

SPICE UP YOUR LIFE – THE ROTUNDONE STORY

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Abstract

A spicy, 'black pepper' aroma is important to some high quality Australian Shiraz (Syrah) red wines. An interesting sesquiterpene, rotundone, was identified for the first time by gas chromatography-mass spectrometry-olfactometry as an important aroma impact compound in a variety of food products and specific wines. This study confirmed that rotundone is mainly responsible for the peppery characters in Shiraz grapes and red wine (and to a lesser extent in wine from other varieties). Furthermore rotundone was also found in much higher amounts in other common herbs and spices. In particular, rotundone was identified, for the first time, in extracts of peppercorns (*Piper nigrum*) where it was found in the highest concentration, and is the only odorant thus far detected in that spice with an obvious pepper-like aroma. The aroma detection threshold for rotundone was 16 ng/L in red wine and 8 ng/L in water. While most of the sensory panellists were sensitive to rotundone, approximately 20% could not detect this compound at the highest concentration tested (4000 ng/L). Thus, the sensory experience of two consumers enjoying the same glass of Shiraz wine or sharing the same meal seasoned with pepper might be very different.

Introduction

Identification of the compounds responsible for the distinctive aroma and flavour of food products and beverages can be a challenging task, as many key odorants are often present in parts per trillion (ng/kg) concentrations only (1-6). A spicy, 'black pepper' aroma is important to some high quality Australian Shiraz (Syrah) red wines (7,8) and we set out to find the compound(s) responsible for this distinctive aroma. This task led us to identify an obscure sesquiterpene, rotundone (9-11), by gas chromatography-mass spectrometry-olfactometry (GC-MS-O) as a hitherto unrecognised important aroma impact compound in a variety of food products (12). Figure 1 shows the mass spectrum of rotundone C₁₅H₂₂O.

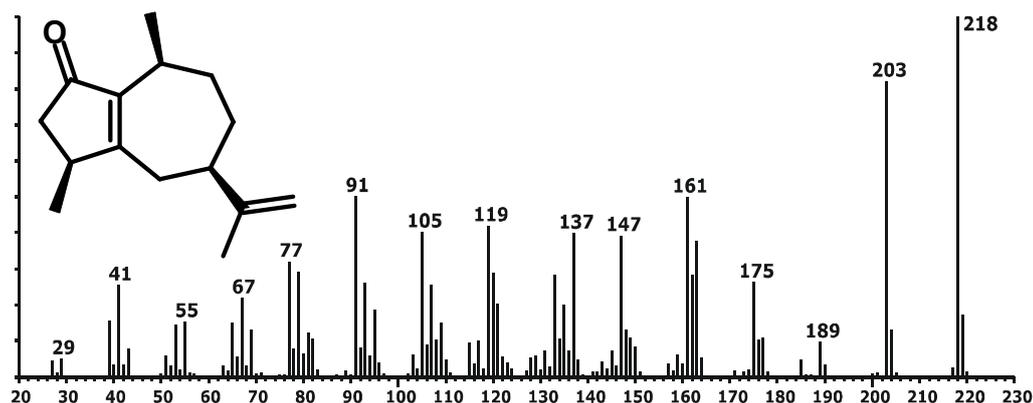


Figure 1. Mass spectrum of (-)-rotundone.

Results

After synthesis of rotundone for reference purposes as reported by us in a recent publication (12) we developed a dedicated analytical method using stable isotope dilution analysis with d_5 -rotundone to provide quantitative data with the required precision (13). By GC-MS we confirmed that not only is rotundone responsible for the peppery characters in Shiraz grapes and red wine (and to a lesser extent in wine from other varieties), but that it can also be found in much higher amounts in other common herbs and spices. In particular, rotundone was identified, for the first time, in extracts of peppercorns (*Piper nigrum*) where it was found in the highest concentration, and is the only odorant thus far detected in that spice with an obvious pepper-like aroma. Table 1 summarises the occurrence of rotundone in various plants and plant products. In grapes, rotundone concentrations ranged from 10 to 620 ng/kg; environmental effects which yet have to be fully characterized led to significant variation between individual vineyard sites and growing seasons (Table 2).

Table 1. Concentration of rotundone in various plants and plant products.

Sample	Rotundone concentration ($\mu\text{g}/\text{kg}$, mean of duplicate extraction and analysis)
White pepper (<i>Piper nigrum</i>)	2025
Black pepper (<i>Piper nigrum</i>)	1200
Wine (<i>Vitis vinifera</i>)	0.15
Grapes (<i>Vitis vinifera</i>)	0.62
Marjoram (<i>Origanum majorana</i>)	208
Geranium (<i>Pelargonium alchemilloides</i>)	25
Nut grass (<i>Cyperus rotundus</i>)	920
Rosemary (<i>Rosmarinus officinalis</i>)	86
Saltbush (<i>Atriplex cinerea</i>)	37
Basil (<i>Ocimum basilicum</i>)	4
Thyme (<i>Thymus vulgaris</i>)	5
Oregano (<i>Origanum vulgare</i>)	1

Table 2. Concentration of rotundone (ng/kg) in Shiraz grapes from six Australian vineyards over two vintages (2002 and 2003). 2002 was widely regarded as being a more 'peppery' year than 2003 for Shiraz grapes in many wine regions in Australia.

Sample	Rotundone concentration (ng/kg)	
	2002	2003
Vineyard A	10	82
Vineyard B	25	31
Vineyard C	76	38
Vineyard D	133	61
Vineyard E	486	117
Vineyard F	619	76

The aroma detection threshold for rotundone was determined according to ASTM method E 679-79 as best estimate threshold of 16 ng/L in red wine and 8 ng/L in water. While most of the 47 sensory panellists were very or moderately sensitive to rotundone, approximately 20% could not detect this compound at the highest concentration tested (4000 ng/L). The variation in individual sensitivity to rotundone suggests that the way wine containing this compound is assessed by consumers or wine judges could vary substantially from one person to another. The observation that a sizable group of people are not very sensitive or completely anosmic might explain why the sensory relevance of rotundone had been overlooked for so many years.

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