RURAL INDUSTRIES RESEARCH
& DEVELOPMENT CORPORATION

# Wild Olive Selection

## for quality oil production

**A report for the Rural Industries Research and Development Corporation**

by Professor Margaret Sedgley

August, 2000

RIRDC Publication No 00/116
RDC Project No UA-41A

ISBN 0 642 58146 0
ISSN 1440-6845

*Wild olive selection for quality oil production*
*Publication N. 00/116*
*Project N UA-41A*



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Published in August 2000
Printed on environmentally friendly paper by Canprint

# Foreword

The olive (*Olea europaea* L.) is a small evergreen tree adapted to a mediterranean climate. It yields two products, table olives and olive oil, both of which are important commodities on world markets. One of Australia's first industries following European settlement was table olive and olive oil production, and many introductions of olive varieties were made from overseas. Despite this, the Australian olive industry went into decline and almost all olive products consumed are now imported.

Olives are ideally suited to the southern Australian environment, as demonstrated by its status as an invasive weed, by natural seed propagation from the original introductions. The olive competes so well with native vegetation in disturbed sites, that eradication programs are underway throughout southern Australia in an attempt to preserve bushland areas.

It is essential that superior wild material is identified and propagated before it is destroyed, as it represents the progeny of an uncontrolled outcrossing 'experiment'. Based on this wild material, which is clearly well-adapted to Australia, there is the potential to increase Australian olive oil production, and so to replace imports of olive products currently valued at $100 million. More importantly, the industry intends to develop an export market in olive products, and this is increasingly likely following crop failures overseas. Improved planting material is needed for the industry renaissance.

This thrust has been achieved via selection of superior genotypes from wild escapes of material imported in the past, which has become ideally adapted to southern Australian conditions. New cultivars selected are under evaluation in the National Olive Variety Assessment project trials.

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# Acknowledgments

The project interfaced with that conducted by Charles Sturt University (CSU) and NSW Agriculture (NSWA) which generated detailed information on the extensive olive cultivar collection located at CSU.

# Contents



# List of Tables

# Executive Summary

The aim of the research was to develop new and improved olive cultivars based on selection, oil analysis, DNA fingerprinting, sensory evaluation and propagation. These new olive selections are based on wild material that has escaped from cultivation, providing improved yield and quality of Australian olive products for both domestic and export markets. We also provide a quality assurance service to the developing olive industry.

Oil yield and quality analysis methods are established for olives, mainly to address adulteration problems and to provide quality assurance. Improvements in technology for quality evaluation have been made, and this was an important thrust of our research. DNA analysis is now widely used for plant genetic studies as it provides evidence of identity. It is possible to establish family relationships and pedigrees, and to develop a unique genetic fingerprint for each plant. DNA fingerprints can also be used as a character in cultivar registration, or for positive identification at any stage of growth. Selection and breeding of superior olive cultivars is an important activity to enable Australia to have a competitive advantage over other olive producing countries.

Data were collected from 121 wild trees during 1997, with wide variation in oil yield and fatty acid profiles recorded. Of the 121 trees sampled in 1997, ten showed superior oil yield and quality characteristics. Six of these trees were revisited in 1998 to test for reproducibility between years.

During 1998 collections of fruit, leaves and cuttings were made on 188 feral trees from ten populations throughout South Australia, and the data showed variability between and within these populations for fruit morphological characters. The largest fruit on average came from populations 1 and 2 while the smallest fruit were derived from population 9. Population 5 showed the largest flesh to pit ratio while population 8 showed the lowest. Oil percentages were calculated on a fresh and dry weight basis and also at the equivalent of 50 percent moisture. Population 4 showed the highest mean oil percentage per dry and fresh weights and at 50 percent moisture. The lowest mean oil percentages were recorded in population 8.

Fatty acid profiles were measured, including palmitic, palmitoleic, oleic and linolenic acids. Mean oleic acid levels were highest in population 4 at 75.8 % and lowest in population 9 at 65.2%. Population 4 had the lowest mean palmitic, palmitoleic and linolenic acid levels, while population 8 had the highest means of two of these fatty acids. Of the 188 trees sampled in 1998, 20 showed superior oil yield and quality characteristics. Seven of these trees were revisited in 1999 to test for reproducibility between years.

During 1999, collections were made on 95 feral olive trees from a further eight populations in South Australia. The same sampling protocol was followed as in 1998. Oil percentages were calculated at 50 percent moisture. Population 12 showed the highest mean oil percentage, while the lowest mean oil percentages were recorded in population 18. Fatty acids measured included palmitic, palmitoleic, stearic, oleic, linoleic and linolenic acids. Mean oleic acid levels were highest in population 12 at 73.5 % and lowest in population 18 at 58.4 %. Population 16 had the lowest mean palmitic, palmitoleic and amongst the lowest mean linolenic acid levels along with populations 12, 13, and 14; population 13 had the lowest mean stearic acid levels; population 12 had the lowest mean linoleic acid levels. Population 18 had the highest mean palmitic, palmitoleic, linoleic and linolenic acid levels. Population 14 had the highest mean stearic acid levels. Of the 95 trees sampled in 1999, 20 superior trees have been chosed based on their oil yield and quality.

In conclusion, collections were made from 121 feral trees during 1997. Oil yield varied from 5.9% w/w to 33.7% w/w. Oleic acid ranged from a low of 49.3% to a high of 86.1%. Linolenic acid levels varied between 0.1% and 4.6%. Ten feral populations were sampled during 1998 and a further eight populations during 1999, with fruit, cuttings, and leaves for DNA analysis taken from 283 trees. Oil yields varied from 1.6% to 33.4% at 50% moisture. Oleic acid levels varied from a low of 40.9% to a

high of 87.7%. Linolenic acid levels varied between 0.2% and 2.1%. Fifty superior trees have been selected from the three collections, and are under comparative evaluation in the National Olive Variety Trial at the Roseworthy Campus of the University of Adelaide.

The results confirm that there is great variation in all of the measured characters amongst the wild olive populations in South Australia. While the current focus of the program is on oil quality, the selections with large fruit will be investigated in the future for table olive potential. With this extraordinary gene pool at our fingertips much can be achieved through the University of Adelaide selection and breeding programme utilising wild olives that show superior morphological and oil characteristics.

The olive industry will benefit from this research. At present the industry is very small in terms of value, with a large number of interested growers, but a dearth of improved planting material. The extra virgin olive oil market worldwide is estimated to be growing at approximately 15% per year. There is the potential to increase production to replace imports of olive products currently valued at $100 million. In addition we can develop an export market in olive products based on niche markets with high quality and distinctive flavour. The potential of this approach has been demonstrated by the Australian wine industry. Vital components of this research thrust are DNA analysis of cultivars for nursery quality insurance, chemical analysis as a key element of oil quality assurance, organoleptic assessment and efficient propagation methods.

# 1. Introduction

Olives are cultivated for table fruit and oil in many countries, the most important of which are Italy, Spain, Greece and Tunisia (FAO 1977, Hobman 1995, PISA 1995). Olive oil is a major commodity which is traded internationally (International Olive Oil Council 1992, Rocchi 1993, Mueller 1994, Parras-Rosa and Torres-Ruiz 1994). Olive trees are vegetatively propagated, and a wide range of cultivars is available (Lasareishvili and Zenaishvili 1991, Miranovic et al. 1993, Barranco 1995). Nevertheless, all olive producing countries rate plant improvement programs as a high industry priority (Fernandes-Serrano 1990, Loreti et al. 1993, Tous et al 1993, Boschelle et al 1994, Hilali and El-Antari 1994, Loussert and Berrichi 1995), and the most important producers have active olive breeding research already underway (Fontanazza and Baldoni 1990, Lavee 1990, Arsel and Cirik 1994, Boulouha and Hilal 1995, Rallo 1995, Trigui 1996).

Oil yield and quality analysis methods are well established for olives (Di Giovacchino et al 1991, Frega et al. 1992, Proto 1992, Mariani et al. 1993, Bianchi and Vlahov 1994, Boas et al. 1994, Paulo et al. 1994). Much of the international impetus for such work derives from adulteration problems and issues of quality assurance (Burr 1996), but improvements in technology for quality evaluation can still be made. DNA analysis is a powerful new tool in plant biotechnology, which uses a small amount of material to establish family relationships and pedigrees (Sedgley et al 1994). A unique genetic fingerprint is developed for each plant genotype, and this can be used as a character in cultivar registration (Sedgley 1995a, b), as well as for positive identification at any stage of growth. DNA analysis has been applied to olive cultivars in California (Fabbri et al. 1995), but no work has yet been done on determining family relationships of breeding progeny or of wild material. Tissue culture and transformation techniques have been tested on olive, but more research is needed before they can be applied routinely in an olive improvement programme (Rugini and Pannelli 1993).

The olive (*Olea europaea* L.) is a small evergreen tree adapted to a mediterranean climate. It yields two products, table olives and olive oil, both of which are important commodities on world markets. One of Australia's first industries following European settlement was table olive and olive oil production, and many introductions of olive varieties were made from overseas. Despite this, the Australian olive industry went into decline and almost all olive products consumed are now imported.

Olives are ideally suited to the southern Australian environment, as demonstrated by its status as an invasive weed, by natural seed propagation from the original introductions. The olive competes so well with native vegetation in disturbed sites, that eradication programs are underway throughout southern Australia in an attempt to preserve bushland areas.

It is essential that superior wild material is identified and propagated before it is destroyed, as it represents the progeny of an uncontrolled outcrossing 'experiment'. Based on this wild material, which is clearly well-adapted to Australia, there is the potential to increase Australian olive oil production, and so to replace imports of olive products currently valued at $100 million. More importantly, the industry intends to develop an export market in olive products, and this is increasingly likely following crop failures overseas. Improved planting material is needed for the industry renaissance.

This thrust has been achieved via selection of cultivars from material already imported in the past, which has become ideally adapted to southern Australian conditions. New cultivars selected are under evaluation in the National Olive Variety Assessment project trials.

# 2. Objectives

The aim of the project was selection, oil analysis, DNA fingerprinting, breeding and propagation of new improved olive cultivars based on wild southern Australian material. This will improve yield and quality of olive oil for domestic and export markets, and provide quality assurance to the industry. The project interfaced with a project at CSU/NSWA addressing the extensive olive cultivar collection at CSU.

# 3. Methodology

## 1. Identification and propagation of adapted wild olives

The collaborators for this phase of the project were Michael Burr, Michelle Wirthensohn, Steve Choimes, Margaret Sedgley and Andrew Granger. Between 50 and 100 cultivars were introduced in the 1800s, and many of these trees have reproduced successfully and become perfectly adapted to the southern Australian environment. They provide an important gene pool for selection and breeding. We assessed yield and fruit characteristics, and identified and propagated superior trees by sampling and tapping into local knowledge. Collections were made from 121 wild and colonial trees during 1997, a further ten wild populations were sampled in 1998 and eight more populations during 1999 totalling 404 trees sampled within South Australia so far. Two regimes of collection were followed, firstly the size of the population was measured with respect to distance across the population and one tree was sampled at every tenth of the total distance; secondly any trees that looked potentially good on the basis of crop load, fruit size or were interesting in some way, were also sampled. All trees were tagged and their exact location noted by recording GPS coordinates. Samples taken included leaves for DNA analysis, cuttings for propagation, and fruit for oil analysis. The physical condition of each tree was noted including tree height, trunk circumference at 5 cm, crop load, distance to nearest olive neighbour, leaf colour, tree habit, presence of shot berries, and presence of disease or insect infestation.

## 2. Oil yield and quality

Graham Jones lead this phase of the project, which was involved in the analysis of early introductions and adapted wild selections for oil yield and composition. Oil yield of the fruit was measured using Soxhlet and rapid refractometry methods. In addition oil quality parameters, including fatty acid profiles, total polyphenols and flavour compounds were investigated by gas chromatography, high performance liquid chromatography and mass spectrometry techniques. The group also provides an analytical service to industry for quality assurance purposes.

Oil yields of all fruit samples collected were determined by Soxhlet extraction and oil composition was measured by gas chromatography (International Olive Oil Council, 1968; American Oil Chemistry Society, 1978). Superior trees were selected on the basis of their oil qualities, with trees showing high oil content of the fruit (>18%) and high oleic acid content in the fatty acid profile (>70%) selected for further investigation.

## 3. Genetic characterisation

Margaret Sedgley, Graham Collins, Bruce Field and Genet Teshome were involved in DNA analysis to develop genetic fingerprints of the early introductions and adapted wild selections. The wild plants derive from introductions from overseas, and computer software was used to determine the pedigree of the adapted wild selections so that family relationships could be identified. Inheritance of important agronomic characters such as oil yield and quality characters would be followed, and lineages identified for further investigation. This also provided quality assurance, as each plant has a unique fingerprint which can be checked at any time in the nursery or field, and authenticity problems can be overcome.

## 4. Sensory evaluation

The University of Adelaide Department of Horticulture, Viticulture and Oenology tasting laboratory is seeking accreditation with the International Olive Oil Council. Dr. Luciano Di Giovacchino from Italy trained an experienced panel, which includes project staff, who can evaluate oil from each selection. The results are statistically analysed for quality assurance and identification of unique flavours. This will allow the development of niche markets based on flavour and quality.

## 5. Identification of the best adapted wild selections

All researchers collaborate with Margaret Sedgley, Susan Sweeney, Barry Tugwell and Andrew Granger to use the yield, morphological, oil analysis and genetic data to make decisions on which selections are propagated and multiplied for evaluation in the National Olive Variety Assessment project. Superior cultivars will be registered for Plant Breeders Rights.

## 6. Australian olive breeding programme

The development of an olive breeding programme is essential if Australia is to maintain its competitive advantage. Margaret Sedgley and Andrew Granger, in collaboration with the Australian olive oil industry, will use superior selections and cultivars as breeding parents in a hybridisation program. Oil analysis and DNA evaluation of the progeny will be important tools in this work. Transformation technology may be developed in the longer term.

# 4. Results

## 1. Identification and propagation of adapted wild olives

Collections were made from 121 wild and colonial tees during 1997, 188 in 1998 and 95 in 1999, with plant material sent to the Waite laboratories for analysis. Tissue culture research was commenced, with successful establishment *in vitro* of the cultivars Koronieki, Kalamata, Picholine and Frantoio.

## 2. Oil content and quality

Oil yield and composition of olive fruit obtained from all trees, identified on the basis of morphological characters have been measured. Oil yield varied from 5.9% w/w to 33.7% w/w amongst the trees sampled. Similarly a high variation in fatty acid profiles was observed with oleic acid ranging from a low of 49.3% to a high of 86.1%. Linolenic acid levels varied between 0.1% and 4.6%. In order to determine potential flavour compounds and total polyphenols, oil was extracted from approximately 2.5 kg of fruit in an in-house mini-extraction plant with a hammer mill, malaxer and centrifuge in a manner similar to commercial centrifuge systems. The levels of total polyphenols measured in the oils ranged from 40 to 500 mg/kg gallic acid equivalent. An oil testing service was offered to industry in 1997, which is administered through Oltech Pty. Ltd.

## 3. Genetic characterisation

Investigations have confirmed that there is confusion in the nomenclature of some olive cultivars, but not in others. For example Correggiolo and Frantoio, thought by some in the industry to be identical cultivars, produce different fingerprints. Similarly for Nevadillo Blanco and Picual. In contrast, accessions of Manzanillo from California, Israel and Australia are very similar in their fingerprints. Kalamata is intermediate in variability. A plant fingerprinting service was offered to the industry in 1997, which is administered through Oltech Pty. Ltd.

## 4. Sensory evaluation

A successful tasting school was run during 1997, under the tuition of Dr. Luciano Di Giovacchino an Italian instructor recognised by the International Olive Oil Council. This first Australian tasting panel was found to be highly reliable in repeat blind tastings. Research has commenced into identification of the compounds responsible for the desirable pungent flavours of olive oil.

## 5. Identification of the best adapted wild selections

Of the trees sampled during 1997, 1998 and 1999, many showed superior oil yield and quality characteristics. These trees will be revisited during susequent seasons to ensure reproducibility. Cuttings have been taken for propagation, and the plants established for comparative testing in the National Olive Variety Trial.

## 6. Australian olive breeding programme.

Pollinations for hybridisation have been commenced to establish the first Australian olive breeding programme.

# 5. Discussion of Results

Data were collected from 121 wild trees during 1997, with wide variation in oil yield and fatty acid profiles recorded (Table 1).

***TABLE 1* OIL YIELDS AND FATTY ACID PROFILES OF 121 TREES SAMPLED IN 1997**

| | Water content | % oil w/w | % oil at 50% moisture | Palmitic | Palmitoleic | Stearic | Oleic | Linoleic | inolenic |
|---|---|---|---|---|---|---|---|---|---|
| Mean | 58.3 | 16.2 | 17.8 | 13.2 | 1.2 | 2.6 | 68.7 | 12.7 | 0.8 |
| SE | 0.8 | 0.5 | 0.6 | 0.3 | 0.1 | 0.1 | 0.8 | 0.6 | 0.04 |
| Range | 3.8–82.8 | 2.3–33.7 | 4.1–33.3 | 6.6–22.0 | 0–6.9 | .1–5.2 | 7.8–86.1 | 1.7–30.6 | 0–4.6 |

SE, Standard error

Of the 121 trees sampled in 1997, ten showed superior oil yield and quality characteristics. Six of these trees were revisited in 1998 to test for reproducibility between years (Table 2).

***TABLE 2* COMPARISON OF SUPERIOR TREES IDENTIFIED IN 1997 AND REVISITED IN 1998**

| **Tree** | **% water** | | **% oil** | | **% oil at 50% moisture** | | **% Oleic acid** | | **% Linolenic acid** | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1997** | **1998** | **1997** | **1998** | **1997** | **1998** | **1997** | **1998** | **1997** | **1998** |
| 1 | 52.4 | 70.7 | 23.0 | 9.2 | 24.2 | 15.6 | 71.9 | 66.7 | 0.6 | 1.0 |
| 2 | 49.4 | 64.4 | 33.7 | 17.6 | 33.3 | 24.7 | 75.3 | 70.2 | 0.5 | 1.0 |
| 3 | 66.0 | 66.0 | 18.8 | 19.9 | - | 29.3 | 81.1 | 81.3 | 0.7 | 0.7 |
| 4 | 55.2 | 63.6 | 18.9 | 6.2 | 21.1 | 8.5 | 77.9 | 77.5 | 0.6 | 0.5 |
| 5 | 50.8 | 61.7 | 23.7 | 19.6 | 24.0 | 25.6 | 67.7 | 66.5 | 0.6 | 0.8 |
| 6 | 64.0 | 55.6 | 20.1 | 17.7 | - | 19.9 | 77.8 | 73.8 | 0.7 | 0.7 |

During 1998 collections of fruit, leaves and cuttings were made on 188 feral trees from ten populations throughout South Australia, and the data show variability between and within these populations for fruit morphological characters (Table 3). The largest fruit on average came from populations 1 and 2 while the smallest fruit were derived from population 9. Population 5 showed the largest flesh to pit ratio while population 8 showed the lowest. Oil percentages were calculated on a fresh and dry weight basis and also at the equivalent of 50 percent moisture (Table 4). Population 4 showed the highest mean oil percentage per dry and fresh weights and at 50 percent moisture. The lowest mean oil percentages were recorded in population 8.

***TABLE 3* FRUIT CHARACTERISTICS OF TEN WILD POPULATIONS IN SOUTH AUSTRALIA IN 1998**

| **Population** | **No. trees sampled** | **Fruit length (cm)** | | **Fruit diameter (cm)** | | **Flesh:pit ratio** | |
|---|---|---|---|---|---|---|---|
| | | **range** | **mean** | **range** | **mean** | **range** | **mean** |
| 1 | 12 | 1.1–2.7 | 1.9 | 0.9–2.0 | 1.3 | 3.3–7.3 | 4.5 |
| 2 | 19 | 1.6–2.1 | 1.9 | 1.3–1.6 | 1.4 | 4.5–6.2 | 5.3 |
| 3 | 10 | 1.5–1.7 | 1.6 | 1.0–1.1 | 1.0 | 2.8–4.1 | 3.6 |
| 4 | 33 | 1.1–2.3 | 1.7 | 0.9–1.5 | 1.2 | 2.6–5.7 | 4.1 |
| 5 | 12 | 1.2–2.4 | 1.8 | 1.0–1.6 | 1.3 | 3.3–9.6 | 5.6 |
| 6 | 12 | 1.3–2.5 | 1.7 | 0.9–1.5 | 1.1 | 2.6–5.9 | 3.8 |
| 7 | 17 | 1.3–2.1 | 1.6 | 0.9–1.4 | 1.1 | 3.7–6.6 | 4.8 |
| 8 | 14 | 1.2–2.1 | 1.7 | 0.8–1.5 | 1.1 | 2.1–6.1 | 3.1 |
| 9 | 12 | 1.0–1.5 | 1.3 | 0.9–1.3 | 1.0 | 3.5–8.4 | 5.4 |
| 10 | 5 | 1.4–2.0 | 1.6 | 1.0–1.5 | 1.2 | 4.0–6.6 | 5.1 |

***TABLE 4* OIL PERCENTAGES OF TEN WILD OLIVE POPULATIONS IN SOUTH AUSTRALIA IN 1998**

| Population | No. trees sampled | % oil fwt range | % oil fwt mean | % oil dry wt range | % oil dry wt mean | % oil at 50% moisture range | % oil at 50% moisture mean |
|---|---|---|---|---|---|---|---|
| 1 | 12 | 7.1–27.2 | 15.5 | 20.2–66.8 | 42.6 | 10.1–33.4 | 21.3 |
| 2 | 19 | 11.1–24.6 | 15.3 | 23.7–50.2 | 35.3 | 11.9–26.4 | 18.5 |
| 3 | 10 | 9.7–26.9 | 15.9 | 30.5–50.1 | 41.5 | 15.2–25.1 | 20.8 |
| 4 | 33 | 12.0–25.7 | 18.3 | 31.5–66.3 | 46.6 | 15.8–33.3 | 24.2 |
| 5 | 12 | 10.2–24.5 | 16.1 | 27.7–63.9 | 44.0 | 13.9–32.0 | 22.0 |
| 6 | 12 | 5.8–20.5 | 13.3 | 15.7–53.4 | 36.2 | 7.9–26.7 | 18.1 |
| 7 | 17 | 4.0–22.2 | 14.8 | 15.3–53.8 | 40.6 | 7.6–26.9 | 20.4 |
| 8 | 14 | 1.6–17.2 | 11.2 | 6.4–47.8 | 29.2 | 3.2–23.9 | 14.6 |
| 9 | 12 | 6.5–22.2 | 13.6 | 21.1–41.9 | 32.2 | 10.6–21.0 | 16.5 |
| 10 | 5 | 8.8–19.9 | 12.9 | 30.9–56.4 | 44.4 | 15.5–28.2 | 22.2 |

Fatty acid profiles were measured, including palmitic, palmitoleic, oleic and linolenic acids (Table 5). Mean oleic acid levels were highest in population 4 at 75.8 % and lowest in population 9 at 65.2%. Population 4 had the lowest mean palmitic, palmitoleic and linolenic acid levels, while population 8 had the highest means of two of these fatty acids. Of the 188 trees sampled in 1998, 20 showed superior oil yield and quality characteristics. Seven of these trees were revisited in 1999 to test for reproducibility between years (Table 6).

***TABLE 5* FATTY ACID PROFILE OF TEN WILD OLIVE POPULATIONS IN SOUTH AUSTRALIA IN 1998**

| Population | No. trees sampled | % Palmitic range | % Palmitic mean | % Palmitoleic range | % Palmitoleic mean | % Oleic range | % Oleic mean | % Linolenic range | % Linolenic mean |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 12 | 7.9–16.1 | 13.1 | 0.4–1.7 | 0.9 | 56.2–80.1 | 70.7 | 0.4–1.3 | 0.8 |
| 2 | 19 | 9.8–20.3 | 13.4 | 0.3–3.6 | 1.3 | 43.6–77.0 | 67.6 | 0.2–1.2 | 0.6 |
| 3 | 10 | 5.6–18.8 | 13.2 | 0.2–4.5 | 1.4 | 49.9–87.7 | 65.9 | 0.3–1.2 | 0.8 |
| 4 | 33 | 7.8–14.1 | 11.0 | 0.3–2.6 | 0.8 | 67.7–84.1 | 75.8 | 0.4–1.0 | 0.6 |
| 5 | 12 | 10.3–17.2 | 13.6 | 0.5–1.6 | 0.9 | 53.2–78.1 | 66.8 | 0.5–0.9 | 0.7 |
| 6 | 12 | 10.8–16.7 | 13.9 | 0.5–2.6 | 1.1 | 55.9–77.9 | 67.4 | 0.2–1.2 | 0.8 |
| 7 | 17 | 10.4–17.0 | 13.3 | 0.5–2.2 | 1.1 | 40.9–79.1 | 68.8 | 0.5–1.4 | 0.7 |
| 8 | 14 | 10.7–19.4 | 15.3 | 0.4–3.1 | 1.5 | 52.1–73.0 | 65.4 | 0.5–2.1 | 1.1 |
| 9 | 12 | 10.2–17.7 | 14.4 | 0.4–2.4 | 1.6 | 51.6–82.0 | 65.2 | 0.2–1.2 | 0.6 |
| 10 | 5 | 8.0–17.6 | 12.1 | 0.4–1.8 | 1.1 | 57.3–82.1 | 73.9 | 0.6–1.0 | 0.8 |

***TABLE 6* COMPARISON OF SUPERIOR TREES IDENTIFIED IN 1998 AND REVISITED IN 1999**

| Tree | % oil at 50% moisture 1998 | % oil at 50% moisture 1999 | % Oleic acid 1998 | % Oleic acid 1999 | % Linolenic acid 1998 | % Linolenic acid 1999 |
|---|---|---|---|---|---|---|
| 7 | 30.2 | 30.8 | 70.2 | 69.9 | 0.7 | 0.6 |
| 8 | 30.2 | 25.3 | 76.9 | 77.4 | 0.5 | 0.4 |
| 9 | 32.0 | 23.4 | 78.1 | 81.2 | 0.5 | 0.4 |
| 10 | 29.7 | 22.8 | 69.2 | 60.5 | 0.9 | 1.1 |
| 11 | 26.9 | 22.2 | 74.6 | 73.5 | 0.6 | 0.5 |
| 12 | 32.0 | 21.0 | 60.0 | 58.3 | 0.9 | 0.9 |
| 13 | 25.1 | 13.3 | 70.5 | 55.3 | 0.5 | 2.1 |

During 1999, collections were made on 95 feral olive trees from a further eight populations in South Australia. The same sampling protocol was followed as in 1998. Oil percentages were calculated at 50 percent moisture (Table 7). Population 12 showed the highest mean oil percentage, while the lowest mean oil percentages were recorded in population 18. Fatty acids measured included palmitic, palmitoleic, stearic, oleic, linoleic and linolenic acids (Table 8). Mean oleic acid levels were highest in population 12 at 73.5 % and lowest in population 18 at 58.4 %. Population 16 had the lowest mean palmitic, palmitoleic and amongst the lowest mean linolenic acid levels along with populations 12, 13, and 14; population 13 had the lowest mean stearic acid levels; population 12 had the lowest mean linoleic acid levels. Population 18 had the highest mean palmitic, palmitoleic, linoleic and linolenic acid levels. Population 14 had the highest mean stearic acid levels. Of the 95 trees sampled in 1999, 20 superior trees have been chosed based on their oil yield and quality.

***TABLE 7*** **OIL PERCENTAGES OF EIGHT WILD OLIVE POPULATIONS IN SOUTH AUSTRALIA IN 1999**

| Population | No. trees sampled | % oil @ 50% r range | mean |
|---|---|---|---|
| 11 | 5 | 14.0-25.1 | 21.1 |
| 1 2 | 9 | 12.4-31.5 | 23.5 |
| 1 3 | 14 | 4.6-23.2 | 16.6 |
| 1 4 | 18 | 8.3-26.9 | 16.6 |
| 1 5 | 11 | 2.7-26.5 | 13.7 |
| 1 6 | 6 | 14.7-24.1 | 21.1 |
| 1 7 | 28 | 1.7-29.4 | 13.3 |
| 1 8 | 4 | 10.2-15.5 | 12.6 |

***TABLE 8*** **FATTY ACID PROFILES OF EIGHT WILD OLIVE POPULATIONS IN SOUTH AUSTRALIA IN 1999**

| Population | No. trees | % Palmitic | | % Palmitoleic | | % Stearic | | % Oleic | | % Linoleic | | % Linolenic | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | sampled | range | mean | range | mean | range | mean | range | mean | range | mean | range | mean |
| 11 | 5 | 9.6-15.7 | 13.7 | 0.4-2.2 | 1.4 | 2.0-3.3 | 2.6 | 57.3-73.3 | 67 | 10.2-21.0 | 13.5 | 0.6-0.8 | 0.7 |
| 12 | 9 | 9.3-14.1 | 12.3 | 0.7-1.9 | 1.2 | 2.0-3.1 | 2.4 | 59.9-82.7 | 73.5 | 3.7-20.4 | 9.1 | 0.5-0.8 | 0.6 |
| 13 | 14 | 8.2-21.0 | 11.9 | 0.4-2.4 | 0.9 | 1.5-3.4 | 2.2 | 47.3-81.3 | 70.6 | 4.3-25.6 | 12.6 | 0.4-1.2 | 0.6 |
| 1 4 | 18 | 9.1-19.4 | 13.7 | 0.4-3.1 | 1.3 | 2.0-9.7 | 3.3 | 49.6-77.1 | 65.2 | 6.7-25.3 | 14.5 | 0.4-0.9 | 0.6 |
| 15 | 11 | 10-17.3 | 13.2 | 0.4-2.0 | 1 | 2.1-3.7 | 2.7 | 54.3-77.5 | 69.8 | 5.0-25.7 | 11.7 | 0.4-1.7 | 0.7 |
| 1 6 | 6 | 8.5-14.0 | 11.4 | 0.4-1.6 | 0.8 | 2.2-4.8 | 3.1 | 60.5-81.2 | 72.8 | 5.2-17.3 | 10.4 | 0.4-1.1 | 0.6 |
| 1 7 | 28 | 9.3-21.2 | 13.5 | 0.3-3.6 | 1.1 | 1.7-4.1 | 2.9 | 55.8-79.3 | 67.7 | 3.8-20.4 | 13.1 | 0.5-1.1 | 0.7 |
| 18 | 4 | 14.2-18.2 | 16.4 | 1.4-2.2 | 1.7 | 2.0-3.1 | 2.4 | 52.3-64.8 | 58.4 | 12.5-22.6 | 18.8 | 0.7-0.9 | 0.8 |

The results suggest that there is great variation in all of the measured characters amongst the wild olive populations in South Australia. While the current focus of the program is on oil quality, the selections with large fruit will be investigated in the future for table olive potential. With this extraordinary gene pool at our fingertips much can be achieved through the University of Adelaide selection and breeding programme utilising wild olives that show superior morphological and oil characteristics (Sedgley and Wirthensohn, 1999).

# 6. Implications

The olive oil industry will benefit from this research. At present the industry is very small in terms of value, but has a large number of interested growers who suffer from a dearth of improved planting material. The olive oil market is estimated to be growing at a rate of approximately 15% per year, and there is the potential to increase production, and so to replace imports of olive products currently valued at $100 million. We further aim to assist in the development of an export market in olive products by targeting niche markets of high quality and distinctive flavour, a powerful potential demonstrated by the Australian wine industry. Vital components of this benefit will be the development of new improved cultivars, DNA analysis of new cultivars for nursery quality assurance, and chemical analysis as a key element of oil quality assurance for growers and processors.

# 7. Recommendations

Superior selections are currently under evaluation alongside established cultivars in the National Olive Variety Trial at the Roseworthy Campus of the University of Adelaide. Further years of testing are required to determine which should be registered with the Plant Breeders Rights Office in Canberra.

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