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FLASH COMMUNICATION FOR 1ST OR 2ND YEAR STUDENTS (5 MIN)

PROGRESS IN HAZELNUT QUALITY ASSESSMENT VIA ARTIFICIAL INTELLIGENCE (AI) SMELLING BASED ON GC×GC

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Introduction

The European hazelnut (*Corylus avellana L.*) is a tree nut that is mainly used by the confectionery industry in the form of raw or roasted kernels and in addition to chocolate pastes. The quality assessment of the raw materials has crucial repercussions in the supply chain costs; it is nowadays mainly based on the human examination, but to continue ensuring and fulfilling quality standards, fast, accurate, and objective quality control methods are of primary importance to support and sustain the human judgment. The whole volatile fraction of raw nuts, also referred to as volatilome, encrypts quality related information on cultivar/geographical origin, post-harvest treatments, bacteria/moulds contamination, oxidative stability, and overall sensory perception. The Artificial Intelligence (AI) smelling concept defined within *sensomics*[1] is based on the detection of key odorant that have been proved to evoke a specific smell, it was realized in this research on a comprehensive two-dimensional gas chromatography system coupled with both mass spectrometer and flame ionization detector (GC×GC-MS/FID) to accurately quantify via multiple headspace solid-phase microextraction (MHS-SPME) more than 40 analytes including key-aroma compounds and spoilage markers.

Materials and Methods

Eight industrial batches and four "ad hoc" samples created to simulate scenarios of extreme climate events from Italy and Turkey were monitored for nine months of storage under two storage conditions: under vacuum or exposed to the standard atmosphere (air), both stored at low temperatures (5°C).
The analytical strategy consisted of a sampling step on 125 mg of grounded hazelnuts by SPME, using a 2cm tri-component fibre, with a sampling temperature of 50°C to avoid matrix degradation. After the two dimensional separation achieved via a reverse fill-flush flow modulator, the eluate was split in two parallel detectors, 30% of the total flow to the MS to gather qualitative information and to solve any co-elutions via the fragmentation spectrum, and 70% of it to the FID for quantitative purposes given the wider linear range of response. Quantification was achieved via MHS-SPME with external calibration curves for a limited number of analytes (6), and extended to 42 analytes by using FID predicted response factors[2].

Results and Discussion

In order to define the role of each analyte on the overall sensory perception, the final step involves the introduction of odour thresholds (OTs). The ratio between each analyte concentration and its OTs is defined as odour activity value (OAV), and analytes with OAV greater than 1 are considered to impact the overall smell of a specific food. Sensory maps for each cultivar at different shelf life stages were created using OAV to enable rapid comparisons by visual inspection. Raw fresh samples from different high-quality cultivars have similar sensorial maps with the aroma dominated by 3-methyl-4-heptanone, which is responsible for the nutty note – **Fig. 1**. After 9 months of under vacuum storage, differences among samples arise according to the cultivars: *Tonda Gentile Trilobata* samples tend to maintain the original characteristics for longer periods of time without major changes in the aroma perception and seem to elicit stronger resistance to rancidity without the perception of any major off notes. Contrarily, after 9 months of open air storage, an increase in the amount of rancid and musty smells correlated to the higher amounts of short-chain fatty acids occurs – **Fig. 2**.

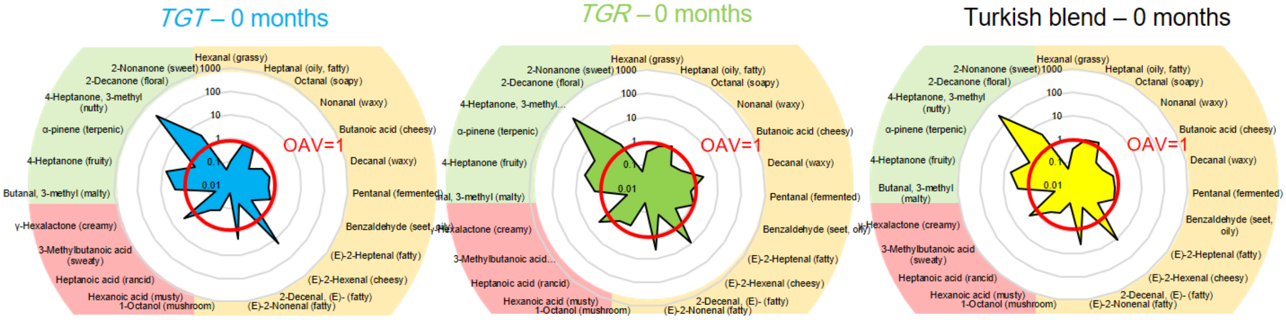

Figure 1. Sensory maps visualized in log_{10} scale of *Tonda Gentile Trilobata*, Turkish blend and *Tonda Gentile Romana* samples at T0. The green region represents the positive notes, the yellow region represents markers of the lipid degradation, the red region represents markers of defects by microbials.

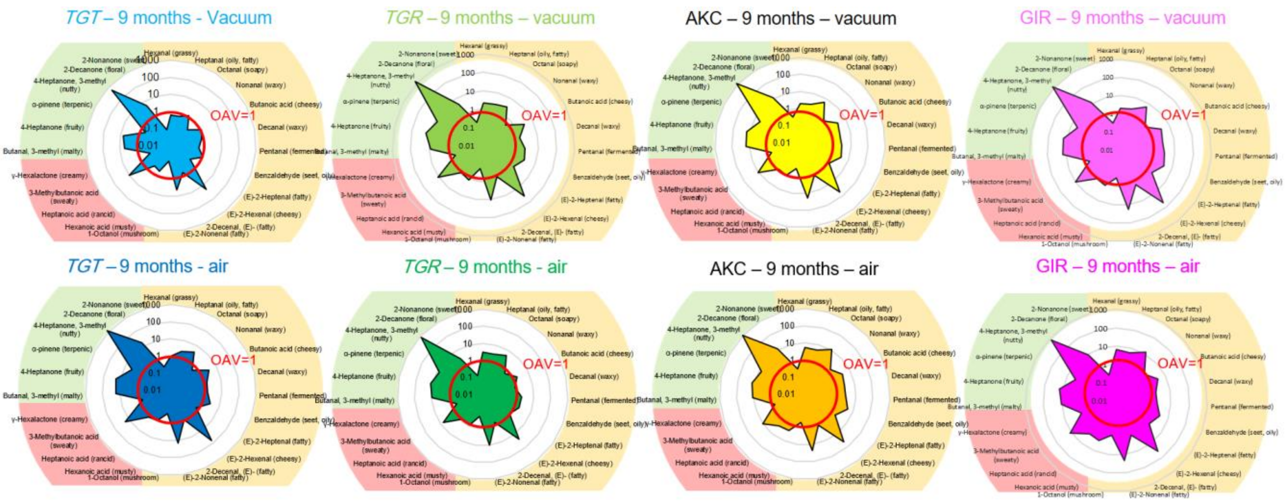

Figure 2. Sensory maps visualized in log_{10} scale of *Tonda Gentile Trilobata*, Akçakoca and Giresun blend, and *Tonda Gentile Romana* samples at T9 with different storage conditions. The green region represents the positive notes, the yellow region represents markers of the lipid degradation, the red region represents markers of defects by microbials.

Conclusions

The proposed methodological approach, highly transferable on a routine basis, offers a great increase in resolution compared to the current quality control protocols. From one analytical run information regarding cultivars, rancidity state and microbial defects can be extracted and automatically correlated to the sensory profile.

References

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2. De Saint Laumer JY, Cicchetti E, Merle P, Egger J, Chaintreau A. Quantification in gas chromatography: Prediction of flame ionization detector response factors from combustion enthalpies and molecular structures. Anal Chem. 2010;82(15):6457-6462. doi:10.1021/ac1006574