The scientific truth on cooking with extra virgin olive oil

Which is the “ideal” cooking oil? Many factors determine it, but it is not about the best solution. A study by Lorenzo Cerretani, Giovanni Lercker and Tullia Gallina Toschi sheds finally light on old and unresolved prejudices

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In the real and experimental kitchens of the world the never ending gastronomic, molecular and nutritional debate on the “ideal” cooking oil involves socio-economic aspects, such as the cost or availability of oil in that specific corner of the world.

It is well known that everyone tends to give value to what he has and knows. Asians have soy, Northern Europeans butter, Italians lots of olives...and Italians, aware of their identity, lucidly try to understand why their “Mediterranean” choice is, at least in theory, the best.

First of all, let’s wear the toque, and let’s get busy with the most drastic cooking. A chef, when frying, looks for the excellence of the taste, the fulfillment of hedonistic and sensorial qualities, the balance between oil and food, the crispness, the right temperature, the freshness, the good smell, the lightly deep fried balance, a not too greasy taste.

A nutritionist doctor would not share the same concerns, but would be interested in the healthiness of the oil, the potential toxicity, and would only approve a sporadic intake of fried food, or with moderation. The type of oil would not affect the concern for the caloric intake, which would become more relevant with saturated fats rich oils, such as coconut oil, margarine and lard, which are deeply absorbed by the food.

As chemists and food technologists, we would look for the oil that better resists to oxidation, and that preserves its chemical and sensorial properties. If the oil is not changed, but only consumed and added, this is an issue of relevance.

In presence of such different points of view, what is the right oil? The “gastro-physicist” Nicholas Kurti said once at Oxford, in order to give impulse to a wider application of scientific concepts in the kitchen and to a less empirical approach to cooking: “It is sad that nowadays we can measure the temperature of Venus atmosphere, but we do not know what is going on inside our soufflé”.

Inspired by these words, we can go back to the cooking procedures, starting with frying, which is an extreme application, together with baking. A food fries, vibrating as it is dipped

into the oil, sustained by water vapour in micro bubbles, cooks, dehydrates and becomes crispy.

The oil temperature varies from 160 to 240 °C, with an optimal value around 180 °C. The oil heating and the effect of oxygen are factors that can ignite the oxidative process. Oxidation produces a chemical degeneration of the oil, an accumulation of free radicals and other toxic molecules. The resistance to oxidation of an oil is affected by two factors mostly: the fat acids composition, or the unsaturation degree, that can visually perceived as a higher or lower fluidity of the oil at room temperature; and the presence of anti-oxidative compounds, that protect both the oil and the food.

The fluidity of the oil, which depends in particular on the higher presence of poli-unsaturated fat acids, can cause a more easily oxidable oil. This is typical of those oils which are less adapt to frying, such as soy and corn oils, which are very rich in poli-unsaturated fat acids, with a preponderant presence of linoleic acid (about 50%) and an amount of linolenic acid greater than 5%. On the contrary, palm oil is more stable thanks to a high content of saturated fat acids, such as palmitic acid, present in quantities larger than 40%.

The chefs are right, though, when they say that a soy oil, perfectly preserved and used just once, can give a light fried food, because its fluidity allows the food not to absorb too much oil. For example, this can be the case of the Japanese tempura. Still, a food fried with a highly unsaturated oil could be rich in free radicals and oxidation products.

At home, it is not easy to control the quality of our oil. How long does a bottle remain open? What is its storing temperature? How much “dangerous” air is in it? Is it stored away from light? A soy oil, in bad storing conditions, can fully oxidate.

Olive oil represents a good compromise between fluidity and resistance for its high content (65-70%) in oleic acid, which is mono-unsaturated and less oxidable than poli-unsaturated fat acids. It is less fluid than soy oil, but, as the peanut or sunflower (with high oleic acid content, as it is now preponderant on the market) oils, it is much more fluid than palm oil. This means that the fried food will not be too greasy (especially if we do not forget to dry it!) and the oxidation is limited.

An added protection can come from antioxidants, which belong to two categories, lipophilic antioxidants (mainly tocopherols), more soluble in oil, and hydrophilic antioxidants (mainly acids, phenolic alcohols and compounds), more soluble in water. Tocopherols are destroyed or inactivated at 180 °C, while biphenols and polyphenols are more resistant and oil protective at higher temperatures.

These compounds are present exclusively in the extra virgin and virgin olive oils. Polyphenols are important for cooking, tocopherols for the preservation at room temperature. Actually, phenolic substances and tocopherols act in synergy, but this topic is another story. Here, we can be content to remind that the important variables for the resistance to oxidation of a cooking oil are an average index of unsaturation and the presence of phenolic antioxidants. The lattest, according to a recent study by Università Federico II di Napoli

researchers (Napolitano et al., 2008), prevent the International Agency for Research on Cancer and can form during the uncontrolled frying of potatoes, or the baking of some food or the roasting of coffee.

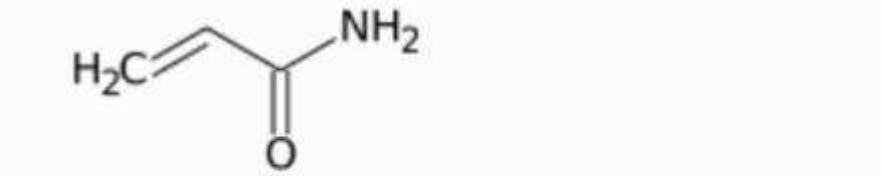

Figura 2: Acrilammide (2-propenammide).

All these evidences support the use of extra virgin olive oil. Only virgin and extra virgin olive oils can be commercialized without refinement, thus maintaining the phenolic substances. There are still two factors against extra virgin olive oils: the smoke point and its sensorial features.

The smoke point refers to the temperature at which an oil begins to emit toxic, mutagenic, and carcinogenic smokes, which contain aldehydes, such as acrolein, whose formation should be limited as much as possible.

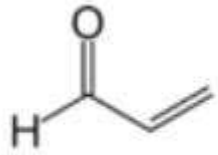

Figura 3: Acroleina (2-propenale).

Oddly enough, the smoke point does not depend on the degree of unsaturation of the oil but it is rather an indicator of the breaking of the bond between the glycerol and fat acids (Katragadda et al. 2010). At high temperatures, the glycerol undergoes oxidation and turns into acrolein, which can form in other ways too, although the decomposition of glycerol is preponderant at high temperatures (> 230 °C). The oil burns at as low temperatures as the carbonic chain of fat acids is short (short acids, such as lauric acid, are not adapt to cooking), producing several other aldehydic substances, not desirable from a nutritional standpoint.

The rule that recommends to use high smoke points oils is correct, although the smoke point of extra virgin olive oil is not so critical as one may think, especially if the oil is of good quality and the temperature of frying is in the right range. The smoke point is lower (<160°C) for those highly acid virgin oils which are not adequate for frying neither for composition or for taste when heated (what a disgusting thought is the idea of frying with a flawed oil!). As recently indicated by Katragadda, an extra virgin olive oil can have a smoke point higher than 190 °C and it could produce less acrolein than a safflower oil or rape seed oil 180°C. The acidity should be low, as well as the concentration of partial glycerides, free acids, and glycerol, that reduce the smoke point. According to the law, the acidity of an extra virgin

olive should not exceed 0,8 (g/100 g), but a good and fresh oil can easily have an acidity lower than 0,4 (g of acido oleico per 100 g di olio). The only remaining issue is taste: some chefs are just skeptical about frying with extra virgin oils due to their too intense aroma and taste.

The idea of an excessive “aromatic charge” of extra virgins is often a prejudice. If we consider the variability of volatile and persistent compounds (smell and taste) according to the cultivar, it is evident that the right oil can be found for any use. Varieties such as the Taggiasca from Liguria or the Casaliva from the Garda lake region are characterized by a delicate “aromatic charge” (as it is classified in competitions), very different from very intense qualities such as the Nocellara from Belice in Sicily or the Nostrana from Brisighella in Romagna. Nonetheless, the fruited taste of an olive and of its oil is not a univocal flavor.

The first two oils, from Taggiasca and Casaliva, are characterized by a pleasant smell of olive and tones of almond, whereas the Nocellara contains notes of tomato and the Nostrana notes of artichok and thistle. The chefs who do possess an oil culture are masters are taking the most out of these smell notes, although they know that these peculiar smells tend to be perceived less during the frying of a good. They are volatile, and high temperatures tend to remove.

Fortunately and unfortunately, the extra virgin olive oil is a prized product, but the market is saturated with low quality oils, such as those low price oils, with a “cat urine” smell, which results persistent, and preponderant, although it is often identified as “varietal smell”. This note does not give any value, is not subject to the heating, covers the other, more valuable notes, and is responsible for the consumers habituation to a not authentic “extra virgin smell” in their smell memory.

This effect is especially harmful with children who eat junk food or fries fried in low quality oils, because they become used to heating defects and rancid smells, that they do not associate any longer to something negative for the taste.
The sensorial concerns inherent to the use of extra virgin olive oils when frying, rather than being due to combination problems, which are actually stimulating, are due to the lack of a diffused culture of “oil taste” and in the large quantity of bad extra virgin oils on the shelves, tables, and kitchen.
Our research group has investigated the use of extra virgin oils in different cooking contexts (Bendini et al., 2007), using three types of oils and fats in typical receipts of the homely Italian gastronomy: meat sauce, baked roasted veal, pan fried beef slice. Two different types of extra virgin oils, different for their bitter and hot notes, a sunflower oil and butter have been tested with respect to their resistance to oxidation.

Our results have supported the use of extra virgin olive oils. The reasons of their better performance have been found to be related to the presence of phenolic substances, able to protect the fat substances from the acceleration of oxidation induced by the heating. Only the drastic conditions of the meat sauce cooking have brought to an almost complete decomposition of phenols.
Our reasoning brings to a conclusion: using extra virgin olive oils to cook is an excellent choice, both for the taste and for health, provided that a high quality, fresh and not acid oil is chosen.

One last observation. Does it make sense to use extra virgin oils to cook, especially to fry,

given their price and value? In our opinion, yes, and we can suggest solutions to save, such as frying less often or frying according to the Asian style, in a wok type pan, where the oil is concentrated at the concave bottom of the pan, thus reducing the necessary quantity that dips the food.

Last, frying requires a great quantity of oil, so that a good idea could be mixing more oils in the same pan: for instance, by diluting a peanut oil with 30-40% of excellent quality olive oil to protect the oil, the food and our organism from the free radicals and from the toxic substances that are produced by the chemical reactions occurring while frying.

References:

Bendini A., Cerretani L., Cane A., Gallina Toschi T., Lercker G. L'impiego a caldo degli oli extravergini di oliva. In atti del "8° Congresso Italiano di Scienza e Tecnologia degli Alimenti (CISETA)" Tuttofood, Fieramilano, 7-8 maggio 2007, pp. 11.

Katragadda, H.R., Fullana, A., Sidhu, S., Carbonell-Barrachina, A.A. Emissions of volatile aldehydes from heated cooking oils. Food Chemistry 120 (1), pp. 59-65 (2010).

Napolitano, A., Morales, F., Sacchi, R., Fogliano, V. Relationship between virgin olive oil phenolic compounds and acrylamide formation in fried crisps. Journal of Agricultural and Food Chemistry 56 (6), pp. 2034-2040 (2008).

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