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Phenolic content of olive oil is reduced in extraction and refining

Analysis of phenolic content of three grades of olive and ten seed oils.

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Three grades of olive oil and ten vegetable cooking oils were analysed for their phenolic content. It was hypothesised that as olive oil passed through the chemical extraction process, polyphenols would also be removed, thus reducing the antioxidant properties of olive oil. Other commonly used edible vegetable oils were analysed for comparative reasons. Extra virgin olive oil was found to have the greatest amount (48 µg/gram of oil) of polyphenols, when compared with other olive or vegetable oils. No polyphenols were detected in sunflower, walnut, peanut or almond oils. All other oils tested had a polyphenolic content between 2 and 10 µg/gram of oil. The results of the study confirms the above hypothesis that the phenolic content of olive oil is reduced by chemical extraction and refining.

Introduction

The Mediterranean diet, though it can be very high in fat, is associated with a low incidence of coronary heart disease (CHD)[1,2]. In the Seven Countries Study, it was found that in Crete 40% of the energy came from fat, yet the incidence of CHD was approximately one-thirtieth the incidence of Finland which had a similar level of fat intake[3]. The fat intake in Crete was predominantly from olive oil, whereas the fat in Finland was predominantly from animal sources. Olive oil is rich in the monounsaturated fatty acid, oleic. In contrast, animal fat is rich in saturates such as palmitic, myristic and lauric acids.

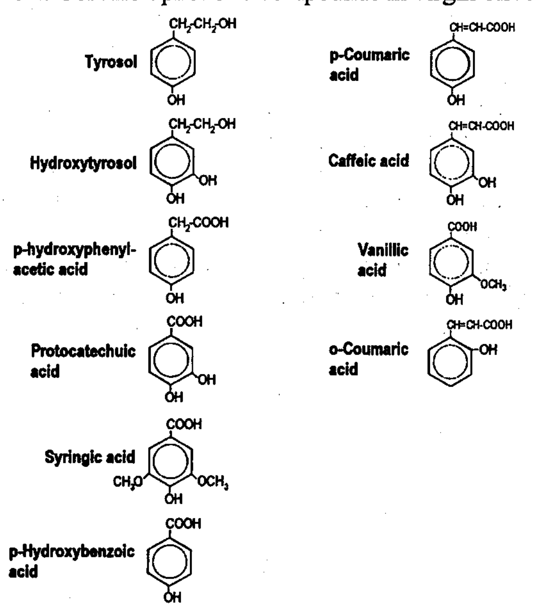
The saturates from animal sources increase serum cholesterol, where unsaturates tend to lower serum cholesterol. An elevated serum cholesterol or more precisely an elevated low density lipoprotein (LDL) is the primary cause of atherosclerosis[4].

A diet rich in monounsaturated fat has similar efficacy to a diet rich in polyunsaturated fat with regard to lowering serum LDL. A diet rich in polyunsaturated fat may induce a decrease in high density lipoproteins (HDL), whereas monounsaturated fat maintains or increases HDL[5,6].

Native LDL is poorly atherogenic, at least experimentally, unless it is modified. *In vivo*, the modification process appears to be predominantly oxidation[7]. A diet rich in monounsaturated fat from olive oil has been found to inhibit oxidation of the LDL[8]. However, Scaccini et al have found that the antioxidant effect is not fully explained by the monounsaturated fatty acid content nor by the vitamin E and carotenoids which are in olive oil[9].

Olive oil has other components apart from fatty acids, which effect taste, colour and may have significant biological actions. In the "polar fraction" of olive oil there are more than a hundred different compounds, a significant proportion being the phenolic compounds; polyphenols and tocophenols. Phenols are a large class of compounds seen in nature and are molecules with an hydroxyl group attached to a benzene ring. There are over 4000 different phenols found in plants. In olive oil the term "polyphenols" is used by convention because not all of them are polyhydroxy derivatives. There are at least ten polyphenols which are reported to occur frequently in olive oil. (Figure 1).

Figure 1. Common phenolic compounds in virgin olive oil.



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The polyphenolic content of olive oils affects the stability of the oil and there is a strong antioxidant effect according to the amount in the oil[10]. They also have a significant effect on flavour.

Polyphenols also inhibit oxidation (lag phase) of LDL and may stimulate antioxidant enzymes such as catalase[11,12]. Phenolic compounds may inhibit eicosanoid metabolism, have antiplatelet effects and may increase HDL[13]. Antifungal and anticarcinogenic properties have also been reported. The phenols; Butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT) which have significant anti-oxidant properties inhibit experimental atherosclerosis. Other phenolic compounds have been shown to have a vasodilator action and phenols may inhibit ischaemic and reperfusion arrhythmias[14]. Recently, the Zutphen Elderly Study was reported to show flavonoid intake significantly inversely associated with mortality from CHD (p=0.015)[15]. The relative risk of CHD mortality in the highest versus the lowest tertile of flavonoid intake was 0.42 (95% CI 0.20-0.88). In olive oil 3,4-dihydroxyphenyl-ethanol (hydroxytyrosol) probably is the most important phenol responsible for the highest oxidation resistance of the oil[10]. In addition, hydroxytyrosol purified from olive oil has been shown to inhibit oxidation of LDL *in vitro*[16].

Methods

The oils were commercially produced. The polar fraction of the oils was extracted by a methanol-water mixture. This was evaporated in a rotary evaporator, the residual was dissolved in ethanol and spectrophotometric determination was made according to the method of Gutfinger[17].

Results and discussion

There was a significant difference in polyphenolic content in the three grades of the olive oil (Table 1). With refining, the polyphenolic content decreased significantly and there was also fewer polyphenols in the nut and seed oils. The extra virgin olive oil had significantly more polyphenols than the other oils and four of the other oils had no detectable phenols. Clearly, the phenolic content in commercially available edible oils varies considerably, with the highest content being in extra virgin olive oil in this study. The amount found in our study is considerably less than in the Papadopoulos study[10], and this is not explained. The amount of polyphenol in oil depends upon the conditions in which the oil is extracted from the fruit. For example, a continuous centrifugal system of extraction may reduce the amount of phenols in the oil compared to classic pressing. Also in the refining process longer mixing times lower phenolic content of oils[11]. In contrast higher temperatures increase phenolic content. The nut and seed oils analysed in our study had little or negligible polyphenolic content and this may relate to the extraction process rather than the presence in the nut itself.

Table 1. Polyphenolic contents of olive oils and other seed oils

Oil	Description	Total Polyphenols (μg/g oil)
Olive - extra virgin	Giralda, Spain	48
Olive - extra light	Giralda, Spain	11
Olive - cold pressed	Bertolli, Italy	10
Macadamia	Aussie Mate, Aust.	9
Avocado	Australia	6
Sesame	Proteco, Australia	6
Canola	Meadow Lea, Aust.	4
Soya	Top Cook, NZ	4
Grapeseed	Azalea, Italy	2
Sunflower	Meadow Lea, Aust.	0
Peanut	Chefol, Australia	0
Walnut	Rougie, France	0
Almond	Expeller pressed, Hain USA	0

Seed oil extraction almost invariably involves the use of hexane as an organic solvent extractor. Probably this is responsible for the low or nondetectable levels of polyphenols in these oils. When hexane extraction is used to extract oil from the olive pomace the resultant oil is also low in polyphenols. Further refining by bleaching and decolouration may also contribute to polyphenol loss. Along with polyphenols, other significant compounds may be lost with refining.

Conclusion

The high polyphenolic content in extra virgin olive oil may be of clinical relevance in a diet rich in monounsaturated fat. These compounds appear to have favourable health effects, and their levels may be a surrogate for other important biologically active constituents in the polar fraction of oils. More research is needed to establish the polyphenolic content and individual phenols in various edible oils and foods. These so-called "minor constituents" of food and oils may have a considerable influence on health and disease, and in particular, atherosclerosis.

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橄欖油經抽提和精製後酚含量減少：三個等級的橄欖油和十種植物種子油酚含量的分析

摘要

作者分析了三個等級的橄欖油和十種植物食用油的酚含量，並與其它常用植物油分析的結果相比較。他們假定橄欖油經化學抽提後多酚被除去，因而降低了橄欖油的抗氧化性質。作者發現特別純淨的橄欖油，與其它橄欖油和植物油比較，含有最大量的多酚（每克油含 48 微克）。除葵花油、胡桃油、花生油和杏仁油測不到多酚外，所有其它油酚含量每克在 2～10 微克之間。作者証實了上述的假定，橄欖油經化學抽提和精製後酚含量減少。

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