Primary and Secondary Organic Aerosols from Cooking Emissions

Tengyu Liu[1], Qianyun Liu[2], Zijun Li[3], Lei Huo[4], ManNin Chan[3,5], Xue Li[4,6], Zhen Zhou[4,6] and Chak K. Chan[1,*]

1. School of Energy and Environment, City University of Hong Kong, Hong Kong, China
2. Division of Environment, Hong Kong University of Science and Technology, Hong Kong, China
3. Earth System Science Programme, The Chinese University of Hong Kong, Hong Kong, China
4. Institute of Atmospheric Environment Safety and Pollution Control, Jinan University, Guangzhou, China
5. The Institute of Environment, Energy and Sustainability, The Chinese University of Hong Kong, Hong Kong, China
6. Guangdong Provincial Engineering Research Center for On-line Source Apportionment System of Air Pollution, Guangzhou, China

Abstract

Cooking is an important source of organic aerosols (OA) in ambient air. We have found that cooking contributions in primary OA (POA) exceeded those related to vehicles in Mong Kok, an urban site in Hong Kong, although traffic was still the major submicron particulate matter source when elemental carbon was included. Cooking emissions can also potentially contribute to secondary organic aerosol (SOA) but their impacts to OA need to be ascertained. Here, the formation of SOA from gas-phase emissions of five heated vegetable oils (i.e. corn, canola, sunflower, peanut and olive oils) as well as stir-frying spices (i.e. garlic, ginger, myrcia and zanthoxylum piperitum) was investigated in a potential aerosol mass (PAM) chamber. The efficiency of SOA production, in ascending order, was peanut oil < olive oil < canola oil < corn oil < sunflower oil. The major SOA precursors from heated cooking oils were related to the content of mono-unsaturated fat and omega-6 fatty acids in cooking oils. The average production rate of SOA, after aging at an OH exposure of 1.7×10^{11} molecules cm^{-3} s, was 1.35±0.30 μg min^{-1}, three orders of magnitude lower compared with emission rates of fine particulate matter ($PM_{2.5}$) from heated cooking oils in previous studies. The average carbon oxidation state (OS_c) of SOA was -1.51 – -0.81, falling in the range between ambient hydrocarbon-like organic aerosol (HOA) and semi-volatile oxygenated organic aerosol (SV-OOA), indicating that SOA in these experiments was lightly oxidized. Stir-frying garlic and ginger generated similar POA concentrations to those from heating corn oil while stir-frying myrcia and zanthoxylum piperitum generated double the amount of emissions. No SOA was observed from stir-frying garlic and ginger. The rates of SOA production from stir-frying myrcia and zanthoxylum piperitum were 1.8 μg min^{-1} g_{spice}^{-1} and 8.7 μg min^{-1} g_{spice}^{-1}, equivalent to 13.4% and 53.1% of

their own POA emission rates, respectively. Therefore, the contribution of stir-frying spices to ambient organic aerosol levels is likely dominated by POA.