ICEPTP 2025

LITHUANIAN RESEARCH CENTRE FOR AGRICULTURE AND FORESTRY

Funded by the European Union NextGenerationEU

# Beneficial nutrients recovery from biofuel ash via extraction with organic acids

NEW GENERATION LITHUANIA


**D. Drapanauskaitė[1], K. Bunevičienė[1], K. Barčauskaitė[1]**

*Lithuanian Research Centre for Agriculture and Forestry[1]*

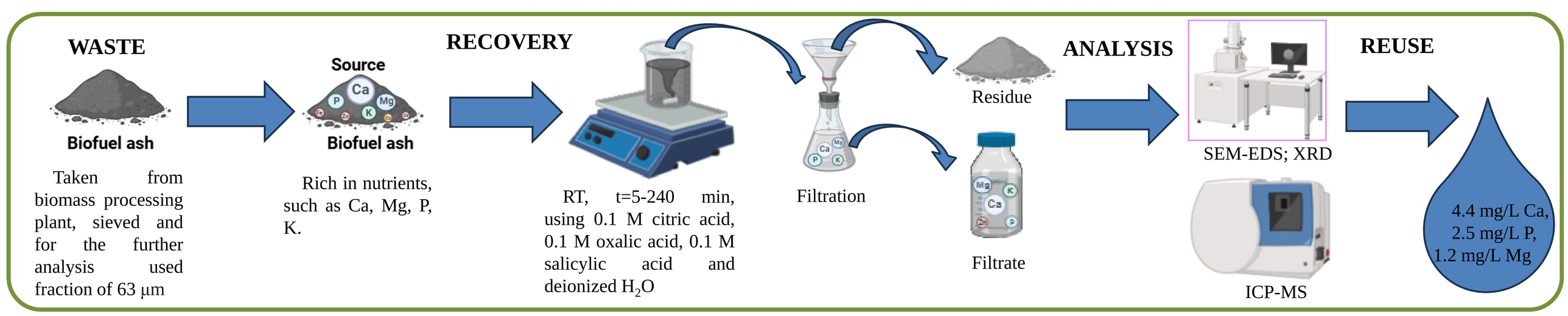
Presenting author: Dr. D. Drapanauskaitė
E-mail: donata.drapanauskaite@lammc.lt


## INTRODUCTION

The amount of generated solid waste is globally rising [1], and managing this waste properly, is essential due to its influence on our environment [2]. Careful consideration should be given to the nutrients in waste, which are lost if the waste is not recycled or otherwise utilized [3]. So, nutrient recovery from waste allows to reduce the use of natural resources [4].

**The aim** of this study was to explore the effect of three different organic acids such as salicylic acid, citric acid, and oxalic acid, on the recovery of beneficial nutrients from biofuel ash.

## MATERIALS AND METHODS




## RESULTS AND DISCUSSION

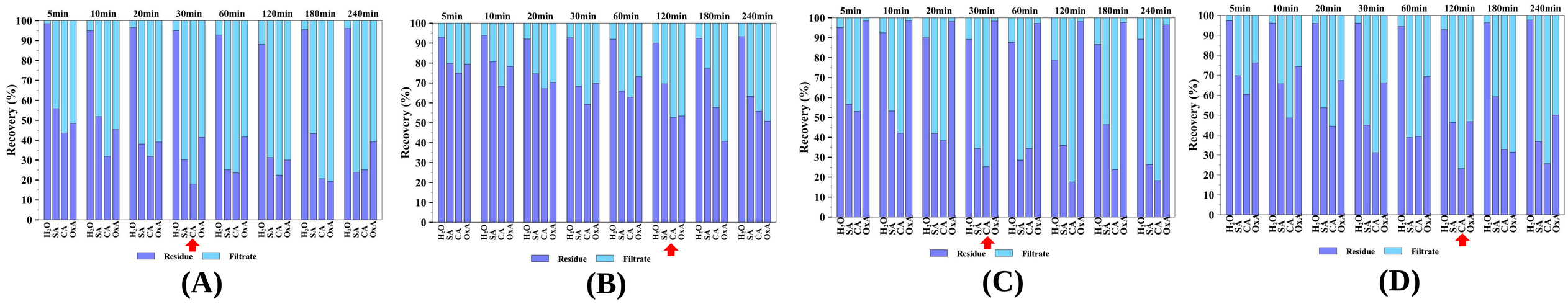



**Figure 1.** Recovery of **(A)** P, **(B)** K, **(C)** Ca, **(D)** Mg from biofuel ash after extraction with different leaching agents. *Note: $H_2O$* deionized water, *SA* 0.1M salicylic acid, *CA* 0.1M citric acid, *OxA* 0.1M oxalic acid.

The findings of the study indicated that 0.1 M citric acid was the most efficient for plant nutrient recovery, with 82% of P recovered after 30 min, 82% of Ca, 77% of Mg, and 47% of K after 120 min.

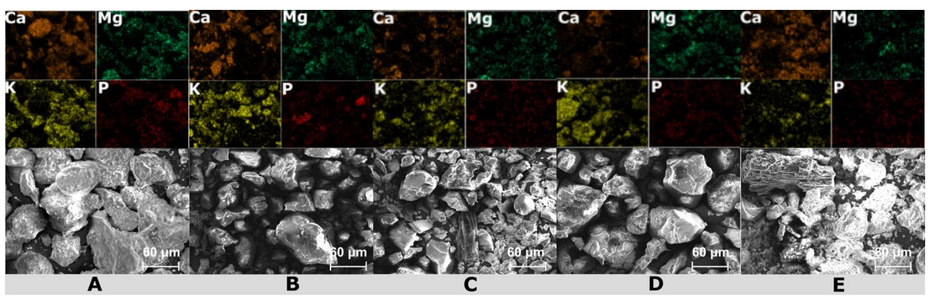



**Figure 3.** Scanning Electron (SEM) images and Energy Dispersive Spectroscopy (EDS) maps of untreated biofuel (A) and biofuel ash residue after

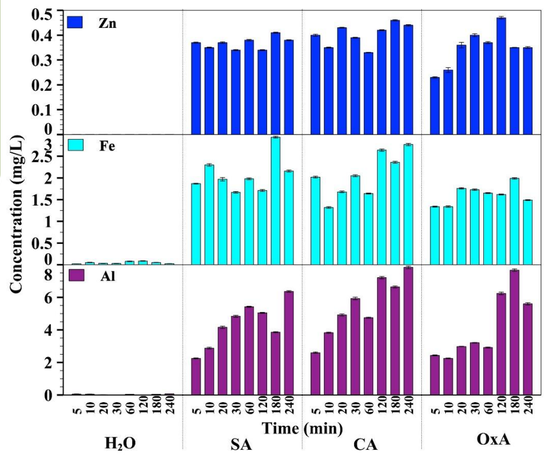
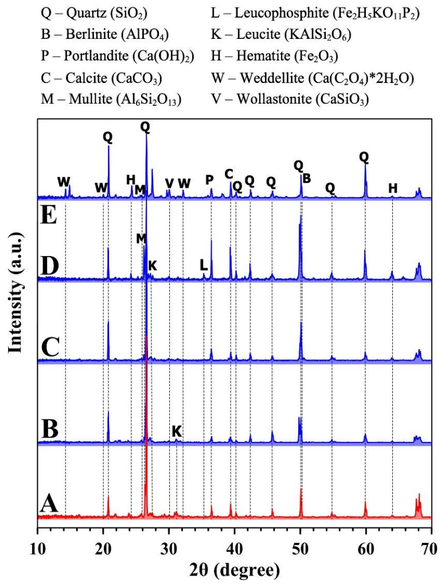



**Figure 2.** Concentration of trace elements at different times in leachates from biofuel ash using various leachants.

pXRD data showed that the dominant phase in biofuel ash was quartz. In all the samples, small quantities of berlinite, portlandite, calcite, mullite, and hematite were found. After treatment with 0.1 M of oxalic acid, small quantities of weddellite and wollastonite were observed. Weddellite belongs to the organic oxalate minerals group, which showed the formation of calcium oxalates and later precipitate.




SEM-EDS showed that Ca, Mg, K, P are evenly distributed all over the particle surface and P distribution on the particle surface is decreasing compared to the untreated sample and ash sample treated with deionized water.

The leachates were not contaminated with heavy metals. The concentrations of Cu, Cd, Cr, Ni and Pb were very low, lower than limit of detection. Just Zn, Fe and Al were detected in higher concentrations.

**Figure 4.** pXRD patterns of untreated biofuel ash (**A**) and biofuel ash residue after 4 hours treatment with deionized water (**B**), 0.1 M salicylic acid (**C**), 0.1 M citric acid (**D**), 0.1 M oxalic acid (**E**).

## CONCLUSIONS

Biofuel ash has a significant potential for beneficial nutrient recovery. 0.1 M citric acid was selected as the optimum beneficial nutrients leachant. The optimized leaching conditions were: extraction time 30 min for P, 120 min for K, Ca, and Mg, acid concentration – 0.1 M, liquid to solid ratio – 500:1. The concentration of nutrients in leachates: P – 2.5 mg/L, K – 2.0 mg/L, Ca – 4.4 mg/L, Mg – 1.2 mg/L. The second best leaching agent for extracting beneficial nutrients from biofuel ash was 0.1 M oxalic acid for recovery of P and K and 0.1 M salicylic acid for recovery of Ca and Mg.


**References**

[1] J.N. Jebaranjitham, J. Durairaj, S. Christyraj, A. Prasannan, K. Rajagopalan, K. Subbiahanadar, J. Kamalapriya, J. Samuel, "Current scenario of solid waste management techniques and challenges in Covid-19 - A review", *Heliyon*, vol. 8, no. 7, pp. e09855, 2022.

[2] K.S. Mulya, J. Zhou, Z.X. Phuang, D. Laner, K.S. Woon, "A systematic review of life cycle assessment of solid waste management: Methodological trends and prospects", *Sci. Total Environ.*, vol. 831, pp. 154903, 2022.

[3] D. Drapanauskaite, K. Buneviciene, M. Silva, A. Slepetiene, J. Baltrusaitis, "Phosphate removal from simulated wastewater using industrial calcium-containing solid waste". *J. Environ. Chem. Eng.*, vol. 9, no. 6, pp. 106575, 2021.

[4] K. Barčauskaite, Z. Braziene, D. Avižienyte, M. Silva, D. Drapanauskaite, K. Honer, K. Gvildiene, R. Slinksiene, K. Jancaitiene, R. Mazeika, G. Staugaitis, T. Dambrauskas, K. Baltakys, J. Baltrusaitis, "Mechanochemically synthesized gypsum and gypsum drywall waste cocrystals with urea for enhanced environmental sustainability fertilizers". *J. Environ. Chem. Eng.*, vol. 8, no. 4, pp. 103965, 2020.


LAMMC