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Data Article

Dataset on exposure conditions to Fe_2O_3 and SiO_2 colloidal suspension and airborne particulate matter (PM) suspensions: crude NIST1648a and with reduced content of organic matter, LAp120

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ABSTRACT

Particulate matter (PM) present in the air pollution increases morbidity and mortality due to several reasons. The dataset presents a comparative analysis of nebulization process of Fe_2O_3 and SiO_2 nanoparticles or crude PM (NIST1648a) and that with reduced content of organic matter (LAp120). Nebulization tests were carried out to determine concentrations of nanoparticle and PM suspensions, in order to create an atmosphere with a concentration of PM particles about 1000 $\mu g/m^3$ of air in the exposure chambers. It is important to properly recreate environmental conditions during further research on animals. The absorbance spectrum of the suspensions of the tested materials was measured in the range of 300–700 nm. The changes in the absorbance of these suspensions depending on the concentration after their passage through the nebulizers were examined. Based on the absorbance, it was determined to what extent the suspensions are passed out and dispersed by the nebulizers. The operating mode of the nebulizers and the concentration of suspensions were determined in order to establish the optimal exposure conditions and the microclimate of the chambers

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for further studies with mice. The dataset can help in optimization of nebulization process for all researchers exploring the further issue of the influence of the air pollution on the broadly understood animal functions, behavioral parameters and biochemical aspects.

Specifications Table

Subject	Environmental Science, Pollution
Specific subject area	Toxicity of particulate matter (PM)
Type of data	Figure
Data collection	NIST1648a (from the National Institute of Standards and Technology, Gaithersburg, MO, USA) was treated with low-temperature oxygen plasma for 120 min in order to remove organic compounds using the Plasma Zepto system (Diener Electronic GmbH, Ebhausen, Germany). Absorbance was measured with a Synergy MX microplate reader working with Gen5 software (both BioTek Instruments, Winooski, VT, USA). Exposure conditions were recreated with DSI's Mass Dosing System (Data Sciences International, St Paul, MN USA) composed of exposure chambers equipped with Aerogen Aeroneb® Lab nebulizers (Aerogen (Ireland) Limited, Galway, Ireland) and controllers. Concentration of PM10 in the exposure chambers was measured with Aerocet 831 handheld particle counter (Met One Instruments, Inc., Grants Pass, OR, USA). Microclimate parameters (temperature, relative humidity and CO_2 concentratios) were measured with AZ77535 air parameters detector (AZ Instrument Corp., Taichung, Taiwan).
Data source location	Department of Brain Biochemistry, Maj Institute of Pharmacology, Polish Academy of Sciences Kraków Poland
Data accessibility	Repository name: Mendeley Data,V1 Data identification number: 10.17632/k9y6rz5ghh.1 Direct URL to data: https://data.mendeley.com/datasets/k9y6rz5ghh/1

1. Value of the Data

- Data represent analysis of nebulization process of nanoparticles (Fe_2O_3, SiO_2) or PM, and support further studies for estimating their pathophysiological effects on laboratory animals.
- The data may be useful for scientists studying the influence of airborne PM or engineered nanoparticles on the laboratory animals through nebulization method and are significant for the APARIC project [1].
- These data indicate how properly recreate environmental conditions in laboratory exposure chambers.

2. Background

Particulate matter (PM) air pollution is an important factor negatively affecting the health of modern man [2,3]. PM is a mixture of various components of natural and anthropogenic origin, characterized by exceptional complexity and variability in terms of chemical composition and physical properties. Among the components of PM, silica accounts for the largest part of its mass, while iron is the most common transition metal of biological importance [4,5].

The production of aerosols from aqueous suspensions of PM are a common method of their reintroduction to the atmosphere in laboratory studies of the effects of inhalation exposure with animals [6,7]. The absorbance of Fe_2O_3 and SiO_2 nanoparticle suspensions as well as both PM forms as a measure of their concentration was investigated. Suspension concentrations and operating parameters of nebulizers were determined in order to obtain the desired PM concentration in the air in the exposure chamber, while maintaining other microclimate parameters that did not adversely affect welfare of mice.

3. Data Description

In the first step, the absorbance spectra of Fe_2O_3 and SiO_2 nanoparticle suspensions as well as both forms of PM, i.e. NISTA1648a and Lap120, were assessed. The obtained data are presented in Fig. 1A–D. On the basis of the obtained data, the wavelength of 300 nm was selected for further measurements of the suspension concentration. At this wavelength, the dependence of absorbance on suspension concentration was confirmed (Fig. 2A–D). In the next stage, the suspensions of Fe_2O_3 and SiO_2 nanoparticles and both forms of PM were nebulized with the use of four nebulizers, and the concentration of the suspensions after nebulization was determined. Absorbance was measured at 300 nm of wavelength, and the obtained data are presented in Fig. 3A–D. The data presented in the above figures is included in the file in the repository at https://data.mendeley.com/datasets/k9y6rz5ghh/1 [8].

In the second part of the experiment, changes in the concentration of PM10 as well as air temperature and relative humidity in empty chambers (without animals) during nebulization

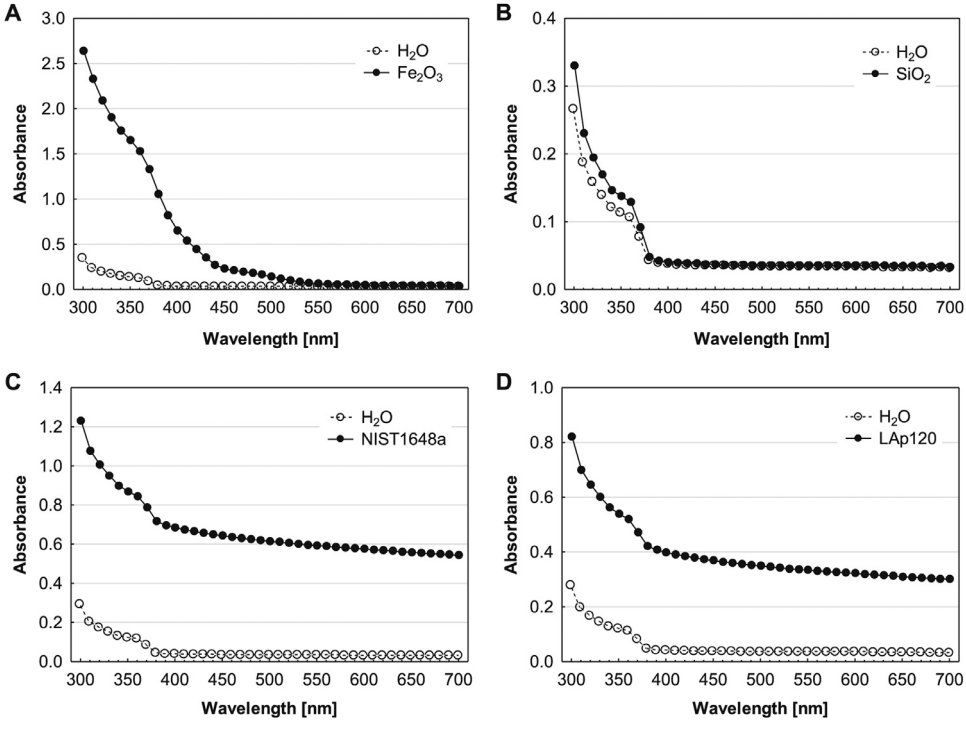

Fig. 1. Absorbance spectra of Fe_2O_3 (A) (0.4 mg/ml) and SiO_2 (B) (0.8 mg/ml) nanoparticle suspensions and NIST1648a (C) and LAp120 (D) suspensions (both 1.5 mg/ml)) in the range of 300–700 nm compared to the absorbance of deionized water.

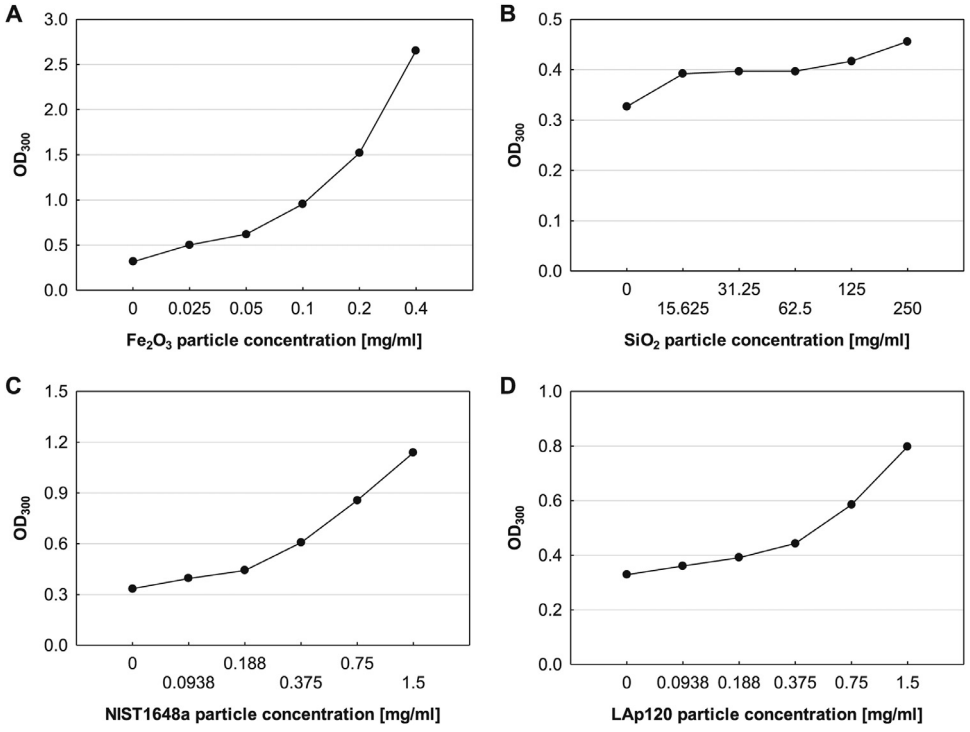

Fig. 2. The relationship between the optical density and the concentration of Fe_2O_3 (A) and SiO_2 (B) nanoparticle suspensions as well as NIST1648a (C) and LAp120 (D) suspensions at a wavelength of 300 nm.

of Fe_2O_3 and SiO_2 nanoparticle suspensions and both PM forms: NIST1648a and LAp120 were investigated. The obtained data are presented in Figs. 4 and 5. The data shown in these figures is included in the file DiB data.xlsx in the repository at https://data.mendeley.com/datasets/k9y6rz5ghh/1 [8]. CO_2 concentration in the chambers did not change during nebulization and was the same as in the experimental room (mean +/− SD = 420 +/− 3.8 ppm).

4. Experimental Design, Materials and Methods

4.1. Materials

Fe_2O_3 and SiO_2 nanoparticles were purchase from PlasmaChem (Berlin, Germany) and diluted to required concentration with deionized water. NIST1648a is a reference particulate material of urban air pollution purchased from Sigma-Aldrich (St. Louis, USA). NIST1648a was treated with a low-temperature plasma for 120 min in order to decrease the content of organic carbon and obtained powder is further referred to as LAp120. Such the treatment does not significantly alter the morphology of particles [9].

4.2. Preparation of suspensions

NIST1648a and LAp120 powders were suspended in deionized water, then the stock suspension were sonicated for 15 min in an ultrasonic water-bath and shook for 72 h on rotary shaker.

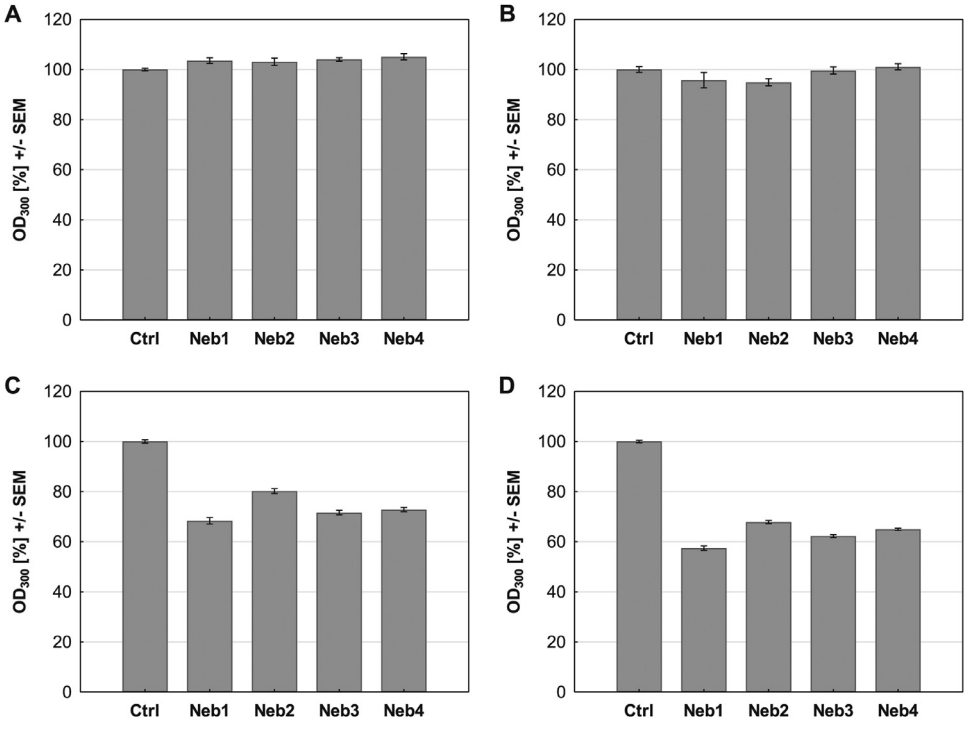

Fig. 3. Concentrations of Fe_2O_3 (A) and SiO_2 (B) nanoparticle suspensions and NIST1648a (C) and LAp120 (D) suspensions, control, non-nebulized (Ctrl) and after passing through nebulizers (Neb1-4), determined at the wavelength of 300 nm and expressed as a percentage of the control suspensions. The concentrations of the control suspensions as in Fig. 1.

Immediately before use the suspensions were vigorously mixed, diluted to required concentration in deionized water and the final suspensions of each particles were sonicated for 15 min. Concentration of particle suspensions are indicated above in the figure captions.

4.3. Experimental design

Nebulization of particle suspensions is one of the methods of introducing dust particles of air pollutants in experimental conditions into the atmosphere (e.g. [7]). The nebulizers used in the present experiment produce aerosols with droplet sizes in the range of 4–6 µm (according to the manufacturer's instruction). The Fe_2O_3 and SiO_2 nanoparticles are 4–8 and 10 nm in size, respectively. The average particle size of NIST1648a is 5.85 µm (according to the manufacturer's certificate) and cold plasma treatment had no effect on particle size or aggregation [9]. Since some of NIST1648a and LAp120 will not be dispersed by nebulizers due to their size, it is necessary to determine the concentration of suspensions of these materials after passing through nebulizers. A turbidimetric method was used to estimate the concentration of suspensions passing through the nebulizers [10]. As an assessment of the concentration of suspensions, the absorbance was measured with a Synergy MX microplate reader working with Gen5 software (both BioTek Instruments, Winooski, USA). We initially measured the light absorbance spectrum of the suspensions in the range of 300–700 nm. Based on the obtained data, a wavelength of 300 nm was selected for further concentration studies. The choice of this wavelength was confirmed by measurement of absorbance on the concentration of suspensions. In the next step, the absorbance of control, non-nebulized suspensions, and suspensions after passing through

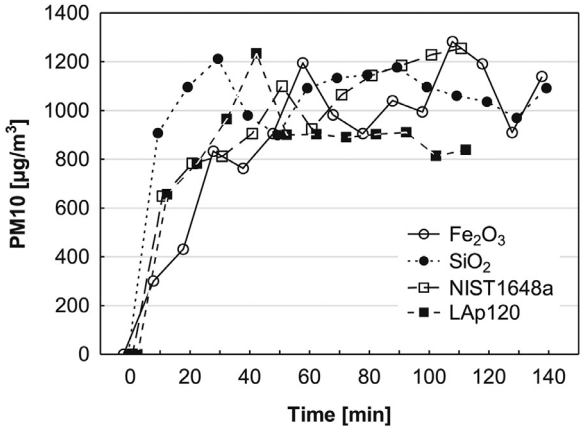

Fig. 4. PM10 concentration in empty chambers, without animals, during nebulization of nanoparticle suspensions Fe_2O_3 (0.4 mg/ml) and SiO_2 (0.6 mg/ml) and suspensions of NIST1648a and LAp120 (both 1.2 mg/ml).

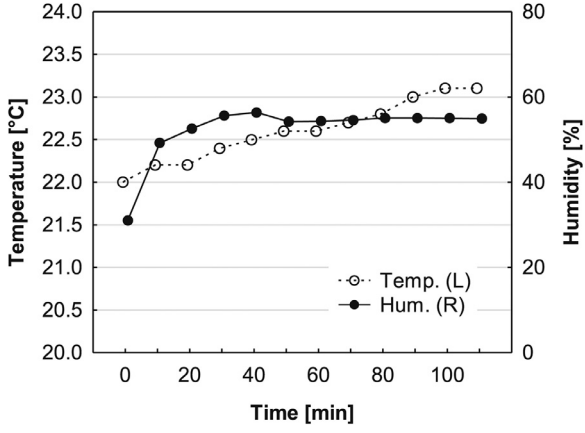

Fig. 5. Air temperature and relative humidity in empty chambers, without animals, while nebulizing LAp120 suspension (1.2 mg/ml). Changes in these parameters during nebulization of the remaining suspensions were similar to those presented here and thus are not shown.

nebulizers were measured, and from this, the extent to which particles pass through nebulizers and are dispersed in the exposure chamber was estimated.

Nebulization tests were carried out in order to determine concentrations of particle suspensions and the parameters of the nebulizer's operation for recreate an atmosphere with a concentration of PM10 about 1000 µg/m^3 of air in the exposure chambers without a substantial changes of other parameters of microclimate, i.e. temperature, humidity and CO_2 concentration. The experiments were performed on empty chambers in order to establish a proper exposure conditions for further experiments with laboratory animals. Fifteen air exchanges per hour were applied in order to maintaining microclimate parameters that did not adversely affect welfare of mice during further studies.

Experiments were carried out with DSI's Mass Dosing System (Data Sciences International, St Paul, USA) composed of exposure chamber equipped with Aerogen Aeroneb® Lab nebulizer (Aerogen Limited, Galway, Ireland) and outlet air filter, and controller for control of nebulizer and provides air exchange in the chamber. Four sets of the exposure system were used. During nebulization, concentration of PM10 as well as temperature, the relative humidity and CO_2 con-

centration were measured with Aerocet 831 handheld particle counter (Met One Instruments, Inc., Grants Pass, USA) and AZ77535 air parameters detector (AZ Instrument Corp., Taichung, Taiwan), respectively. These parameters were measured in 10-min intervals up to 140 min (SiO_2 and Fe_2O_3 suspensions) and 110 min (NIST1648a and LAp120 suspensions) of nebulization.

Preliminary experiments have shown that the concentration of suspensions should be as high as possible and the output capacity of the nebulizers should be low, which prevents suspensions from condensing on the walls of the nebulizers and undesirable increases in humidity inside the exposure chambers.

Limitations

None.

Ethics Statement

The authors have read and follow the ethical requirements for publication in Data in Brief. This study does not include research with animals or humans nor any data collected from social media platforms.

CRediT Author Statement

Monika Jankowska-Kieltyka: Conceptualization, Investigation, Resources, Writing – Original Draft Preparation. **Adam Roman**: Conceptualization, Formal Analysis, Investigation, Data Curation, Visualization, Writing – Original Draft Preparation. **Irena Nalepa**: Conceptualization, Writing – Review & Editing, Supervision, Project Administration.

Data Availability

DiB data.xlsx (Original data) (Mendeley Data).

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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