jolly, N. 2005. Effect of yeast strain and lees contact on Chenin blanc wine quality. Wynboer Tegnies, September. Available from: <http://www.wynboer.co.za/recentarticles/200509yeast.php3> [Accessed: June 2007]

Marais, J. and October, F. 2005. Relationship between grape colour and wine quality. Wynboer Tegnies, July. Available from: <http://www.wynboer.co.za/recentarticles/200507colour.php3> [Accessed: June 2007]

Marais, J. and Pool, H.J. 1980. Effect of storage time and temperature on the volatile composition and quality of dry white table wines. Vitis 19, 151 – 164.

Marais, J. and Rapp, A. 1988. Effect of skin-contact time and temperature on juice and wine composition and wine quality. South African journal of oenology and viticulture, Volume 9, number 1, 22 – 30.

Marais, J., van Rooyen, P.C. and du Plessis, C.S. 1981. Classification of white cultivar wines by origin using volatile aroma components. South African journal of oenology and viticulture, Volume 1, number 2, 45 – 49.

Marais, J., van Schalkwyk, D. and October, F. 2005. Effect of berry size, sunlight exposure and ripeness on Chenin blanc wine quality. Wynboer Tegnies, August. Available from: <http://www.wynboer.co.za/recentarticles/200508berry.php3> [Accessed: June 2007]

Masuda, M., Okawa., E., Nishimura, K. and Yunome, H. 1984. Identification of 4,5-dimethyl-3-hydroxy-2(5H)-furanone (Sotolon) and ethyl 9-hydroxynonanote in botrytised wine and evolution of the roles and characteristics of it. Agricultural Biology and Chemistry. 48, 2707 – 2710.

Merret, F. 1997. Problems of judging wine quality. Australian and New Zealand wine industry journal, February, 79 – 82.

Mora, J. and Mulet, A. 1991. Effects of some treatments of grape juice on the population and growth of yeast species during fermentation. American journal of oenology and viticulture, Volume 42, number 2, 133 – 136.

Mullins, M.G. and Meredith, C.P. 2001. The nature of clonal variation in winegrapes: a review In: Blair, R.J., Williams, P.J. and Høj, P.B. ed. Proceedings of the eleventh Australian wine industry technical conference, October 2001, Adelaide, 79 – 82.

Myburgh, P.A. 2006. Juice and wine quality responses of Vitis vinifera L. cvs. Suavignon blanc and Chenin blanc to timing of irrigation during berry ripening in the coastal region of South Africa. South African journal of oenology and viticulture, Volume 27, number 1, 1 – 7.

Naude, F. 2007. Personal communication. Previous winemaker at L'Avenir, Wine Magazine Chenin blanc Challenge winner and current chairperson of the Chenin blanc association workgroup.

Orffer, C.J. 1979. Wine grape cultivars in South Africa. Cape Town: Human & Rousseau.

Patterson, T. 2006. Clarksburg: Chenin blanc makes a stand in the Delta. Vines and Wines, March, 22 – 27.

Pendock, N. (2007) Chenin calamities. Sunday Times, 7 February, 2008.

Penning-Rowsell, E. 1969. The wines of Bordeaux, London: The International wine and food society.

Peynaud, E. 1987. The taste of wine. 2nd edition. New York: John Wiley and Sons.

Pretorius, I.S., van der Westhuizen, T.J. and Augustyn, O.P.H. 1999. Yeast biodiversity in vineyards and wineries and its importance tot eh South African wine industry. South African journal of oenology and viticulture, Volume 22, number 2, 61 – 74.

Puig-Deu, M., López-Tamames, E., Buxaderas, S. and Torre-Boronat, M.C. 1996. Influence of must racking and fining procedures on the composition of white wine. Vitis 35, 141 – 145.

Raats, B. (2006) South Africa potential world leader in quality Chenin blanc production. Available from: http://www.wine.co.za/news/news.aspx?NEWSID=8852&Source=News [Accessed: June 2007]

Rankine, B.C. 1986. Nature, origin and prevention of hydrogen sulfide aroma in wine yeast. Journal of food science and agriculture 114, 79 – 91.

Rankine, B. 1989. Making good wine. Sydney, Australia: Pan Macmillan.

Reynolds, A.G., Edwards, C.G., Cliff, M.A., Thorngate, J.H. and Marr, J.C. 2001. Evaluation of yeast strains during fermentation of Riesling and Chenin blanc musts. American journal of oenology and viticulture, Volume 52, number 4, 336 – 344.

Rankine, B.C., Fornachon, J.C.M., Boehm, E.W. and Cellier, K.M. 1971. Influence of grape variety, climate and soil on grape composition and on the composition and quality of table wines. Vitis 10, 33 – 50.

Riberéau-Gayon, P., Glories, Y., Maujean, A. and Dubourdieu, D. 2000. Handbook of enology, Vol 2. Chichester: John Wiley and Sons.

Robinson, J. 1986. Vines, Grapes and Wines. Mitchell Beazley, Great Britain.

Robinson, J et al. 1994. Oxford Companion to Wine, Great Britain: Oxford University Press.

Robinson, J. 2003. The best Chenins in the world? JancisRobinson.com. Available from: <http://www.jancisrobinson.com/articles/winenews0706.html> [Accessed: June 2007]

Sadie, E. (2006) in White mischief. Wine Magazine, November 2006, 40-44.

Serrano, M. and Paetzold, M. 1994. Les acquisitions récentes dans les traitements physiques du vin. Ed Donèche, B. Tec. et doc. Paris: Lavoisier.

Schneider, V. 1998. Must hyperoxidation: A review. American journal of oenology and viticulture, Volume 49, number 1, 65 – 73.

Schuster, M. 2000. Essential winetasting. Great Britain: Mitchell Beazley.

Sims, C.A., Eastridge, J.S. and Bates, R.P. 1995. Changes in phenols, color, and sensory characteristics of Muscadine wines by pre- and post-fermentation additions of PVPP, casein and gelatine. American journal of oenology and viticulture, Volume 66, number 2, 155 – 158.

Singleton , VL & Ough, CS. 1962. Complexity of flavour and blending of wine, Journal of Food Science 12, 189-196.

Sinton, T.H., Ough, C.S., Kissler, J.J. and Kasimatis, A.N. 1978. Grape juice indicators for the prediction of potential wine quality. I. Relationship between crop level, juice and wine composition, and wine sensory ratings and scores. American journal of oenology and viticulture, Volume 29, 267 – 27.

Sivertsen, H.K., Dewey, F.M., and Heymann, H. 2005. Relationship between sensory descriptive analysis and levels of Botrytis antigens in dessert wines. American journal of oenology and viticulture, Volume 56, number 4, 330 – 335.

Smart. R.E. 1973. Sunlight interception by vineyards. American journal of oenology and viticulture, Volume 24, number 4, 141 – 147.

Smart, R. 1993. Vine age – Does it really affect wine quality? Practical winery and vineyard, July/August, 44 – 45.

Smart, R.E., Dick, J.K., Gravett, I.M and Fisher, B.M. 1990. Canopy management to improve grape yield and wine quality – principles and practices. South African journal of oenology and viticulture, Volume 11, number 1, 3 – 17.

Smart, R. and Robinson, M. 1991. Sunlight into wine. Winetitles, Australia.

Somers, T.C. and Evans, M.E. 1974. Wine quality: correlation with colour density and anthocyanin equilibria in a group of young red wines. Journal of food science andf agriculture, 25, 1369 – 1379.

Somers, T.C. and Pocock, K.F. 1991. Phenolic assessment of white musts: Varietal differences in free run juices and pressings. Vitis 30, 189 – 201.

South African Wine Industry Information and Systems. 2007a. SA Wine Industry Statistics nr 31. Paarl, SA: SAWIS. Available from: <http://www.sawis.co.za/SAWISPortal/uploads/Book_2007_WEB.pdf> [Accessed: June 2007]

South African Wine Industry Information and Systems. 2007b. South African Vines Database Statistics. Available from: <http://www.sawis.co.za/SAWISPortal/DesktopDefault.aspx?ParentId=53&tabindex=3&tabid=63> [Accessed: June 2007]

Spillman, P.J., Pocock, K.F., Gawel, R. and Sefton, M.A. 1995. The influence of oak, coopering and microbial activity on oak-derived wine aroma. In: Stockley, C.S., Sas, A.N., Johnstone, R.S. and Lee, T.H.. ed. Proceedings of the ninth Australian wine industry technical conference, July 1995, Adelaide, 66 – 71.

Stevenson, T. 2003. Christies World Encyclopaedia of Champagne & Sparkling wine. Great Britain: Absolute Press.

Terrier, A. and Blouin, J. 1975. Observations sur l'extraction des jus des raisins blancs. Connais. Vigne Vin 9, 273 – 303.

Voss, R. 1995. Wines of the Loire. London: Faber and Faber.

Wilker, K.L., Dharmadhikari, M.R. and Goin, J.C. 2004. Effect of sweetening treatments on white wine aroma and composition. American journal of oenology and viticulture, Volume 55, number 2, 168 – 173.

Van Huyssteen, L. 1989. The effect of soil management and fertilization on grape composition and wine quality with special reference to South African conditions. In: Williams, P.J, Davidson, D.M and Lee, T.H. ed. Proceedings of the seventh Australian wine industry technical conference, August 1989, Adelaide, 16 – 25.

Van Leeuwen, C., Friant, P., Choné, X., Tregoat, O., Koundouras, S. and Dubourdieu, D. 2004. Influence of climate, soil, and cultivar on Terroir. American journal of oenology and viticulture, Volume 55, number 3, 207 – 217.

Van Rooyen, P.C., de Wet, P., van Wyk, C.J. & Tromp, A. 1982. Chenin blanc wine volatiles and the intensity of a guava-like flavour. South African journal of oenology and viticulture, Volume 3, number 1, 1 – 7.

Van Rooyen, P.C. and Tromp, A. 1982. The effect of fermentation time (as induced by fermentation and must conditions) on the chemical profile and quality of a Chenin blanc wine. South African journal of oenology and viticulture, Volume 3, number 2, 75 – 80.

Van Schalkwyk, H. and Archer, E. 2000. Determining optimum ripeness in wine grapes. Wynboer Tegnies, May. Available from: <http://www.wynboer.co.za/recentarticles/0500optimum.php3> [Accessed: June 2007]

Van Schalkwyk, D. and de Villiers, F.S. 1996. Wanneer moet trosvermindering by wyndruiwe toegepas word? Wynboer Tegnies, January, 5 – 7.

Van Schalkwyn, D., Hunter, J.J. and Venter, J.J. 1995. Effect of bunch removal on grape composition and wine quality of Vitis vinifera L. cv. Chardonnay. South African journal of oenology and viticulture, Volume 16, number 2, 15 – 25.

Van Wyk, J. 1995. Die gebruik van askorbiensuur by die bereiding van tafeldruiwe. Wynboer Tegnies, July. 4 – 6.

Van Zyl, J.L., van Huyssteen, L. 1980a. Comparative studies on wine grapes on different trellising systems: I. Consumptive water use. South African journal of oenology and viticulture, Volume 1, number 1, 7 – 14.

Van Zyl, J.L., van Huyssteen, L. 1980b. Comparative studies on wine grapes on different trellising systems: II. Micro-climatic studies, grape composition and wine quality. South African journal of oenology and viticulture, Volume 1, number 1, 15 – 25.

Wagener, G.W.W. 1980. The effect of mechanical harvesting on wines of Chenin blanc grapes in South Africa. Vitis 19, 338 – 345.

Wilson, J. 1998. Terroir. The Role of Geology, Climate and Culture in the Making of French Wines. Great Britain: Mitchell Beazly.

Zeeman, A.S. 1981a. Plantwydtes in Burger, J. & Deist, J. ed. Wingerdbou in Suid-Afrika. Cape Town, SA: CTP Boekdrukkers, 179 – 184.

Zeeman, A.S. 1981b. Oplei in Burger, J. & Deist, J. ed. Wingerdbou in Suid-Afrika. Cape Town, SA: CTP Boekdrukkers, 185 – 201.

7. APPENDICES

APPENDIX A: "FRESH AND FRUITY" STYLED CHENIN BLANC TABLE WINES

Chenin blanc table wine in South Africa is made in a variety of styles from fresh and light early drinking wines to riper wooded versions (CBA, c2004). There is an opinion that wine tasting panels, specifically in South Africa, do not always fairly recognise all the styles of Chenin blanc table wines from South Africa and it would appear that it is usually very ripe, wooded wines that triumph at wine competitions (Pendock, 2007).

However, more than half of the approximate 35,000,000 litres of Chenin blanc table wine exported from South Africa is bulk wine (SAWIS, 2007) and much of this wine is made in a lighter style without the influence of oak. This section will provide an overview of the general viticultural and oenological practices that are utilised in the production of these "fresh and fruity" styled Chenin blanc table wines from South Africa.

Viticulture

The lighter styled Chenin blanc table wines from South Africa often originate from the inland irrigation scheme areas where yields tend to be higher. Many good quality "fresh and fruity" styled Chenin blanc wine originate from vineyards yielding as high as 15 – 18 tons per hectare.

Grapes originating from older vineyard blocks (10 – 15 years) tend to produce wines with more pronounced fruit flavours. Canopy management practices are important for this style of wine particularly to prevent conditions that promote the development of bunch rot.

Grapes for "fresh and fruity" styled Chenin blanc wine is harvested earlier to promote the drinkability of the wine. The decision to harvest is largely based on the sugar content of the must. Other criteria that are considered include an assessment of the colour of the skins of the grapes. A yellow skin colour appears to be a useful indication of the appropriate degree of ripeness for this style of wine.

The inclusion of botrytis cinerea infected grapes is not desirable for lighter styled Chenin blanc table wines and earlier harvesting naturally limits the development of the disease.

Oenology

The acid level of the must is universally adjusted with tartaric acid as is standard practice with the majority of white wines produced in South Africa.

Skin contact is generally avoided for this style of Chenin blanc wine since the skins do not contain significant concentrations of primary flavours and also due to the risk of excessive phenolic extraction.

Some degree of oxidation prior to fermentation will promote the ultimate stability of the wine and strictly reductive techniques are generally not practiced. The fermentation aromas of the wine are however very sensitive to oxygen and any treatment after fermentation is normally performed under inert gas.

Lighter styled Chenin blanc wines depend on fruity esters produced during fermentation for character and is therefore fermented cold and exclusively with cultured yeasts. The must is typically clarified by spontaneous settling overnight prior to fermentation to produce either brilliant or clear juice to ensure the formation of clean fermentation aromas. The selection of yeast can enhance the flavour of this style of wine. VIN 7 produces wine with slightly elevated levels of volatile acidity that may complement the tropical character of the grape variety. Cold fermentation temperatures (12 - 16°C) are generally thought to be critical to promote and retain the formation of fruity esters.

“Fresh and fruity” styled Chenin blanc wine is produced without the influence of malolactic fermentation and oak.

Maturation of this style of Chenin blanc wine on its lees after fermentation is not always practiced partly because the wines are usually destined for bottling as early as March each year.

The elevation of the residual sugar level of the wine prior to bottling will improve the fullness and mouthfeel of these wines.

Conclusion

Although there seems to be a trend, particularly in wine competitions, to promote riper, wooded Chenin blanc wines there are also claims within the South African wine industry that the more delicate, drinkable and balanced examples of the grape need to be acknowledged (Pendock, 2007; Raats, 2006). Ultimately the success of Chenin blanc table wines from South Africa will depend on the success of all the major styles that it is made in.

Source: Jandre Human – Brandvlei Cellars winemaker (white wine)
Fred Viljoen – Viljoensdrift Wines winemaker