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Authenticity of Edible Oils—Heading for New Methods

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Dear Reader,

Food fraud is a phenomenon that has existed since people have been doing business with food. Since that time some people have tried to gain benefit by fraud. This kind of fraud started with measures that today seem to be very simple. Examples from that early time of food fraud are addition of water to wine, mixing of sand to flour, or incorrect weights of food. In parallel to food fraud, methods were developed to check food products for authenticity. At the beginning, these methods were limited to sensory tests, microscopic observations, and simple analytical tests such as the detection of acids by the color change of plant extracts.

Nowadays, the fight against food fraud is as relevant as before, and since 2017, with the publication of regulation (EU) 2017/625, issued on March 15, 2017, the focus was also laid in legal regulations dealing with this issue. One aim of this regulation is that risk-oriented control should not be limited only to food safety but also includes authenticity of food. As a consequence of this new regulation in Germany, the National Reference Center for Authentic Food (NRZ-Authent) was established in 2017 at the Max Rubner-Institut to give "competent authorities access to updated, reliable, and consistent technical data, to research findings, new techniques, and expertise necessary for the correct application of [European] Union legislation."

Food adulteration is not only to be seen with regard to the aspect of fraud, but also in terms of a serious safety issue for consumers. Examples are the Toxic Oil Syndrome in 1981, when rapeseed oil denaturated by the addition of aniline was illegally sold as "olive oil" on street markets or the mixing of melamine into baby formula milk. Thus, not only the economic loss is an important aspect but also safety of consumers when discussing about food fraud.

If we look at edible fats and oils, olive oil belongs to the most frequently adulterated foods according to the U.S. Pharmacopeial Convention Food Fraud Database, even though for olive oil in contrast to other edible oils, various European regulations or specifications of the International Olive Council (IOC) are valid. Adulterations comprise wrongly labeled quality, not declared or illegal processing or wrong indication of geographical origin that can only be partially detected using existing standard methods defined in regulation (EEC) No 2568/91. However, not only olive oil is in the focus of counterfeiters but also other high-price edible oils such as argan oil or cheaper oils that are purchased in high quantities. Illegal processing becomes more and more sophisticated by, e.g., soft-deodorization at low temperature and high vacuum for a short time, and in regulation (EU) No 29/2012 on marketing standards for olive oil, the labeling of the geographic origin is mandatory, but there are no official analytical methods for reviewing this regulation. Therefore, more advanced methods are necessary to keep up with the ingenuity of the counterfeiters. With a simple analysis of the identity by fatty acid, and sterol composition or *K*-values and steradienes most adulterations cannot be traced.

Today, the idea is to move away from methods that look on the resulting values one-dimensionally, but to combine analytical results of several parameters with more challenging multivariate statistical tools such as linear discriminant analysis to identify significant differences between different groups of oils that help to identify adulteration. For this untargeted approach it is unimportant to identify and to know individual compounds but the detection of adulteration is made by characterizing profiles of compounds that are useful for the detection of adulteration. By use of multivariate analysis methods relationships between different variables are clarified and explained and in the case of samples with similar background similar relationships should be found. On the basis of such statistical models, it is possible to detect adulterations. This approach makes it much more difficult for counterfeiters to trim products in such a way that adulteration is not noticeable, since a much larger number of parameters can be included in the evaluation that cannot be all adjusted by the fraudsters mimicking an unadulterated oil.

Such methods include profiling techniques using LC–MS or GC–MS for measuring nonpolar, polar, or volatile compounds or spectroscopic methods such as nuclear magnetic resonance (NMR) spectroscopy or near infrared spectroscopy (NIR) using the whole spectrum of oils. For the development of statistical models, a high number of authentic samples is necessary that represent the variation of genuine oils, but also samples that reflect the possibilities of adulteration. The challenge is the selection of appropriate samples but also to identify variables that significantly differ between genuine and adulterated samples. The higher the number of samples involved in the calculation of the model the better the prediction accuracy. Therefore, it is highly recommended that the exchange of data that are necessary for the development of models will be more open to bundle forces in the fight against food fraud instead of different groups developing their own models on their own. Especially for NMR and NIR, the use of shared databases for the spectra of samples is easy to manage and only requires common and more trustworthy agreements. By bundling forces toward the common goal, the

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fight against adulteration of edible oils, it will be possible to detect adulteration better and better.

But it is also clear that the model can never cover the entire area of variation. Therefore, a 100% prediction accuracy cannot be expected, but this is also not necessary. Even if these methods only have a prediction accuracy of 80% or 90% they already help to formulate a concrete suspicion. In the next step, this suspicion has to be further investigated by other techniques, not only analytical methods in order to verify the suspicion. Therefore, these analytical tools will help in the fight against fraud of edible oils. A big construction site is still the validation of the statistical methods. In the future it has to be defined how the statistical methods have to be carried out to make them more comparable and consequently accepted.

In the present special issue, several of these different analytical methods are described not only for olive oil but also for other edible oils to differentiate olive oil qualities, to identify heat-treatment or addition of heat-treated oil to olive oil, to differentiate different geographical origins of olive oils, or to differentiate different argan oil qualities. In addition, the tasks and structure of the recently established German National Reference Center for Authentic Food are described.

We have enjoyed organizing the preparation of this Special Issue and we learned a lot about analytical methods to detect adulteration. We thank all the authors for their interesting contributions and their work and, additionally, we are also very grateful to all the reviewers for their valuable and important help. In our opinion this Special Issue on Authenticity of Edible Oils provides some new thoughts on how modern and sophisticated analytical methods in combination with multivariate statistics can contribute to detect adulterations of edible oils. We are sure everyone will find something of interest, helpful for the daily work.


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Conflict of Interest

The authors declare no conflict of interest.

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