






Abstract

Multi-Omics and Sensory Analysis of *Coffea canephora*: Assessing the Impact of Roasting Speed on Safety and Energy Efficiency [†]

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Abstract: Coffee consumption is expected to steadily rise in the next few years, with an increasing incidence of *Coffea canephora* on the market. To date, consumers are demanding high-quality and healthy beverages produced in an environmentally respectful manner. The study aimed to determine the optimal combination of acrylamide formation, sensory quality, and energy efficiency for blockchain-driven environmental accounting during the roasting process of *C. canephora* of different cups and market quality. Coffee was roasted in a professional 5 kg drum roaster at three speeds (fast, intermediate, and slow) and profiles, resulting in a medium roast degree. The quantification of acrylamide complied with the European legal benchmark across all roasting speeds, enabling a qualified panel to perform a sensory analysis of coffees in an espresso brew, including aroma and taste attributes. The chemical fingerprint of coffee was initially investigated through an untargeted metabolomics approach based on high-resolution mass spectrometry (UHPLC-Q-Orbitrap-HRMS). An ANOVA Multiblock Orthogonal Partial Least Squares analysis (AMOPLS) applied to metabolomics data enabled an accurate discrimination of coffee samples based on *coffee market quality* and *roasting speed*. Notably, their interaction was identified as a statistically significant discriminant factor (Residual Structure Ratio *p*-value = 0.01), with the highest contribution to the model (Relative Sum of Squares = 32.6%). The majority of metabolites detected through the VIP² approach belong to the lipid and lipid-like molecules chemical class, highlighting their pivotal role in defining the signature of *C. canephora* coffee. Regarding energy efficiency, the consumption recorded by the natural gas meter at the fast, intermediate, and slow speeds did not show significant differences. The roaster and gas valve employed may influence the efficacy of the “Energy Calculator” of the roasting program “Artisan” (v. 2.10.4), requiring an appropriate configuration. The optimized program resulted in a mean underestimation of real methane consumption by 0.207 kWh (SD 0.124), making it a promising tool for carbon emission calculation in coffee roasting. Moreover, further investigations will be performed to build a multi-omics approach by integrating the UHPLC-Q-Orbitrap-HRMS database with the volatilomic analysis performed by the GCxGC-MS technique to reveal the potential network between the chemical profile and the sensory characteristics of the samples.

Keywords: *Coffea canephora*; volatile compounds; coffee aroma; chemometrics; acrylamide



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