Correlations and Concentrations of Sugars Detected in Particulate Matter Samples Collected from Chiang Mai, Thailand

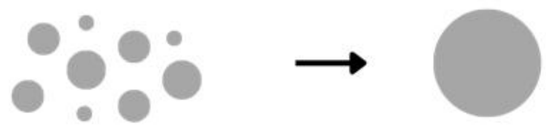
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ABSTRACT

Atmospheric aerosols contain sugar compounds that act as tracers of anthropogenic and biogenic sources. This study investigated the size-dependent distribution and correlations of sugars in five aerosol fractions ($PM_{0.1}$, $PM_{0.5}$, $PM_{1.0}$, $PM_{2.5}$, and PM_{10}) collected in Chiang Mai during the rainy season (May-August 2025) using ion chromatography with pulse amperometric detection. $PM_{2.5}$ contributed the largest fraction of particulate mass (42%) and showed the highest total sugar concentration (176.17 ng m^{-3}), dominated by sugar alcohols such as mannitol and arabitol, indicating strong biogenic influence. Fine particles ($PM_{0.1}$-$PM_{1.0}$) showed correlations between sugar alcohols and anhydrosugars, while $PM_{2.5}$ exhibited strong positive correlations between levoglucosan, sucrose, and glucose (r = 0.85 and 0.81), suggesting combined effects of biomass burning and biological processes. In contrast, coarse particles (PM_{10}) showed negative relationships between sugar alcohols and anhydrosugars, possibly due to leaching and moisture absorption, highlighting seasonal aerosol dynamics in northern Thailand.

INTRODUCTION

Nucleation mode | Accumulation mode | Coarse mode



Coagulation Condensation



Sugars

Anhydrosugars
(e.g. Levoglucosan, Mannosan & Galactosan)



Sugar alcohols
(e.g. Mannitol & Arabitol)



Mono-/Disaccharides
(e.g. Sucrose & Glucose)



OBJECTIVES

1. To analyze the concentrations of sugars in atmospheric particulate matter of different size fractions.
2. To investigate the relationships between sugars and particulate matter concentrations.
3. To evaluate the potential of sugars as indicators for identifying possible sources of atmospheric particulate matter.

METHODS



PM collection using Nanosampler II (Model 3182)



Ultrasonic extraction



Analysis by ion chromatography

RESULTS AND DISCUSSION

Particulate Matter Concentration

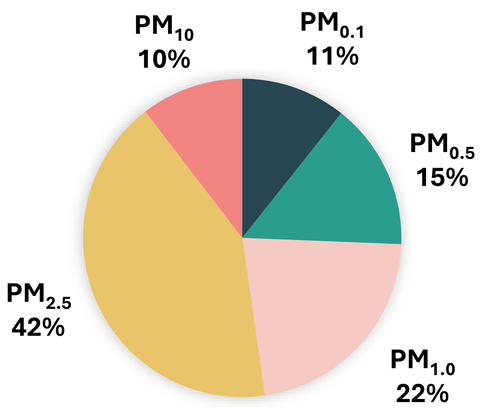


Figure 1. Distribution of PM for size-segregated

Sugar Analysis in Size-Fractionated Particulate Matter

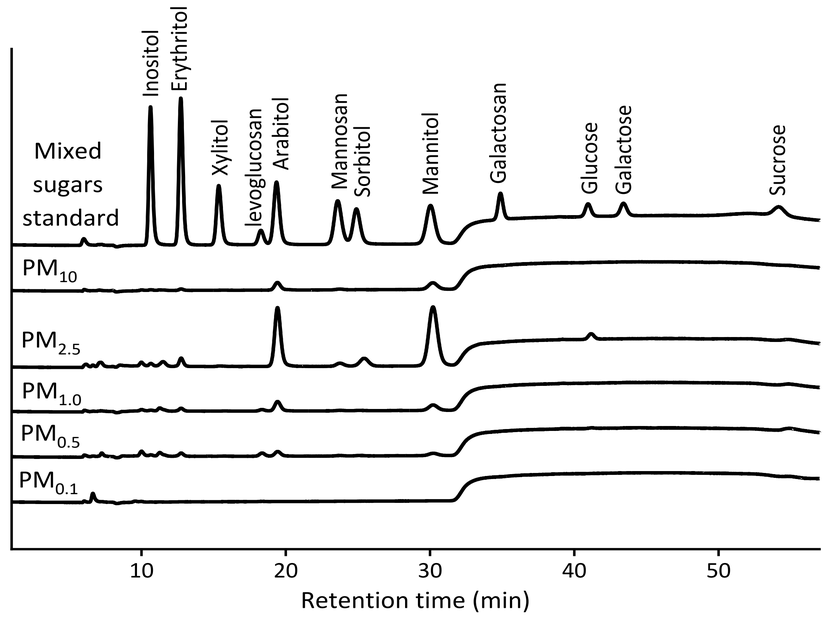
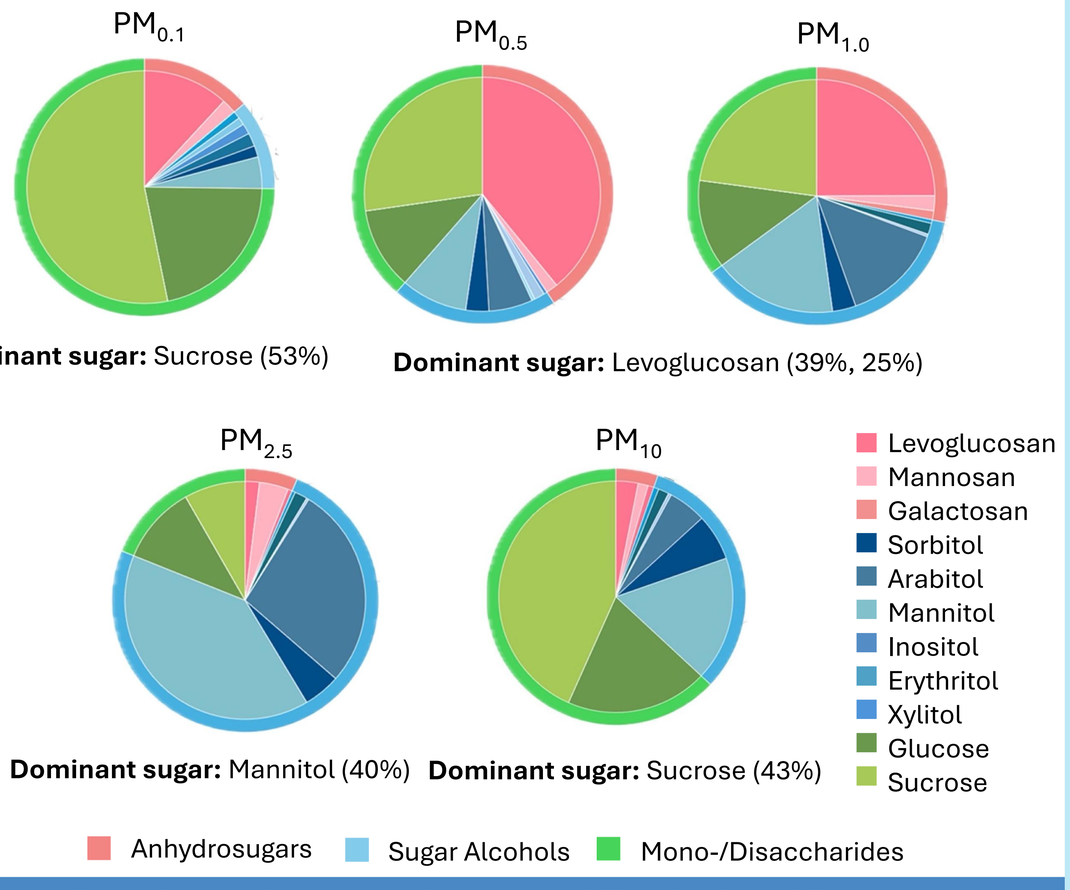


Figure 2. Chromatograms comparison: standard (2.5 mg L^{-1}) vs. particulate matter samples ($PM_{0.1}$, $PM_{0.5}$, $PM_{1.0}$, $PM_{2.5}$ and PM_{10})

Preliminary and Unpublished work



Dominant sugar: Sucrose (53%)

Dominant sugar: Levoglucosan (39%, 25%)

Dominant sugar: Mannitol (40%)

Dominant sugar: Sucrose (43%)

Correlation among Sugars

$PM_{0.1}$
- Levoglucosan ↔ Mannosan, Arabitol (r = 0.60,0.70) → consistent biomass burning tracers.
- Mannosan ↔ Mannitol, Arabitol, (r = 0.66,0.81)

$PM_{0.5\text{-}1.0}$
- Levoglucosan ↔ Sucrose (r = 0.63,0.83) → burning + plant-derived biogenic co-presence.
- Mannosan ↔ Sugar alcohols (r > 0.80,0.57, except inositol and xylitol (r < 0.37))

→ Co-occurrence of burning + fungal biogenic tracers.
- Xylitol ↔ other sugars (r < 0.02)

$PM_{2.5}$
- Several strong pairs, e.g.:
  - Levoglucosan ↔ Mannosan, Sucrose and Glucose (r = 0.58)
  - Mannosan ↔ Sucrose, Glucose and Mannitol (r = 0.59)
- Sugar alcohols intercorrelate from low to strong. (r = 0.24-0.82)

PM_{10}
- Generally, very weak – low correlations (r < 0.5) with no clear groupwise pattern.
- Exception: a small cluster where mannosan correlates well with arabitol, sorbitol, and mannitol (strong positives within this subset) (r > 0.77).

Very weak … Very strong

Strength of correlation (r)

Correlation between Sugars and Particulate Matter

	Levoglucosan	Mannosan	Inositol	Erythritol	Xylitol	Arabitol	Sorbitol	Mannitol	Glucose	Sucrose
$PM_{0.1}$	0.62	0.75	n.d.	n.d.	0.14	0.40	n.d.	0.42	n.d.	0.61
$PM_{0.5}$	0.02	0.36	0.70	0.56	-0.56	0.41	0.50	0.41	0.43	0.10
$PM_{1.0}$	0.49	-0.01	0.25	-0.19	n.d.	-0.20	0.11	-0.14	-0.08	0.57
$PM_{2.5}$	0.73	0.67	0.31	0.26	0.56	0.46	0.31	0.57	0.59	0.70
PM_{10}	-0.14	-0.40	-0.22	-0.21	0.14	-0.33	-0.15	-0.07	0.23	0.35

Preliminary and Unpublished work

CONCLUSIONS

- $PM_{2.5}$ contained the highest particulate mass and total sugar concentrations.
- $PM_{0.1}$-$PM_{2.5}$ were influenced by mixed sources, including biomass burning and biogenic emissions.
- $PM_{2.5}$ showed strong accumulation and atmospheric persistence.
- PM_{10} reflected diverse sources and removal processes (wet scavenging and deposition).
- Relative humidity and precipitation significantly influenced sugar levels and composition.

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