

# Wine

## Flavour Chemistry

SECOND EDITION

Jokie Bakker & Ronald J. Clarke



 WILEY-BLACKWELL

# Wine Flavour Chemistry

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Second edition

Jokie Bakker  
Ronald J. Clarke



 **WILEY-BLACKWELL**

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# **Wine Flavour Chemistry**

# Preface to the Second Edition

Wine is primarily consumed for pleasure, and despite some attributed health benefits, it does not form an essential part of our diet. Therefore the sensory properties of wines are considered very important and the appreciation of its flavour arguably gives the wine drinker most pleasure. The wine is bought for its appeal in the bottle, for the knowledge the wine drinker has about the sensory properties and the anticipated enjoyment of consuming the wine. After evaluating the colour of the wine in the glass, most wine consumers will smell the wine, and judge its qualities. The release of flavours from wine continues when drinking the wine, and gives further flavour sensations in addition to the perception of many other taste and mouthfeel compounds that should be present in balanced amounts in the wine. There is a very wide range of well made wines available, so if a wine does not deliver the flavour the wine drinker desires and appreciates, a different choice can be made for the next occasion. Since wine flavour plays such a crucial role in wine, this makes a book devoted to *Wine Flavour Chemistry* particularly relevant.

The technological advances in viticulture, wine-making and the resulting improved wine flavours have been based upon the scientific exploration of vines, grapes and wines, their constituents, their chemistry and all aspects of the wine-making process by scientists in many disciplines in research establishments world-wide. The understanding of flavour chemistry and its perception is determined by numerous scientific disciplines, ranging from chemistry and laws of physics to human physiology. Since the first edition of *Wine Flavour Chemistry* more research has become available on wine flavours, with new compounds still being identified. In addition, scientists place much emphasis on determining the potential sensory contributions of flavour compounds in wine, making flavour information as relevant as possible. Advantageous in all research dealing with flavours is the increased scientific understanding of the perception of volatiles and the award of the Nobel Prize for Physiology and Medicine in 2004 to Richard Buck & Linda Axel for their pioneering research on the genetics of the perception of odour (ref. in Chapter 4) has given great impetus to this research field.

Although aspects of wine-making may always remain an art, such as the numerous choices to be made in the wine production process in order to optimize the wine flavour, science has definitely got a very sound and well deserved foothold in the wine making industry. Many highly trained and skilled wine makers work in the wine industry, helping to adapt advances in wine science in order to successfully influence wine making and ultimately

wine flavour. All wine drinkers benefit from the well made wines with a wide range of wine flavours available nowadays. This updated book, *Wine Flavour Chemistry* may attract many different readers interested in wine, ranging from wine consumers, students, academics and people working in the wine industry. Information has been gathered from scientific research, review papers and books to update this comprehensive overview of the subject.

I wish to express my grateful thanks to all the scientists who have kindly shared their research information, which was of invaluable help in preparing this updated book.

*Jokie Bakker MSc (Wageningen), PhD (Bristol)*

# Preface to the First Edition

This volume on wine flavour chemistry has been in gestation for many years; an original draft was started some ten years ago. A number of events led to our renewed interest in getting this book published. First, in the UK, wine has become a drink enjoyed by many consumers at numerous occasions, whereas previously, wine tended to be a drink shrouded by mystique and enjoyed mainly by more knowledgeable people. In contrast, in countries where wine production has been established for a long time, a long-standing culture of wine consumption, mainly with meals, has been established. Since there are now many people in the UK as well as in other areas of the world interested in consuming wines there is also an increased quest for knowledge about wine, making a book focused on the flavour and its chemistry particularly pertinent. Second, during the last two decades, there has been an enormous development in knowledge about viticulture and the technology of wine making worldwide. This has resulted in a much-improved wine quality. Third, many 'new' wine regions have been established. These have not been inhibited by cultural preconceptions about wine production, and have experimented in many different ways, pushing the boundaries of both viticulture and wine making. Fourth, financial investments in vineyards and wineries, hand in hand with generally vastly improved wine production skills, have given an array of wine flavours from grapes, which wine-makers in the past could barely have believed possible. The cultivation and production of single variety/cultivar wines have given consumers an insight into the many flavours possible in wines. Of course, the technological advances in viticulture and wine making have been based upon the scientific exploration of grapes and wines, their constituents and their chemistry, by scientists in many disciplines worldwide. Advances in analytical laboratory instruments have proven to be a great help. For example, mass spectrometers have, over the last ten years, become much more sensitive, much smaller, much cheaper and easier to use. This has resulted in an explosion of new data regarding the volatile compounds of wine. Numerous other advances in analytical techniques have aided the quest for knowledge about wine flavour, colour and taste. Interestingly, alongside these technological advances has been the development of sensory science. There is now an array of scientifically based sensory analytical techniques allowing scientists to determine our perception of wine, including the measurements of differences between wines and descriptions of sensory properties.

Two recently published scientific books on wines summarize much of the wine information available. In 1994, Jackson in Canada published his excellent

and wide-ranging book, *Wine Science*, with a second edition in 2000. This was followed in 2000 by the equally excellent *Handbook of Enology* from Ribéreau-Gayon and his colleagues in France. This new book on the chemistry of wine flavours draws together aspects of wine making pertinent to wine flavour, and tries to link chemistry, flavour composition and sensory properties. Our volume draws much information from these antecedent books for which due acknowledgement is readily made. We make similar grateful acknowledgement to several highly perceptive and entertaining, but not overtly scientific, books on wines by British wine writers and journalists. Of course, information from many scientific papers is also used to give a comprehensive overview of the subject. This book, *Wine Flavour Chemistry*, differs from all the foregoing in that it is uniquely devoted to the subject of the *flavour* of the wine. It is based on the chemistry of the compounds, both volatile and non-volatile, together with the application of the techniques of modern sensory analysis.

The quantities of volatile compounds in head-space air, that is, the air above a glass of wine, are determined by *partition coefficients*, which express the ratio between the amount of those compounds in the liquid and in the air above, both amounts often only in parts per million or much less. The quantities present have to be above *threshold levels of detection and recognition* in order for them to be perceived effectively by the olfactory organs of the nose. There are also threshold levels for non-volatile compounds present in much larger quantities in wines (several grams per litre), and detected only by the taste buds of the tongue, which detect the basic tastes of acidity, sweetness, bitterness and saltiness. Signals from these two highly sensitive organs (the olfactory epithelium and taste buds) are transported through nerve fibres to the brain. Certain other elements of sensory analysis, such as colour, appearance and tactile sensations in the mouth, including astringency, contribute to the overall flavour assessment. Perhaps it is the naming of all the different flavour sensations in all the different wines that is of the greatest intellectual and aesthetic interest, together with their association by scientists with particular chemical substances or groups of substances.

This volume, therefore, attempts to bring together in a readable and accessible form the most recent research from this rapidly developing field. It is aimed to be of interest to consumers with an inquisitive mind about wine, and to all those involved with the production of and trade in wines with an interest in the chemical and technical aspects of wine flavour.

A considerable amount of threshold flavour/odour and other flavour compound information has been recently compiled by Flament in his comprehensive book, *Coffee Flavor Chemistry* (2002). Many wine odour compounds, now known to number around 400, are also to be found among the much larger number of volatile compounds (about 800) in green and roasted coffee brews. In wines, alkyl esters from the fermentation of the must and unchanged terpenes from the grapes are particularly characteristic, though they may undergo change during subsequent ageing; in coffee, many distinctive compounds develop from the roasting process.

Reference to coffee flavour, indeed that of other beverages, should not be surprising since one of the authors (RJC), whilst an enthusiastic wine bibber, spent some forty years in the scientific study and industrial manufacture of coffee, and is the author or co-editor of several books on that subject. The other author of this book (JB) brings a wealth of knowledge and experience directly from her research into wine, especially within fortified wines, with numerous scientific research papers published on this subject.

We wish to express our grateful thanks to all those who have helped us with this book, in particular Professor Clifford of the University of Surrey, UK, and Professor André Charrier, ENSA M, France.

*Ronald J. Clarke MA(Oxon), PhD(Hon), CEng, FIChemE, FIFST  
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