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Fuel and Ventilation Determinants of Restaurant Air Pollution in a West African Campus: Phase-Resolved PM2.5, HCHO, and TVOCs vs WHO Air-Quality Guidelines

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Cooking emissions represent a growing yet understudied contributor to urban air pollution across African cities. This study evaluated indoor and near-outdoor air quality in four restaurants within the Federal Polytechnic Ede, Nigeria, using a Temtop M2000C sensor to measure CO2, PM2.5, PM10, formaldehyde (HCHO), total volatile organic compounds (TVOC), temperature, and humidity under three phases: before, during, and after cooking. Comparative analysis across fuel types (charcoal, firewood, and gas) and spaces (kitchen vs dining) revealed that PM2.5, HCHO, and TVOC concentrations peaked during cooking, exceeding WHO 2021 Air-Quality Guideline limits by factors of 2-6 in charcoal- and firewood-based kitchens. Gas-fueled kitchens showed markedly lower pollutant loads. Ventilation efficacy, expressed as post-cooking decay rate, was up to 65% higher in restaurants with mechanical hoods or cross-flow windows than in naturally ventilated spaces investigated in this study. Phase-resolved pollutant trends highlight the combined influence of fuel choice and ventilation on exposure risk. The findings provide the first quantitative evidence linking commercial cooking practice to air-quality exceedances in a West African setting and emphasize practical mitigation measures, such as hood installation, fuel switching, and improved air-exchange design, to protect worker and customer health.

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