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Phenolic profile and Sensory Attributes of New Zealand 'Frantoio' Extra Virgin Olive Oil (EVOO)

A thesis submitted in partial fulfilment of the requirements for the degree of Master of Technology in Food Technology at Massey University, New Zealand

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Abstract

Commercial production of premium extra virgin olive oil (EVOO) in New Zealand (NZ) is gaining international reputation due to distinctive composition and flavour characteristics of the oils. There were two main objectives of this research. The first was to characterise 'Frantoio' olive oil produced from olives from three orchards in different NZ growing regions (Hawke's Bay, Bombay and Waiheke Island) in terms of phenolic profile, sensory attributes and composition of fatty acids and tocopherols. The oil was also analysed for specific EVOO chemical quality index required by the International Olive Council (IOC). The second objective of this study was to investigate the potential application of Maturity Index (MI), dry matter, total solids and fruit firmness as measures of the olive maturity specific to NZ growing climate. The olives were harvested at different maturities after full bloom and oil was extracted by accelerated solvent extraction (ASE) throughout the season and by cold pressed (CP) extraction at two defined harvest maturities. The CP oils were evaluated by a trained panel for sensory attributes and a chemical test for the intensity of bitterness was carried out.

Total phenolics were found to decrease with maturity in the oil from the three orchards. Several simple phenols, hydroxytyrosol, tyrosol, vanillic acid, vanillin, *p*-coumaric acid and ferulic acid were quantified in oils using HPLC. Hydroxytyrosol and tyrosol declined with fruit maturity. Luteolin was the main flavonoid identified. Significant quantitative differences between the orchards was found in the concentration of secoiridoids, which were identified as the main phenolic compounds 3,4-DHPEA-EDA, *p*-HPEA-EDA, 3,4-DHPEA-EA, *p*-HPEA-EA (*p*-value<0.05). The total phenolic content (R^2=0.79), intensity of bitterness (IB) (R^2=0.81) and oleuropein bitter index (OBI) (R^2=0.93) were found to be highly correlated to the perceived sensory bitterness. Strong positive correlations between sensory bitterness, pungency and concentration of individual secoiridoids demonstrated the important role played by these compounds in the flavour of virgin olive oil (R^2>0.73). Oils from the different orchards were found to have different distinctive aroma and flavour attributes for NZ 'Frantoio' VOO which were described as 'bitter salad', fresh 'green bean', 'vanilla toffee', 'walnut' and 'black pepper'. A strong correlation was also found between total phenolics and oxidative stability determined by a Rancimat® (R^2=0.96). All the CP oils were classified as 'extra virgin' by the chemical and sensory tests, except for the Hawke's Bay late harvest that

was found to be rancid due to prolonged effect of frost. Orchard differences in % fatty acid composition were observed. Oleic acid was the lowest in Waiheke (77.3 %), compared to Hawke's Bay (80.5 %) and Bombay (81.3 %) while α-linolenic acid was (1.01 %) in the Bombay VOOs. The concentration of tocopherols was similar in VOOs from the three orchards. Oil accumulation (% dry weight) showed a good indication of olive maturation. Total solids, maturity index and firmness showed strong correlations with % oil content (R^2>0.6). This study revealed orchard differences in phenolic content and sensory attributes of the oils studied. In conclusion, climate and location influenced fruit colouration, growth, accumulation of oil, total solids and composition of phenolics and fatty acids in the oil. To achieve balanced oils with acceptable sensory levels of bitterness, pungency and fruitiness, olives should be harvested at the point of maturity which will provide not only maximum yield but also balanced chemical composition, particularly phenolics.

Dedication

I dedicate this work to my beloved wife, Rosemary Achola

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Acronyms and Abbreviations

3, 4- DHPEA	3,4-dihydroxyphenyl ethanol or hydroxytyrosol
3,4-DHPEA-AC	3,4-dihydroxyphenylethanol acetate or hydroxytyrosol acetate
3,4-DHPEA-EA	3,4-dihydroxyphenyl-ethanol linked to elenolic or dialdehydic form of oleuropein aglycone
3,4-DHPEA-EDA	3,4-dihydroxyphenylethanol linked to dialdehydic form of elenolic acid or dialdehydic form of decarboxymethyl oleuropein aglycone
AOCS	The American oil chemists' society
ASE	Accelerated solvent extraction
C12:0	Lauric acid
C14:0	Myristic acid
C16:0	Palmitic acid
C16:1	Palmitoleic acid
C17:0	Heptadecanoic acid
C17:1	Heptadecenoic acid
C18:0	Stearic acid
C18:1	Oleic acid
C18:2	Linoleic acid
C18:3	Linolenic acid
C20:0	Arachidic acid
C20:1	Eicosenoic acid
C22:0	Behenic acid
C22:1	Erucic acid
C24:0	Lignoceric acid
CP	Cold pressed
DAFB	Days after full bloom
EA	Elenolic acid
EVOO	Extra virgin olive oil
FAME	Fatty acid methyl ester
FFA	Free fatty acids
g	Grams
HPLC	High performance liquid chromatography
IOC	International olive council

LLE	Liquid-liquid- extraction
M	Molar
meq/kg	Milli equivalents per kilogram
mg	Milligram
MI	Maturity index
mL	Millilitre
MUFA	Monounsaturated fatty acid
p- HPEA	*p*-hydroxyphenyl ethanol or tyrosol
p-HPEA-EDA	*p*-hydroxyphenylethanol linked to dialdehydic form of elenolic acid or dialdehydic form of decarboxymethyl ligstroside aglycone
PUFA	Polyunsaturated fatty acid
PV	Peroxide value
SFA	Saturated fatty acid
VOO	Virgin olive oil
µL	Microlitre