

Table 4-8. Studies of 6PPD and 6PPD-q concentrations in road dust and roadside snow

Location	Information	Concentration (varies by study)	Lab Instrumentation	Detection Limit
Guangzhou, China (Deng et al. 2022)	In January 2021, researchers collected one sample each of dust from 10 roads and 10 indoor parking lots using a handheld vacuum and analyzed the samples for a range of antioxidants and transformation products, including 6PPD and 6PPD-q.	The concentrations of 6PPD and 6PPD-q in dust were found to be [median (range), ng/g]: Road dust: 6PPD: 356 (15.1–1,508) 6PPD-q: 122 (10.5–509) Indoor parking-lot dust: 6PPD: 323 (11.4–5,359) 6PPD-q: 154 (4.02–2,369)	HPLC with triple-quadrupole mass spectrometry	Not available*
Tokyo, Japan (Hiki and Yamamoto 2022)	From May to October 2021, researchers collected 22 samples of road dust from two arterial and eight residential roads and analyzed them for 6PPD and 6PPD-q.	The total concentrations of 6PPD and 6PPD-q collected in road dust were found to be [median (range), ng/g]: 6PPD: 329 (45–1,175) 6PPD-q: 809 (116–1,238) The concentrations of 6PPD and 6PPD-q were generally higher in road dust collected from the arterial roads compared to the residential roads.	LC-MS/MS	LOQ (µg/L): 6PPD: 0.63 6PPD-q: 0.18
Germany (Klöckner et al. 2021)	Two road-dust samples were obtained from a tunnel in 2020 using a pressure washer and wet vacuum (three samples from each location). Particles were analyzed for various tire-related chemicals, including 6PPD and 6PPD-q. Concentrations were also reviewed by particle diameter. 6PPD and 6PPD-q increased from coarser (500–100 µm) to finer particles (<50 µm).	The concentrations of 6PPD and 6PPD-q in road dust were found to be [mean ± SD]: 6PPD: 1.5 ± 0.044 and 1.9 ± 0.14 ng/mg dw 6PPD-q: 220 ± 9.5 and 270 ± 27 peak area/mg dw	UPLC-TOF-MS	Not reported
Leipzig, Germany (Maurer et al. 2023)	In February 2021, researchers collected 20 snow samples along roadsides and 3 background snow samples in urban areas away from roads and analyzed them for 489 chemicals of concern, including 6PPD and 6PPD-q.	The concentrations of 6PPD and 6PPD-q in roadside snow were found to be [mean (range), ng/L]: 6PPD: 329 (ND–784) 6PPD-q: 259 (110–428)	LC-HRMS	MDL (ng/L): 6PPD: 60 6PPD-q: 4
Leipzig, Germany (Seiwert et al. 2022)	As part of a study that included a series of laboratory ozonation experiments to evaluate the abiotic transformation of 6PPD and sampling of the influent and effluent of a wastewater treatment plant (during snow melt, rainfall event, and dry conditions), three samples of snow were collected from urban streets after a week of cold weather following a snow event in February 2021. The snow samples were separated into water and particulates and analyzed for the presence of a range of tire and road-wear particles and transformation products, including 6PPD and 6PPD-q.	38 transformation products of 6PPD were detected in the laboratory study, of which 26 were reported for the first time. Snow samples contained 32 transformation products of 6PPD, including 9 transformation products of 6PPD-q. 90%–99% of the load of 6PPD and most of its transformation products were present in the particulate phase. 6PPD-q and some of its transformation products had higher proportions in the water phase than 6PPD and its transformation products. Although snow samples were collected on different roads, their compositions were comparatively similar.	UHPLC-HRMS/ UHPLC-TOF-MS	LOQ (ng/L): 6PPD-q: 25

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Location	Information	Concentration (varies by study)	Lab Instrumentation	Detection Limit
Guangzhou, China (Huang et al. 2021)	In 2020, researchers collected 20 road-dust samples, 10 parking-lot samples, 11 vehicle-dust samples, and 18 house-dust samples in homes located in an e-waste dismantling area in South China. These samples were analyzed for a range of p-phenylenediamines, including 6PPD and 6PPD-q. Both compounds were detected in 100% of the road-dust, parking-lot-dust, and vehicle-dust samples. For house dust, 6PPD and 6PPD-q were detected in 56% and 33% of the samples, respectively.	The concentrations of 6PPD and 6PPD-q in road and parking-lot dust were found to be [median (range)]: 6PPD: Road dust: 52.5 (4.1–238) ng/g Parking-lot dust: 241 (13.5–429) ng/g 6PPD-q: Road dust: 32.2 (3.0–88.1) ng/g Parking lot dust: 41.8 (5.7–277) ng/g	HPLC-MS/MS	LOD (ng/g): 6PPD: 0.11 6PPD-q: Value not reported, but estimated based on the calibration curve and LOD of 6PPD
Hangzhou, China (Jin et al. 2023)	In 2018, researchers collected 16 urban/suburban road-dust samples, 32 agricultural road-dust samples, and 35 road-dust samples in Hangzhou in East China. These samples were analyzed for a range of aminoaccelerators and antioxidants and their transformation products, including 6PPD and 6PPD-q. Both compounds were detected in 100% of the dust samples. 6PPD-q was one of the most abundant analytes detected at 41.4% of the total concentration of transformation product analytes.	The concentrations of 6PPD and 6PPD-q in road dust were found to be [median (range)]: 6PPD: 18.8 (0.46–245) ng/g 6PPD-q: 9.75 (0.46–143) ng/g	UHPLC-HRMS	MDL (ng/g): 6PPD: 0.019 6PPD-q: 0.019
Guiyu Town and Haojiang, China (Zhang et al. 2024)	From 2019 to 2021, researchers collected 40 dust samples from roads in Guiyu Town and Haojiang municipalities in China. Samples were collected with brushes treated with n-hexane, sealed in aluminum foil, and analyzed for 6PPD-q. 6PPD was not analyzed for.	The concentrations of 6PPD-q in road dust in Guiyu Town and Haojiang were found to be [median]: Guiyu Town: 17.4 ng/g Haojiang: 30.3 ng/g	HPLC-MS/MS	IDL (ng/mL): 0.055 IQL (ng/mL): 0.061

Notes: μm =micrometer, $\mu\text{g/L}$ =micrograms per liter, HPLC=high-performance liquid chromatography, HPLC-MS=high-performance liquid chromatography-tandem mass spectrometry, IDL=instrument detection limit, IQL=instrument quantification limit, LC-HRMS=liquid chromatography-high-resolution mass spectrometry, LC-MS/MS=liquid chromatography / tandem mass spectrometry, LOD=limit of detection, LOQ=limit of quantitation, mg dw=milligram dry weight, MDL=method detection limit, ND=nondetect, ng/g=nanogram per gram, ng/L=nanogram per liter, ng/mg dw=nanogram per milligram dry weight, SD=standard deviation, UHPLC-HRMS=ultra-high-performance liquid chromatography-high-resolution mass spectrometry, UHPLC-TOF-MS=ultra-high-performance liquid chromatography-quadrupole time-of-flight mass spectrometry, UPLC=ultra-performance liquid chromatography-time-of-flight-mass spectrometry

*This information may be available in the supplemental information section, but 6PPD Team Members were unable to obtain access to this supplement as of March 2024.

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