# Inspector Clouseau –Please Call Your Office!

By: David C. Kennedy, PhD

Those with a love of mysteries will fondly remember Inspector Jacques Clouseau, the hapless French police detective immortalized in the Pink Panther movies by the late Peter Sellers. Inspector Clouseau, despite his total ineptitude, managed to solve major crime by pure, blind luck. The comedy element here is the counter-intuitive concept that a bumbling, clueless detective could effortlessly solve complicated crimes committed by evil, criminal masterminds. Alas, in the real world, we need all the help, skill and knowledge we can muster to avoid being victimized by the "bad guys", whether they be Ponzi scheme perpetrators, cyber criminals, or even **olive oil counterfeiters.**

That nifty little segue takes us directly into today's topic: the adulteration or counterfeiting of Extra Virgin Olive Oil or EVOO for short. As we shall see, the counterfeiting of EVOO might be one of the most egregious examples of the economic crime of food fraud that is occurring in the world today. EVOO counterfeiting is going on this very minute – both figuratively and literally – right under our noses (and taste buds). But how do we know this?

**The prevalence of adulteration.** A landmark study released in 2010 by the University of California, Davis Olive Center[1] reported that,

> "69% of imported olive oil and 10% of California olive oil samples labeled as extra

> virgin olive oil failed to meet the IOC/USDA sensory (organoleptic) standards for extra virgin olive oil."

The study went on to say, "Sensory defects are indicators that these samples are oxidized, of poor quality and/or adulterated with cheaper refined oils." Unfortunately, this study has been incorrectly reported in the popular press to imply that the majority of extra virgin olive oils are adulterated. However, while the report does not draw that extreme conclusion, it certainly establishes a solid basis for concern.

At the other end of the spectrum, a paper published in 2015 by USFDA scientists[2] reported on the testing of 88 samples labeled as extra virgin olive oil. This study used the IOC (International Olive Council) official method to profile the dimethylsterols and triterpene dialcohols that are characteristic of EVOO. Three of the samples (3.4%) were judged to be adulterated. However, two of the three control samples that had been spiked with 10% hazelnut oil were reported as false negatives. This suggests that the study's 3.4% rate of adulteration could be biased low if used as an estimate of the rate of adulteration that actually occurs in commerce.

**The economic impact.** However, based upon current production figures[3], even a 3.4% level of adulteration translates into 10,000 tons/yr of adulterated product. This 10,000 tons/yr equates to 20 million pounds/yr. of counterfeit EVOO. If we assign a retail value of $6/lb ($48/gallon) for EVOO, this translates to $120 million/year of adulterated EVOO being sold as genuine EVOO. Therefore, even though the rate of adulteration might well be low, there is still a considerable economic impact.

**How is this possible?** How could 20 million pounds of counterfeit EVOO possibly be produced and distributed every year? The simple explanation is that somewhere along the international supply chain, people intentionally diluted genuine EVOO with less expensive edible oils. This results in a "watered down" olive oil product that is impossible to distinguish from "real" EVOO by means of taste and odor, at least by the average consumer. With genuine EVOO retailing for around $6/lb and canola oil selling for about $1/lb, at an adulteration level of 20% counterfeiters would gain *stolen* profits of around $20 million dollars per year—year in and year out. It is clear that consumers are being cheated and equally clear that this is a serious economic crime. Therefore, since the counterfeiting of EVOO is an actual crime, it will be instructive to employ the science of criminology to give us a better perspective on how it can be combated.

**The criminology of olive oil counterfeiting.** There are many excellent references which provide a detailed treatment of the subject of the criminology of food adulteration[4]. However, let me give you the simple summarized version:

> The prevalence of the crime of EVOO adulteration is *directly* proportional to: (a) the potential economic gain and (b) the means and opportunity to commit the crime. However, it is *inversely* proportional to (c) the probability and consequences of getting caught. In other words, the more likely you are to be caught, the less likely you are to commit the crime. Obviously, as was demonstrated above, the economic gain (a) for potential EVOO counterfeiters is very large. Likewise there are plenty of opportunities (b) all along the supply chain to simply dilute the EVOO with less expensive edible oil. Now, consider (c), the probability and the consequences of getting caught; the elements that would deter the potential adulterator. Now, there may indeed be severe consequences *if* you are caught, but first you have to *get*

> caught! If there is a low probability of detecting the crime of adulteration then there is also a low probability that criminals will be deterred. Detection of the crime is the weak link in the EVOO criminology equation and this is precisely where analytical chemistry enters the picture.

Since the deterrence of EVOO adulteration is dependent upon our ability to detect the crime, unless there are reliable tests that can unequivocally distinguish “real” EVOO from the counterfeit product, there is no way to prove that a crime was committed. Furthermore, unless such tests are widely employed at all levels of the supply chain, the risk of detection (and therefore, the probability of deterrence) will be low. This begins to shine a useful spotlight on a practical solution to the problem of EVOO counterfeiting.

**Deterrence through testing**. As it turns out, there are a number of recognized, official testing methods that are capable of distinguishing between pure EVOO and the diluted counterfeit product. The IOC method noted above[5] generates a sterol profile for EVOO that is qualitatively and quantitatively different from potential adulterants, primarily refined “seed oils” such as canola oil, corn oil, soybean oil, etc. Consequently, as shown by the FDA study, the method can detect adulteration from a seed oil at a level as low as 10%. Likewise, the IOC FAME (fatty acid methyl ester) method[6] produces a fatty acid profile that is able to distinguish a wide variety of edible oils.

However, although these official methods may yield acceptable results, they have some significant deficiencies. They all tend to be slow and cumbersome leading to low laboratory throughput and productivity. These physical properties—and the resulting high cost of testing—inhibit the widespread use and deployment of these methods. This low frequency of testing in turn decreases the probability of detecting counterfeit EVOO at all stages of the supply chain and increases the probability that adulteration will occur.

**The need for improved testing.** These aforementioned standard tests have low productivity because they are based upon analytical technology that is decade's old and official methods are not frequently updated. However, if current technology were to be applied, more rapid and economical authentication testing regimes could be established. This would increase the probability of detecting EVOO fraud and, according to criminal behavior theory, the prevalence of EVOO counterfeiting should decrease. This is the dynamic that is driving the current effort to modernize olive oil testing methodology.

To illustrate this modernization trend, two recent significant testing improvement examples are offered. The first example[7,8] describes a revision to the IOC sterol profiling method that greatly increases the speed of sample preparation, thereby increasing sample throughput and improving laboratory productivity. These improvements are achieved simply by substituting modern separation media in place of the older, traditional media used in the official method. The second example[9] features the introduction of an improved GC column for use in FAME GC/FID analysis. This new column has a superior ability to resolve the multiple FAME analytes, which allows for much faster chromatographic run times. Here again, modern chromatography products are able to increase the rate of testing, thereby improving analytical throughput and productivity.

**Conclusion.** The examples cited above illustrate the kinds of methodology improvements that can be made, but many more opportunities exist to increase productivity and reduce the cost of testing, thereby further deterring olive oil adulteration. However, olive oil is not the only high value oil at risk for adulteration. There is growing concern that other specialty oils like almond oil and walnut oil, are also at risk of adulteration by low cost seed oils. However, in such case, those tests designed specifically to detect EVOO adulteration may not be applicable to other high value oils which have a much different lipid profile. Clearly, much more work is needed, either to develop a suite of individual tests for each type of edible oil—or ideally, to develop testing methodologies that are able to detect adulteration irrespective of the type of oil.

What might these new testing regimes look like? Well, for starters, imagine the advantages of replacing GC/FID with GC/MS in sterol profiling and FAME analysis. Certainly there are technical and economic barriers that would make such a changeover difficult. However, if it were to be done, one might see the same level of productivity gains in edible oil testing that were experienced in environmental testing when GC-MS tests replaced GC-FID and GC-EC tests many years ago.

Another promising approach is to replace **GC** with HPLC. One inherent shortcoming of the IOC GC-based sterol test is that it doesn't measure the presence of the adulterant itself. Rather it compares the sterol profile of the tested sample to that of an ideal EVOO sterol profile. This makes the test subject to a high rate of false negatives at low levels of adulteration[2]. HPLC test methods have been developed through IOC that focus upon the measurement of certain triacylglcerides that are indicative of the presence of the seed oil adulterants themselves[10]. Since the

contaminants are being directly measured, this approach in principle should be applicable to all high-value “fruit oils”, not just olive oil. Unfortunately, the IOC HPLC-based tests in their present form are not practical for routine use in a high throughput environment so their ability to deter counterfeiting is marginal. However, many opportunities exist to improve the speed and efficacy of the HPLC approach as well so it is likely that HPLC-based techniques may become as common as GC-based techniques in the not too distant future. As evidence of this trend, the current methodology being developed by the FDA to combat olive oil adulteration is an HPLC-based approach[11].

As the frequency and deployment of improved EVOO testing further increases, the probability of detecting adulterated product will increase and the frequency of counterfeiting will decrease. The long-range goal is to make the probability of detection so high that EVOO counterfeiting will no longer be an attractive criminal enterprise, and Inspector Clouseau can focus on other “bad guys”.

## References

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Summary

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Article Name

Modern Chromatography Combats the Crime of Olive Oil Counterfeiting

Description

David C. Kennedy, PhD explores the world of olive oil counterfeiting and how modern chromatography is fighting these crimes with new testing regimes.

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