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Analysis of heavy metals using Atomic Absorption Spectroscopy (AAS)

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INTRODUCTION

Atomic Absorption Spectrometry (AAS) is widely used for quantitative metal analysis in environmental and food samples. This study compared two AAS instruments, the Shimadzu AA-7800F and the Analytik Jena novAA 400S, for copper and lead determination by evaluating linearity, precision, accuracy and detection limits. In addition, real samples (tap water and spinach) were analysed to assess copper presence and to identify the strengths and limitations of both instruments for routine metal analysis.

MATERIALS AND METHODS

The performance of both instruments was evaluated using calibration curves prepared from certified stock solutions (1000 mg/L). Standard series were used to assess linearity and selectively analyzed as unknowns to check method reliability.

Measurements with both instruments. Flame AAS enables measurement in the ppm concentration range, while the graphite furnace allowed analysis down to the ppb level. Deuterium background correction was applied and selectively disabled to study its effect.

Actual sample: Tap water was analysed directly, while spinach required extensive preparation involving grinding, drying, ashing and acid dissolution to obtain a homogeneous solution.

CONCLUSION

Calibration showed a trade-off between sensitivity and dynamic range. The Analytik Jena novAA 400S was more sensitive but deviated early from Beer–Lambert behavior due to self-absorption, whereas the Shimadzu AA-7800F remained linear over a much wider concentration range. Detection limits for Copper were similar, but for Lead the Shimadzu performed significantly better. Real sample analysis highlighted the importance of matrix correction: Copper in tap water was initially overestimated but corrected using deuterium background correction and KCl buffer. These results demonstrate that instrument choice and proper correction methods are crucial for accurate trace metal analysis.

RESULTS AND DISCUSSION

Table 1: Comparison of performance criteria

	Cu	
	Shimadzu	Analytik Jena
Linearity (up to)	~7 ppm → Better	~6 ppm → Limited
Precision: RSD	< 0,44% → Very good	1,67% → Moderate
Accuracy: bias	+1,2% to +2,3% → Good	-4,4% → Variable
LOD	0,0052 ppm → Better	0,0064 ppm → Good
LOQ	0,015 ppm → Better	0,085 ppm → Limited
	Pb	
	Shimadzu	Analytik Jena
Linearity (up to)	~30 ppm → Better	~15 ppm → Limited
Precision: RSD	< 1% → Good	< 1% → Very good
Accuracy: bias	-1,4% to +4,6% → Good	+1,0% to +8,1% → Better
LOD	0,043 ppm → Better	0,073 ppm → Worse
LOQ	0,143 ppm → Better	0,245 ppm → Worse

Copper was successfully quantified in tap water. Deuterium background correction, combined with KCl as an ionisation buffer, provided the most reliable result, confirming elevated but compliant Cu levels likely related to copper piping.

Copper could not be quantified in spinach. Flame AAS failed to detect Cu, and graphite furnace AAS only confirmed its presence qualitatively, highlighting limitations due to sample preparation and matrix complexity.

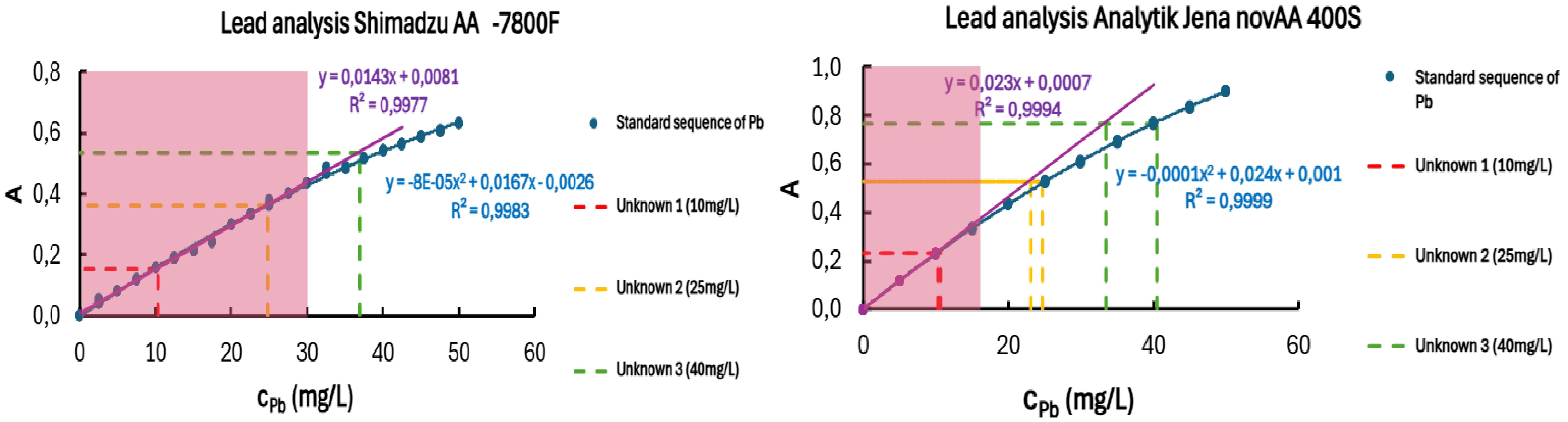

Figure 1: Absorbance as a function of concentration on different instruments

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