Olive Oil Fatty Acid Profiles and Other Components

Guido Costa

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Guido has worked in the family olive farming business in Paarl (60 km from Cape Town, South Africa) since completing studies in 1987: responsibilities include processing of table olives, production of olive oil, propagation of olive trees, conversion of operation to full organic production, etc., etc. The family business (F. Costa & Sons) was founded by his Italian horticulturalist grandfather, Ferdinando Costa, in 1904 as the first olive/olive oil business in South Africa. COSTAS Olives and Olive Oils are the oldest established olive product brands in S.A. His qualifications include: BSc (Physics & Chemistry majors), BSc. (Hons.) (Chemistry), MSc (Chemistry) cum laude, MBA (University of Cape Town).

Varying fatty acid profiles in olive oils from different areas can modify the ratio of Saturated vs. Monounsaturated vs. Polyunsaturated fatty acids(SFAs, MUFAs & PUFAs). Tunisian oil, for instance, is relatively high in SFAs (specifically palmitic) and low in MUFAs (specifically oleic), whilst Australian (and South African) oils are much higher in MUFAs and lower in SFAs. From the health point of view, the latter oils are preferred, because of the proven beneficial effect of MUFAs on our serum cholesterol levels. MUFAs have been shown to lower "bad" LDL cholesterol (low density lipoproteins) yet retain "good" HDL cholesterol (high density lipoproteins). This, chemically speaking, is in fact the major benefit of olive oil over the highly polyunsaturated seed oils, wherein the PUFAs reduce both the "bad" as well as the "good" serum cholesterol levels in our blood.

Once the fatty acids in the oil have hydrolysed into free fatty acids (FFAs), it doesn't make too much difference whether they are saturated or not. All FFAs should be minimised. Olive oil having a FFA of 0.18% is about as good as you'll get without refining. The varying content of PUFAs affect the stability of the oil to quite an extent. Higher polyunsaturation tends to yield a more unstable oil, as the conjugated diene or triene bonds (single-double-single-double-single ...bonds) in these oils are particularly sensitive to thermal- and photo-oxidation. This is because of the free radical chain reaction which takes place during oxidation occurs much more easily in such alternating single and double bonds. This leads to another important benefit of olive oil over its rivals, namely its superior high temperature behaviour (in cooking & frying). Good olive oil can be re-used much more often for frying, for example, than highly polyunsaturated seed oils.

Linolenic acid (C18:3) is an 18 carbon chain with 3 conjugated double bonds. As mentioned, it is one of those fatty acids which are quite sensitive to oxidation. However, the difference between Tunisian and Australian oils in this respect is minimal. One should look at the total content of polyunsaturated fatty acids to gain an idea of potential oxidative stability. This would include the content of both linoleic (C18:2) and linolenic (C18:3) fractions. My own preference would be rather for more monounsaturated oleic acid (C18:1) and less of the linoleic and linolenic. In nature one finds that most of the double bonds in the above-mentioned polyunsaturated fatty acids are of the "cis" geometrical isomers. This is in contrast to the "trans" fatty acids (TFAs) which are prevalent in artificially "hardened" fats like margarine. Trans fatty acids yield more linear molecules, which "pack" more efficiently, consequently yielding fats which solidify at higher temperatures. Reference has previously been made to the supposed ill-effects of TFAs. I am not qualified to comment on these claims, save to say that I don't consume margarine, and would rather have butter if olive oil was not an option.

The fatty acid profile does not, as far as I am aware, affect the flavour of the oil. It is the minor constituents (in the unsaponifiable matter) as well as the degradation products (of hydrolysis and oxidation) which are responsible for the good or bad flavour. Minor constituents affecting the flavour of olive oil include complex polar phenolic compounds (polyphenols, which also act as antioxidants), as well as over 100 other minor alcohols, aldehydes, ketones, esters, ethers, acids, terpenes, thiols and thiophenes. All of these minor components make up a mere 1% of the oil, the balance being the triacylglycerols. More than 30 different compounds have been positively identified as being important in contributing to the specific flavour profile of olive oil, including compounds responsible for "fruity", "green apple-like", "green grassy", "green bitter", "fatty", "earthy", "malty", "metallic", "soapy" and "burnt" notes.

Many of these compounds are polar, or water-soluble, and are unfortunately lost to a greater or lesser extent during extraction, especially in the old 3-phase decanters. Everything is lost during refining (including the bad flavours)!

Viscosity, I think, is affected more by temperature than anything else. Physico-chemically speaking, olive oil does not vary much, so I wouldn't think that viscosity varies perceptibly between Extrra Virgin Olive Oils (EVOOs) at any given temperature. I've heard certain of our friends singing the praises of their fresh "viscous" oils, but I've yet to be convinced that this is more than vivid imagination on their part. I stand to be corrected. There is, however, a possibility that a protein-polymerised phenol complex (sometimes the culprit in persistently cloudy olive oil), can lead to a very slighty increased viscosity.

Nose is very definitely affected by the minor components, as discussed above. A good oil shouldn't have much odour, just a delicate fragrance. It's usually the poorer oils that smell, invariably the result of volatile compounds resulting from the decomposition of the hydroperoxides, formed during the oxidation of the oil, leading to the "winey" and "fusty" defects.

The peroxide value is a measure of the active oxygen bound by the oil. It reflects the hydroxyperoxide value, and is one of the simplest measures of the degree of lipid peroxidation. During oxidation of the oil, 2 atoms (1 molecule) of oxygen attack a double bond, forming a hydroperoxide. The lower the peroxide value, the better. Peroxide value usually increases gradually over time, as the oil slowly oxidises on storage after pressing. The natural antioxidants found in virgin oil (alpha tocopherol (Vitamin E) as well as the polyphenols) help protect the oil against this oxidation, but eventually become completely consumed. The addition of natural tocopherol (especially delta tocopherol) will assist in cases where the inherent tocopherols have been lost in processing or refining.

As can be inferred from the above, extra virgin olive oil is a pretty complex animal (vegetable!). Theoretically it would probably be possible to improve on any specific sample, by slightly increasing this or decreasing that, but the "ideal" olive oil would be like the "ideal" car, or house, or wine. It is a rather subjective concept, and will depend on your specific requirement. Some like a strong, peppery Tuscan oil, others like a mild, easy-going one, some like an over-fruity Spanish one. But all should have a good measure of the positive attributes, no negative attributes, good stability, and high monounsaturation. The natural biosynthesis of oil in the
fruit is dependant on many different factors, including cultivar, climate, terroir, photosynthetic activity, enzymatic activity, etc., etc. It may be liquid gold, but it's not an alchemistical mix.

Rancimat Index

A Rancimat Index of an oil is a measurement of the degree of its resistance to oxidation. It is a high speed oxidation test done at elevated temperature, and entails bubbling air through a sample of oil. The condition of the oil is monitored by constantly measuring its conductivity. A sudden change in conductivity after a few hours indicates the expiry of the inherent antioxidative protection of the oil, and is an indication of the potential shelf life of that oil.

The Rancimat index is always related to the specific temperature at which the test is done. Normally this temperature is 110 degrees C, and it is best to stick to this temperature to make meaningful comparisons between oils.

Groundnut oil without added antioxidant gives a value of 8 to 10 hours @ 110C. Groundnut with 200 ppm delta Tocopherol gives about 18 hours. Groundnut with TBHQ gives about 12 hours. Canola with 200 ppm delta Tocopherol gives about 21 to 23 hours. Sunflower with 200 ppm delta Tocopherol gives about 18 hours. Crude seed oils give higher values than refined seed oils (normally about 8 to 10 hours), as the crude oils contain natural antioxidants (tocopherol), and the refined oils contain none. Refined seed oils thus require the addition of antioxidants, normally TBHQ, BHT, BHA, or preferably, delta Tocopherol. Highly polyunsaturated oils have a lower Rancimat index than highly monounsaturated oils, like olive and canola, as the conjugated double bonds in polunsaturates are targeted in the actual oxidation process. Extra Virgin Olive Oil should have a rancimat index of at least 6 to 8 hours, and preferably more