



The Natural Chemistry of **Australian Extra Virgin OLIVE OIL**



Australian Government
Rural Industries Research and
Development Corporation



NSW DEPARTMENT OF
PRIMARY INDUSTRIES



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RIRDC Shaping the future

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Foreword

Australian olive oil production has expanded over the last ten years in response to the increasing demand for olive oil as a healthy and tasty part of global food consumption. The strongest global demand is for fresh 'extra virgin' olive oil and Australia's modern industry is designed for the production of this fresh natural product. The freshest olive oil is extracted mechanically from the olives and reflects the natural composition of the olive fruits.

Most of the world's major olive varieties are now grown within the range of temperate climates in Australia. The natural extra virgin olive oils produced from these trees have local characteristics reflecting this range of environments.

Olive oil chemistry is the subject of much research as scientists seek to define the nature of this healthy product. Technology continues to improve and now we are able to describe many of the chemical characteristics of fresh olive oil so that those interested in the subject can understand what is available and even select products to suit particular needs.

The collaboration between the Rural Industries Research and Development Corporation and the NSW DPI Wagga Wagga Research Institute to produce this publication has strong support from the Australian olive industry and reflects the desire of Australian growers to produce a unique range of authentic and fresh olive oils that are well defined for consumers. Such natural diversity also offers excitingly different flavours and aromas. This is very good news for consumers who appreciate both taste and health attributes.

Peter O'Brien
Managing Director
The Rural Industries Research
and Development Corporation

Paul Miller
President
Australian Olive Association

Accreditation

This research has been undertaken in NSW Department of Primary Industries laboratories in Wagga Wagga that have an accredited management system ISO 9001:2000; NATA accreditation (ISO 17025); accreditation with International Olive Oil Council for chemical analysis and IOOC Sensory Analysis and was conducted by approved chemists of the AOCS (American Oil Chemists' Society).



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Olive bins waiting for harvest

Background

Australian olive oils provide an array of flavours and qualities. With diverse environments and seasonal differences along with a selection of the best performing cultivars, Australia offers a unique range of olive oils from one country. High quality Australian extra virgin olive oil is being exported in increasing quantities throughout the world.

A wider selection of olive oils

Research has shown that Australian olive oils exceed the range and level of quality generally expected in olive oils from other countries. Australian olive oils are almost entirely extra virgin olive oil with little refining being carried out. Some oils actually surpass the quality limits set for extra virgin olive oil. For example, the proportion of desirable oleic acid is sometimes even higher than 84%. The benefits of oleic acid (olea from olive) have been well documented.

An olive oil for all purposes

Whether oil is required for cooking, to enhance a salad or for any other purpose, there will be products within the range of Australian olive oils that will suit. Oils with high oleic and palmitic acids have long shelf lives and high cooking temperatures. Oils with high levels of mono and polyunsaturates have well documented health benefits. All of these Australian olive oils are high quality, unadulterated and mechanically extracted oils, free of any chemical process.



Australian Cultivars

It is estimated that 90% of Australian olive oil is produced from 10 major cultivars. These include Arbequina, Barnea, Coratina, Corregiola, Frantoio, Koroneiki, Leccino, Manzanillo, Pendolino and Picual. The fruit is grown in widespread areas from the warmer northern regions of Queensland and New South Wales, through temperate New South Wales and Victoria, in coastal southern Western Australia and in the milder climates of South Australia and Tasmania. Fruit harvest times also play a major role in determining the quality and characteristics of the oil. The proportions of fatty acids, sterols and volatile flavour components are evidence of this.

Fatty acids

Olive oils are composed mainly of a range of fatty acids bound into triacylglycerol molecules. There are around 13 main fatty acids in olive oil and the proportions of these fatty acids relate to the stability and nutritive value of the oil. The major fatty acids referred to here include palmitic acid (C16:0), oleic acid (C18:1), linoleic acid (C18:2) and linolenic acid (C18:3).

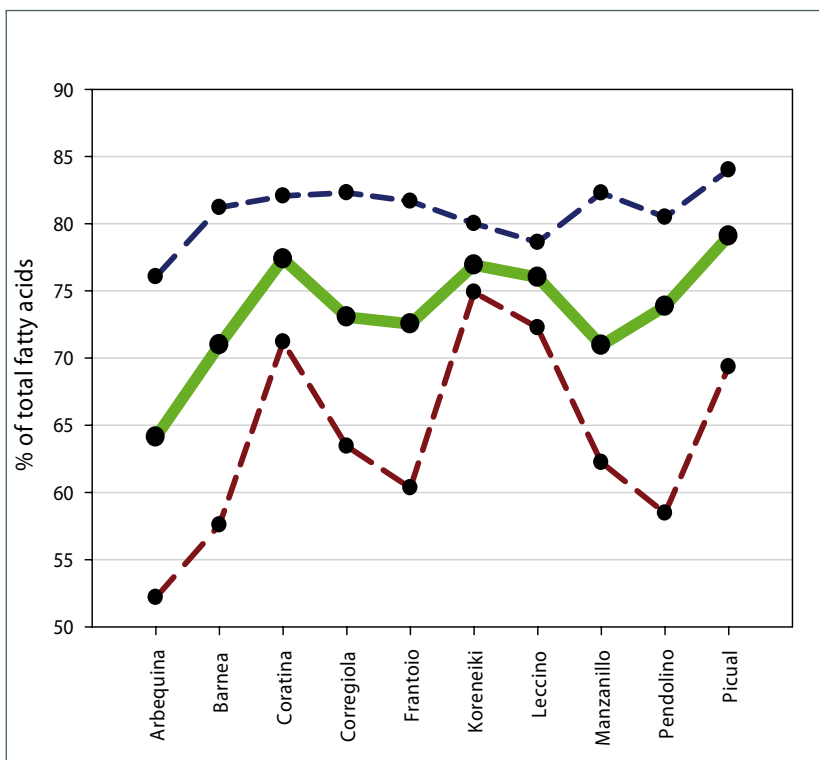


Figure 1. Average level of oleic acid in samples of 10 cultivars from the different environmental regions of Australia. Lines show the mean, minimum and maximum levels measured in scientific surveys.

Oleic acid

The content of oleic acid in Australian olive oil varies significantly from medium levels in warmer climates to extremely high levels in oils produced from the cooler regions of Australia. In scientific studies on oil quality, levels of oleic acid, the fatty acid named after olive oil (olea), have been found to range from 55% to exceptional levels of 85%, perhaps higher than most northern hemisphere oils can achieve. Mono-unsaturated oleic acid is known to have health benefits.



Mr Jamie Ayton and Dr Rod Mailer discuss analysis of olive oil samples

Palmitic acid

Palmitic acid, a saturated fatty acid, provides stability in oils which leads to a longer shelf life. Again, Australian oils are unique in providing the consumer with oils which produce very low levels of saturated palmitic acid from less than 7% in cooler regions to highly stable oils with up to 20% palmitic acid when produced in warmer regions.

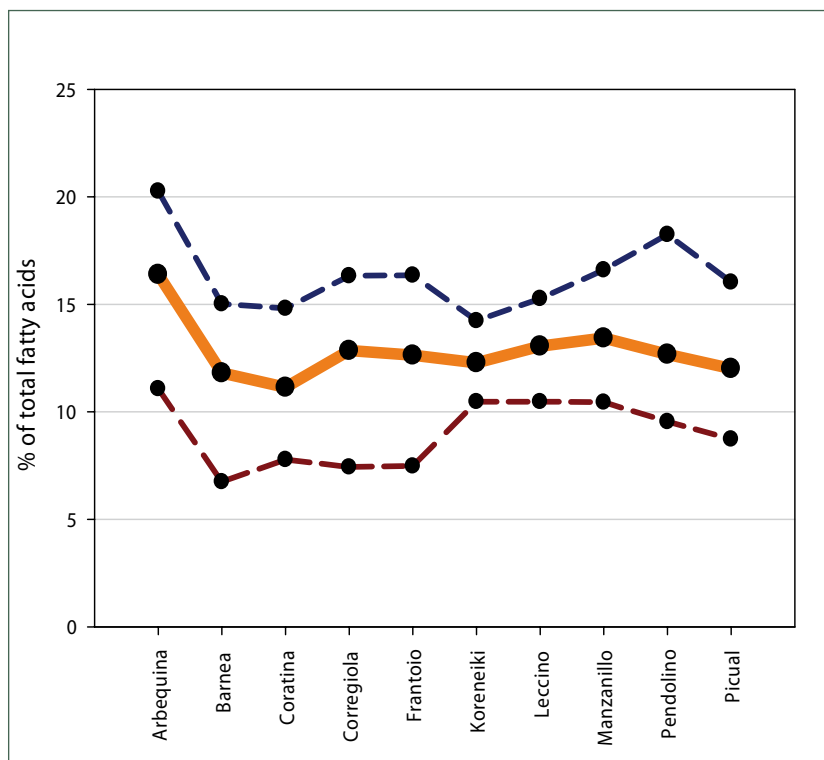


Figure 2. Average level of palmitic acid in samples of 10 cultivars from different environmental regions. Lines show the mean, minimum and maximum levels measured in scientific surveys.



Solvent extraction of olive oil using soxhlet apparatus

Linoleic acid

Other fatty acids are also naturally variable within oils from different regions but cultivar also plays a significant role. Linoleic acid, particularly, can vary from 3% in early harvested Picual to 23% in Barnea or Hardy's Mammoth cultivars. Linoleic acid is a polyunsaturated fatty acid that is less stable than saturated and mono-unsaturated fatty acids.

By selecting the fatty acid profile of the oil to suit the purpose, the best outcomes are achieved with the benefit of the optimum, nutritive, olive oil.

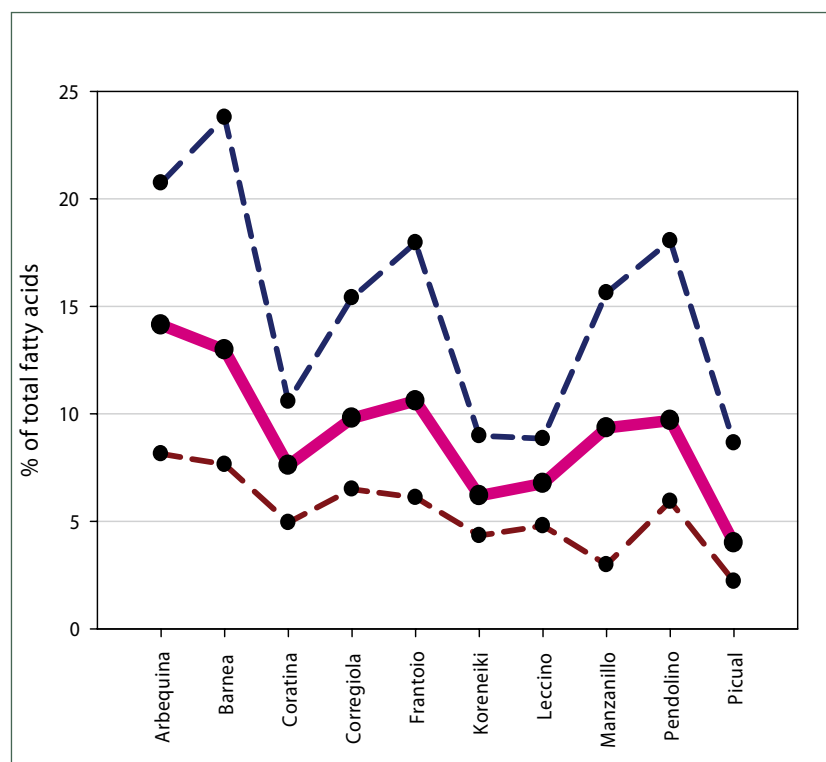



Figure 3. Average level of linoleic acid in samples of 10 cultivars from different environmental regions. Lines show the mean, minimum and maximum levels measured in scientific surveys.



Australian olive oils range from those suited to cooking oil with the stability of high palmitic and low linolenic acids to those used for salad dressings with high oleic acid and low saturated fat.

Linolenic acid

Linolenic acid has received publicity in recent times due to the variations in levels found in olive oil from many countries. High levels have sometimes been used as indicators for the possible adulteration of olive oil. Linolenic acid is an omega-3 acid, a precursor to the nutritionally desirable ‘fish oil’ fatty acids EPA and DHA, and is highly reactive. Food products with high levels of this fatty acid, despite its nutritive value, should not be kept in storage for long as they are less stable. Olive oil has useful levels of this fatty acid but not high levels in comparison with some other products. Its level in Australian olive oils appears to be influenced by seasonal fluctuation with levels in Australian oils reaching up to 1.7%.

Table 1. Average, minimum and maximum levels of fatty acids measured on 153 samples including 10 cultivars grown in environmentally different regions within Australia in 2005 & 2006.

Fatty Acid	Palmitic C16:0	Palmitoleic C16:1	Hepta-decanoic C17:0	Hepta-decenoic C17:1	Stearic C18:0	Oleic C18:1	Linoleic C18:2	Linolenic C18:3	Arachidic C20:0	Gadoleic C20:1	Behenic C22:0
Minimum	6.8	0.3	0.02	0.04	1.1	52.2	2.2	0.3	0.2	0.05	0.04
Average	12.7	1.1	0.05	0.1	1.9	73.6	9.2	0.7	0.3	0.3	0.09
Maximum	20.3	4.1	0.2	0.3	3.8	84.2	23.8	1.7	0.5	0.5	0.2



Determining oil content of mechanically extracted olives

Sterols

Phytosterols are natural products present in all plant material. Many different types and quantities of phytosterols are contained in olive oils. They are well known for their nutritive value and have been shown in human digestion, to reduce absorption of cholesterol. Australian olive oils generally have high levels of sterols in excess of 1000 mg/kg. However levels have been recorded in these studies from as low as 790 mg/kg to as high as 2500 mg/kg. Sterol concentration and composition are affected by cultivar, fruit maturity, processing and extraction. The significant cultivar influence has been demonstrated here with Arbequina and Barnea being relatively higher in sterols than Coratina, Koroneiki and Pendolino.

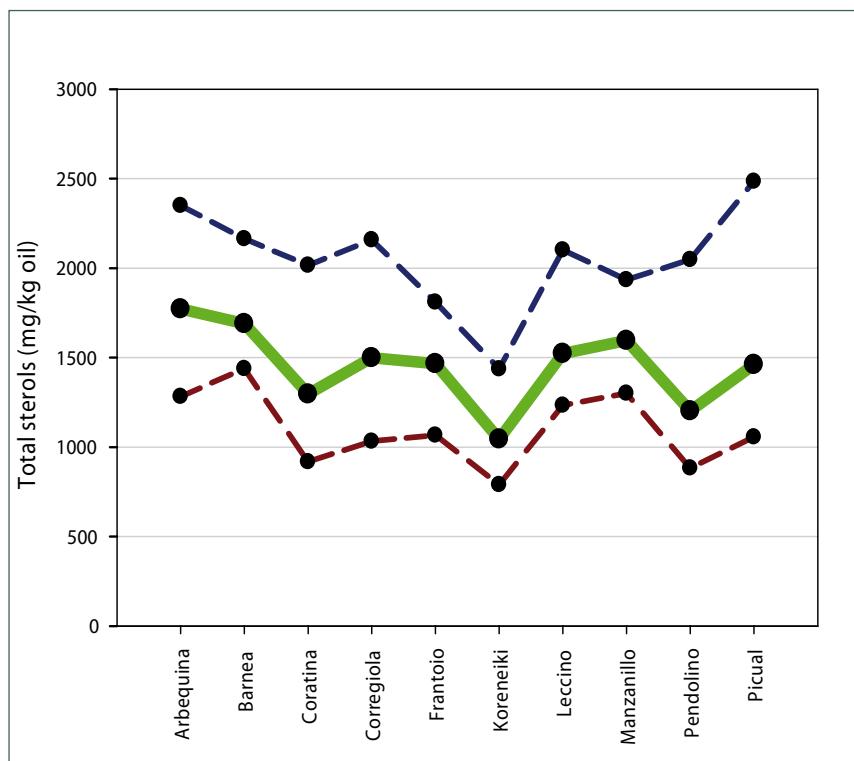


Figure 4. Average level of total sterols in samples of 10 cultivars from different environmental regions. Lines show the mean, minimum and maximum levels measured in scientific surveys.

The three major sterols in olive oil are β -sitosterol, D-5-avenasterol and campesterol. These sterols are very beneficial plant products. Individual sterols vary within the profile of Australian olive oil and campesterol in particular has been found to be significantly higher in some cultivars including Barnea and Koroneiki. β -sitosterol and campesterol are two of the main natural plant sterols added to manufactured foods to reduce cholesterol absorption by humans.

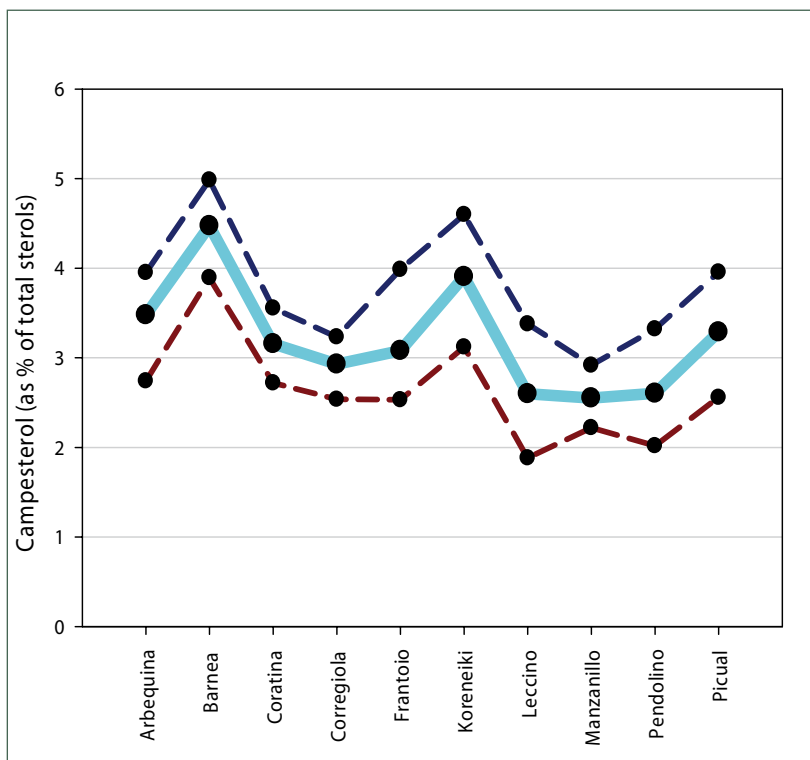


Figure 5. Average level of campesterol in samples of 10 cultivars from different environmental regions. Lines show the mean, minimum and maximum levels measured in scientific surveys.

Table 2. Average, minimum and maximum levels of individual and total sterols from 10 cultivars of olives grown in diverse environments during 2005 and 2006.

Sterol Name	Cholesterol	Brassicasterol	24-Methylene-cholesterol	Campesterol	Campestanol	Stigmasterol	D-7-Campesterol	D-5,23-Stigmastadienol	Clerosterol	β -Sitosterol	Sitostanol	D-5-Avenasterol	D-5,24-Stigmastadienol	D-7-Stigmasterol	D-7-Avenasterol	Total Sterols by %	Apparent β sitosterol	Diols	Total Sterols(mg/kg)
Minimum	0.00	0.00	0.00	1.88	0.00	0.00	0.00	0.00	0.00	58.09	0.04	2.45	0.23	0.00	0.18	100.00	91.72	0.22	789.23
Average	0.14	0.01	0.16	3.19	0.30	0.70	0.28	0.02	0.84	82.37	0.62	10.01	0.61	0.27	0.49	100.00	94.47	1.41	1477.68
Maximum	0.48	0.08	0.95	4.98	0.95	1.92	1.41	0.26	1.36	90.61	2.66	34.10	1.55	0.66	1.08	100.00	96.36	3.22	2484.50



Amanda McFadden, NSW DPI, analyses olive oil by liquid chromatography

Free fatty acids (FFA) and peroxide value (PV)

FFA and PV are indicators of the quality of harvesting, processing and storage operations used by the oil producer. The high quality of grove management, as shown by the low FFA and PV figures, illustrates the high quality of Australian olive oils. In 2005 and 2006, almost 2000 oils were analysed for FFA and PV. The free fatty acid average level was less than 0.3% and the average peroxide value was less than 10 mEq/kg. Only 17 oils exceeded 0.8% free fatty acid and only 8 exceeded 20 mEq oxygen/ kg oil.

	FFA	Peroxide Value
Average	0.26	9.03
Min	0.05	1
Max	3.48	47.8
Total samples	1800	1800

Trans fatty acids

Trans fatty acids in the current study averaged only 0.01% of the total fatty acids, or effectively zero. Trans fatty acids are used as indicators of the presence of refined oil. They are generally produced through the process of hydrogenation but may also be caused by heating and/or bleaching. None of these processes are applied in Australian olive oil.

Wax

No Australian olive oils exceed 250 mg/kg of wax as there is no solvent extraction of olive oils in Australia and the wax content is generally very low. However it is clear that there is some natural variation in wax levels and these appear to be due to variation in the environment. Some oils, produced in the warmer, drier regions of Australia consistently produce higher levels of wax. The range for wax content identified in this study was from 20–245 mg/kg.



Mr Peter Olson carries out sensory evaluations in an official oil testing booth

Sensory tests

Evaluation of large numbers of oil samples by the internationally accredited Wagga Wagga Olive Oil Sensory Panel indicates that a number of factors can influence the organoleptic or sensory profile of olive oil. Harvest date in particular has a strong influence on the aroma and flavour of oil. Oils from fruit harvested early in the season tend to be pungent and bitter, while those harvested later are more mellow and fruity.

The olive cultivar also influences the sensory profile of olive oil. Some cultivars, such as Barnea tend to be lightly flavoured or mellow. Picual has a distinctive unripe banana or green tomato-like flavour while Manzanillo produces very fruity, sweet oils with a wide range of flavours.

The range of Australian environments also accounts for the many and varied oil types which are characterised by their growing conditions. The region in which the olives grow affects the oil's sensory profile. Northern areas with hotter climates, such as Queensland, tend to produce mild and delicate oils, while cooler climates such as Tasmania produce more robust, greener, and pungent oil. In between, from Western Australia to south eastern Australia, are many climates offering an intensity of taste to suit a range of consumers.

The result is an exciting range of flavours available in olive oils from Australia's diverse regions which appeal to consumers around the world.



Heavily laden olive tree ready for harvest

Summary

Australia's olive oil is basically all extra virgin olive oil and is extracted by mechanical means. There is no added heat or solvent used to remove the oil from the olives. Extra virgin olive oil is acknowledged to be superior to refined oil due to the added benefits of the large range of minor components of the oil which may otherwise be eliminated in a refining process. These minor components include sterols, pigments, tocopherols and phenolic compounds. Additionally, the major part of the oil is composed of a range of saturated, mono-unsaturated and polyunsaturated fatty acids. These fatty acids influence the nutritive quality and the stability of the oil.

Australian olive oils have many benefits resulting from good farming systems, harvesting and processing techniques which consistently produce oils characteristic of the region, the cultivar and the oil maturity. The stability of high palmitic and oleic acid oils is complementary to the nutritive value of the oils with more omega-6 and omega-3 polyunsaturated fatty acids. The latter oils are better utilised for more immediate use in salads and cold applications. Generally high levels of sterols and polyphenols ensure products which have a significant health benefit to consumers.

The natural diversity of the Australian environment along with a selection of the best world cultivars harvested under optimal conditions is responsible for the exciting range of high quality olive oil products from the Australian olive industry.



- Olive oil can be selected for a particular purpose based on its fatty acid profile.
- β -sitosterol and campesterol are two of the main natural plant sterols added to manufactured foods to reduce cholesterol absorption by humans.
- Health benefits of mono-unsaturated oleic acid have been well documented.
- Linolenic acid is an omega-3 fatty acid, the concentration of which has been shown to be influenced by temperature and cultivar.



Australian Olive Oil is extracted by mechanical means. The oil is not blended unless stated on the label.

The natural and diverse range of environments and growing conditions account for the significant variation in its inherent chemical composition and sensory properties.



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