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Phytolith particulate matter and its potential human and environmental effects☆

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ABSTRACT

Particulate matter from both natural and anthropogenic sources is known to affect air quality and human health. However, the abundance and varied composition of the suspended particulate matter make it difficult to locate the precise precursors for some of these atmospheric pollutants. Plants deposit appreciable quantities of microscopic biogenic silica in and/or between their cells, known as phytoliths, which get released into the soil surface after the death and decomposition of plants. Dust storms from exposed terrains, forest fires, and stubble burning disperse these phytoliths into the atmosphere. Their durability, chemical composition, and diverse morphology prompt us to view phytoliths as a possible particulate matter that could impact air quality, climate, and human health. Estimating the phytolith particulate matter, its toxicity, and environmental impacts will help take effective and targeted policies for improving air quality and decreasing health risks.

1. Introduction

Particulate matter (PM) from natural and anthropogenic sources affects air quality and human health (Kampa and Castanas, 2008). PM varies in size (0.01–100 μm), density, shape, and composition, which depends on the emission sources, meteorological factors, and aerodynamic diameter (Von Schneidemesser et al., 2015); however, the profusion and mixed composition of PM makes it sometimes difficult to precisely locate their precursors. Once airborne, the trajectory of particulate matter is affected by drag forces, inertia, and gravity. The mean residence time of ultrafine particulate matter (<1 μm) in the atmosphere is 10^2–10^3 h, while particles of size 1–10 μm (PM_{10} and $PM_{2.5}$) have a mean residence time of 10–100 h (Esmen and Corn, 1971; Von Schneidemesser et al., 2015; Yang et al., 2020), though precipitation events can shorten this residence time. Due to its microscopic size, PM can get deep into the lungs and bloodstreams, threatening human health, accounting for nearly one-third of deaths from chronic respiratory disease, lung cancer, and one-quarter of deaths from heart attacks (Agay-Shay et al., 2013; Kim et al., 2015). PM also affects the climate and atmospheric characteristics by modulating atmospheric chemistry and meteorological processes (Von Schneidemesser et al., 2015). Moreover, PM influences photosynthetic processes in plants and alters soil properties (Grantz et al., 2003; Mukherjee and Agrawal, 2017). Among different PM types, phytoliths constitute an appreciable quantity of atmospheric dust (Folger et al., 1967; Romero et al., 2003). Twiss (1983) found phytoliths in the dust collected over the Great Plains. Romero et al. (1999) reported wind-transported phytoliths in the equatorial and tropical Atlantic derived from Africa's Sahara and Sahel regions. Later, the first analysis of airborne phytoliths was practically carried out by Latorre et al. (2012) in the air of Argentina, who reported phytolith concentrations to be more than 1500 particles/m^3 on the driest day. Recently, Funk et al. (2022) found 8.3 percent of phytoliths in the wind-eroded dust from an arable agricultural field in La Pampa, Argentina, that was predominantly transported as finer dust and accumulated as PM fractions. Pertinently, a plethora of researchers highlights the archeological, anthropological, paleovegetation, and paleoenvironmental reconstruction potential of phytoliths from the soils and other sediments (Rashid et al., 2019). However, there remains a knowledge gap in viewing phytoliths as a particulate matter in the atmosphere to address health and environmental issues. Therefore, this short communication hypothesis the potential of phytoliths as particulate matter and suggests that these tiny particles can have impact on the air quality, human health, and environment akin to other amorphous silica particles. The application of this hypothesis can help in

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