

# ポリアミド製調理器具から溶出する第一級芳香族アミンの分析 および由来推定

(2025年5月6日受付)

(2025年8月5日受理)

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## Analysis of primary aromatic amines migration from polyamide cooking utensils and determination of the origins

(Received May 6, 2025)

(Accepted August 5, 2025)

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### Abstract

The migrated primary aromatic amines (PAAs) from polyamide cooking utensils on the Japanese market were examined using LC-MS/MS and the origins of the detected PAAs were investigated. The migration conditions were based on EU methods, employing 3% (w/v) acetic acid as food simulants at 100°C for 2 hours. For 25 PAAs confirmed to be stable under the migration conditions, validation tests were conducted at concentrations of 2.0 µg/kg, 10 µg/kg, and 20 µg/kg. The results of the performance evaluation indicated that all PAAs met the target criteria.

Using the validated method, 31 polyamide cooking utensil samples were analyzed, and 9 of them exceeded the EU regulatory limits. The most frequently detected PAAs was aniline, with concentrations ranging from 4.1 to 199.4 µg/kg in 9 samples. The highest concentration of detected PAAs was 4,4'-methylenedianiline, with a maximum detection of 1655.6 µg/kg. Other PAAs detected, excluding aniline and 4,4'-methylenedianiline, were *o*-toluidine, 2,4-diaminotoluene, and 3,3'-dichlorobenzidine. In this study, the detected PAAs and their trends were similar to those reported in other countries.

Moreover, the origins of the detected PAAs were determined using atmospheric solid analysis probe mass spectrometry and pyrolysis gas chromatograph mass spectrometry. The analysis revealed that diphenylamine was commonly detected in several samples containing aniline, suggesting that black colorants such as aniline black (polyaniline) and nigrosine might be sources of aniline. On the other hand, it was suggested that 4,4'-methylenedianiline may have been intentionally added to the sample as a monomer.

**Keywords:** 第一級芳香族アミン、ポリアミド、調理器具、高速液体クロマトグラフタンデム質量分析計、熱分解ガスクロマトグラフ質量分析計

primary aromatic amines, polyamide, cooking utensil, high performance liquid chromatography-tandem mass spectrometer (LC-MS/MS), pyrolysis-gas chromatography-mass spectrometer (PY-GC/MS)

## I 緒言

第一級芳香族アミン (Primary Aromatic Amines; PAAs) は芳香環に第一級アミノ基が結合した化合物群であり、多くの種類が存在する。代表的な PAAs にはアニリン (ANL) やフェニレンジアミンがあり、農薬、染料、化

粧品、医薬品やポリマーの原料として、化学産業において幅広い分野で使用されている<sup>1)</sup>。しかし、PAAs の中には発がん性を有する、あるいは発がん性の疑いがある物質<sup>2)</sup>、アレルゲン性<sup>3)</sup>や遺伝毒性<sup>4)</sup>を有する物質がある。

PAAs に関する調査報告は複数あり、化粧品<sup>5)</sup>や繊維製品<sup>6,7)</sup>のほか、紙ナプキン<sup>8)</sup>、食品用包装紙に使用さ