Atmospheric Pollution Research xxx (2016) 1–9

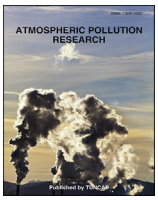
HOSTED BY

ELSEVIER

Contents lists available at ScienceDirect

Atmospheric Pollution Research

journal homepage: http://www.journals.elsevier.com/locate/apr



Chemical composition of particulate organic matter at industrial, university and forest areas located in Bouira province, Algeria

Sidali Khedidji [a, b, *], Catia Balducci [c], Riad Ladji [d], Angelo Cecinato [c], Mattia Perilli [c], Noureddine Yassaa [a, e]

[a] Faculty of Chemistry, University of Sciences and Technology Houari Boumediene (USTHB), BP 32 El-Alia, Bab-Ezzouar, 16111, Algiers, Algeria
[b] Departments of Chemistry, University of Akli Mohand Oulhadj, Bouira, 10000, Algeria
[c] Istituto sull' Inquinamento Atmosferico del C.N.R., Area della Ricerca di Roma, Via Salaria Km 29.300, C.P.10, 00015, Monterotondo Scalo, RM, Italy
[d] Unité de Recherche en Analyse et Développement Technologiques en Environment, Centre de Recherche Scientifiques et Techniques en Analyses Physico-chimiques (UR-ADTE/CRAPC), BP 384, Bou-Ismail, 420004, Tipaza, Algeria
[e] Centre de Développement des Energies Renouvelable (CDER), BP 62, Route de l'Observatoire, Bouzaréah, Algiers, Algeria

ARTICLE INFO

Article history:
Received 25 July 2016
Accepted 7 December 2016
Available online xxx

Keywords:
PM_{10}
n-alkanes
PAHs
Bouira province
Sources apportionment

ABSTRACT

The diel cycles of principle organic compounds enriched into particulate matter with aerodynamic diameter lower than 10 μm (PM_{10}) were determined between March and May 2014 at industrial, urban and forested areas located in the Bouira province, Algeria, to gain information about their ambient concentration levels and source impacts.

The net concentrations of n-alkanes, polycyclic aromatic hydrocarbons (PAHs) and highly-polar organic compounds (HPOCs) allowed to estimate the health risk associated with particulate organic matter (POM) in studied areas. Besides, anthropogenic and biogenic emission could be discriminated thanks to calculated *n*-alkane carbon preference indexes and to natural wax percentages, while diagnostic ratios between concentrations of individual PAHs were applied to identify the main anthropogenic sources. According to them, PM_{10} came out overall from road traffic and industrial manufacture. During the period of investigation, the concentration of BaP remained below the guideline value (1 ng/m^3 as annual average) valid for European Union, ranging from 0.02 to 0.27 ng/m^3 at all sites. In contrast, total carcinogenic power resulted relatively high in Bouira, overall with regard to employees and students. Finally, illicit substances such as Δ^9-tetrahydrocannabinol THC (up to 0.19 ng/m^3) were detected for the first time in Algeria.

1. Introduction

In the last decades, international guidelines have been established for several air pollutants such as O_3, CO, SO_2, NO_2, Pb, fine and respirable airborne particulates ($PM_{2.5}$, PM_{10}), and polycyclic aromatic hydrocarbons (PAHs), based on their adverse health effects and climate-forcing impacts (Danny and Kaufmann, 2002). In this regard, many studies were carried out by scientists from around the world which were not limited to picture the situation, but also aimed at mitigating the ambient pollution rate and impact.

In particular, particulate organic matter (POM) is becoming a major problem at regional and global levels rather than a local phenomenon. Fine particles, in particular, have long residence time in the atmosphere (up to several days), and can be transported over long distances (even thousands of kilometres). As for the POM sources, the principal biogenic emissions are volcanic eruptions, epicuticular waxes of vascular plants and microbial degradation (Simoneit et al., 1991; Stephanou and Stratigakis, 1993), while anthropogenic emissions include fossil fuel (diesel and gasoline), biomass (forest fires, landfills, agricultural activities, and incinerators), and coal combustion (Mastral and Callen, 2000, Pio et al., 2001a,b). Both kinds of primary emission forms can give rise to secondary pollutants through gas-phase photochemical

* Corresponding author. Faculty of Chemistry, University of Sciences and Technology Houari Boumediene (USTHB), BP 32 El-Alia, Bab-Ezzouar, 16111, Algiers, Algeria. Tel.: +213 559 059 500; fax: +213 21247406.
E-mail address: skhedidji@gmail.com (S. Khedidji).

Peer review under responsibility of Turkish National Committee for Air Pollution Research and Control.

http://dx.doi.org/10.1016/j.apr.2016.12.005

Please cite this article in press as: Khedidji, S., et al., Chemical composition of particulate organic matter at industrial, university and forest areas located in Bouira province, Algeria, Atmospheric Pollution Research (2016), http://dx.doi.org/10.1016/j.apr.2016.12.005

reactions developing in the atmosphere (Finlayson-Pitts and Pitts, 1997).

Composition of atmospheric particles is comprised, among other chemicals, of aliphatic and aromatic hydrocarbons, carboxylic acids and carbonyls. PAHs are considered among toxicants due to their ascertained carcinogenicity (World Health Organization [WHO], 2000; Yu, 2002; Pedersen et al., 2004) while PAHs are hugely associated with anthropogenic emissions, coming from incomplete combustion of petrochemicals, biomass, wood, coal and tobacco (Chuesaard et al., 2014; Shen et al., 2013).

According to previous studies, in Algeria most POM is released by industrial manufacturing (including asphalt yeast productions, fat manufacturing, petroleum refining, plastic recycling and pharmaceuticals production), as well as by old and poorly maintained vehicles and poor road networks (unpaved roads) (Yassaa et al., 2001a,b; Yassaa and Cecinato, 2005, Ladji et al., 2009a; Khedidji et al., 2015). Algeria is dependent >93% on fossil fuels for energy needs, whilst the hydraulic power accounts for only 2% (Djalel et al., 2012).

In this paper, airborne particulates with aerodynamic diameter <10 μm (PM_{10}) were chemically characterized in the Bouira province, Algeria, ca. 80 km southeast of Algiers city centre. The period of investigation was March to May 2014; four locations of distinct types were examined, namely: *i)* the university area of Bouira city; *ii)* the industrial district hosting a cement plant and a detergent manufacture; *iii)* the unit of cleaning products; and *iv)* the forest area inside the national park of Tikjda.

Our focus was on n-alkanes, PAHs, and a set of highly-polar organic components (HPOCs); among these compounds, psychotropic substances and phthalate esters are listed. Until now, very few studies reported the occurrence of phthalates in the air of Algeria; here, six alkyl phthalates were studies in the Bouira province. The results of this study were compared to those obtained elsewhere in Algeria and abroad, and the ambient toxicity associated with the occurrence of target compounds was assessed.

2. Experimental

2.1. Description of sampling sites

The airborne organic matter was collected in four locations of Bouira province, representing residential, industrial, urban background and forest contexts (see Fig. 1). One location was the city of Sour El Ghozlane (SEG), located 120 km south of Algiers city centre (latitude 36°10′43, 17″ N, longitude 03°44′52.38″ E), situated at an altitude of 836 m above sea level; measurements were carried out both indoors and outdoors. The climate of this area was quite rainy/cold during winter, and warm/dry during summer season. Several industrial activities were implanted in this area. Therefore, two sampling points were selected, the first at Society of Cement plant (ERCC), and the second at National Detergent Company (ENAD). The former location (ERCC) could be regarded as severely polluted within the region, because of the direct influence of cement plant emissions; ENAD was located within a proximity distance from the cement plant, which was characterized by small production and insignificant internal emission rates; hence, the main source of pollution came from ERCC emissions. The airborne particulate samplers were positioned at 8 m and 3 m above ground, respectively, at ERCC and ENAD, and both ca. 50 m away from National Road No. 5.

The second location was the industrial district of Lakhdaria city, hosting the National Unit of Cleaning Products (UNCP). The third

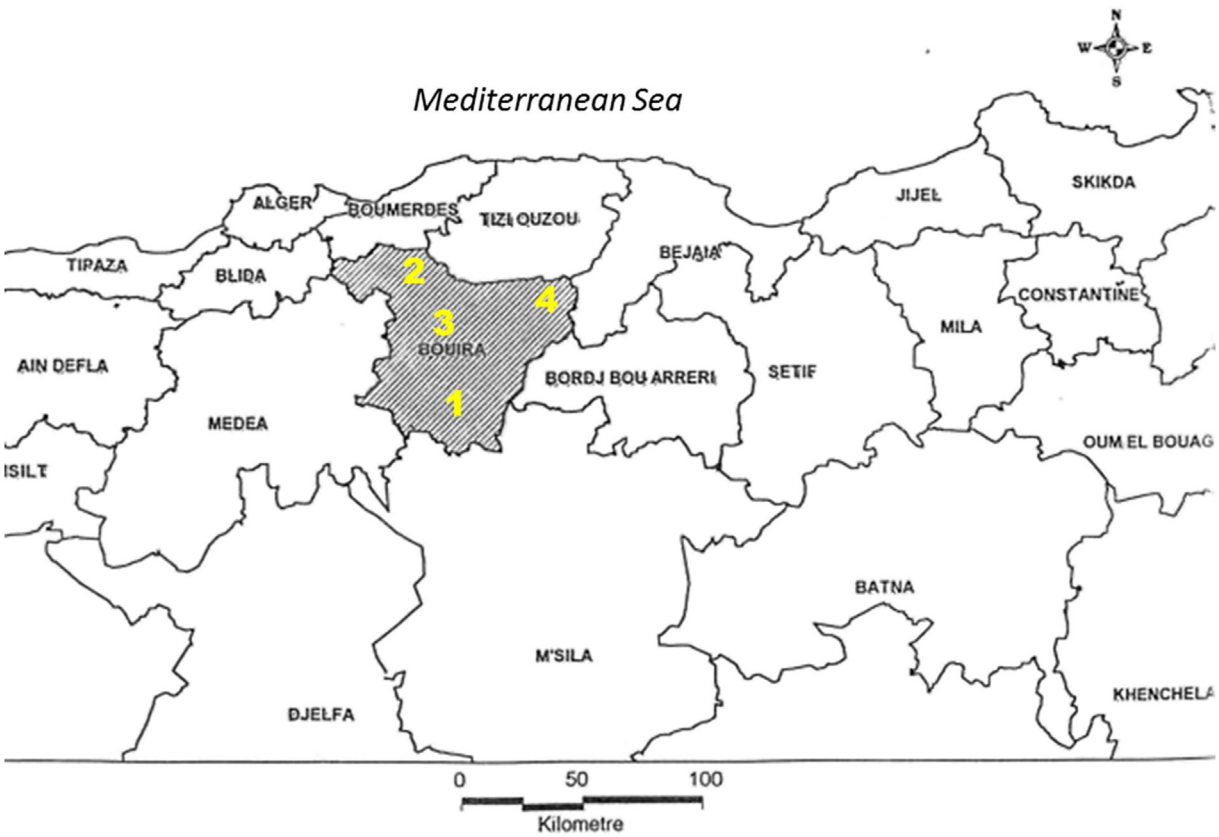


Fig. 1. Detailed geographical position of the sampling sites in the Bouira province.

Please cite this article in press as: Khedidji, S., et al., Chemical composition of particulate organic matter at industrial, university and forest areas located in Bouira province, Algeria, Atmospheric Pollution Research (2016), http://dx.doi.org/10.1016/j.apr.2016.12.005