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RETASTE:

**Rethink Food Resources,
Losses, and Waste**

5th International Conference

Athens, September 24-27, 2025

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Publication

Hellenic Mediterranean University, School of Agriculture, Department of Agriculture
Estavromenos, 71 410 Heraklion, Greece

First published on September 24-27, 2025, in Heraklion, Greece by Hellenic Mediterranean University, School of Agriculture, Department of Agriculture.

ISBN: 978-618-87330-1-5

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RETASTE 2025 was co-organized by the Hellenic Mediterranean University and Harokopio University.

From Waste to Resource: Crayfish Shells as Adsorbents and Biofillers in Natural Rubber

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Abstract

Faxonius limosus is the most widespread invasive species of crustacean. It poses a threat to native crustacean species throughout Europe, which is why it is necessary to prevent its spread in river courses. The river crayfish *Faxonius limosus* is an autochthonous species of North America that first populated the river courses of Europe at the end of the 19th century in Poland, and to date, it has been found in more than 20 European countries. In the territory of the Republic of Serbia, it was discovered in 2002 in the Danube river (Kaldre et al., 2020, Layarević et al., 2022). One of the sustainable methods of prevention of its spreading is the hunting and use of meat and shells, following the principles of the Circular Economy. Crayfish meat has a high nutritional value, and it can be used to produce food products, while the shells, that are generated as waste, can be used as adsorbents in wastewater treatment. Biosorption is a promising, cost-effective process for the removal of heavy metals from wastewater. However, the commercial application of biosorbents has been limited because a significant amount of toxic waste is generated during adsorption process. In this study, the possibility of managing postsorbent, obtained after Zn ions removal from water, by incorporating it into rubber products was investigated. The investigation were performed with natural caoutchouc. Rubber blend containing loaded shells (LS) were prepared using commercial components commonly used in the rubber industry, such as sulfur as crosslinker, carbon black as filler, zinc oxide and stearin as vulcanization activators and isopropyl-N-phenyl-1, 4-phenylenediamine as antioxidant. The relative composition of a mixture is expressed in phr (parts per hundred rubber) units, meaning parts of non-rubbery material per hundred parts of caoutchouc. The rubber bland was prepared according to the procedure described in (Blagojev et al., 2022). Mechanical and rheological properties of rubber were tested. The tensile strength is lower (20.3MPa) compared to the sample without added LS (27 MPa). The elongation at break is higher for the sample containing 5 phr of LS (358.9%) compared to the sample without added LS (317.46%), showing that added LS influenced crosslinking and prevented vulcanization reaction to occure. Additionally, when rheological properties were tested, lower maximum torque was observed for the sample containing LS (11.62 MPa) compared to the sample without LS (13.56 MPa), confirming that added LS causes a slower vulcanization process in the rubber compound. Lower amounts of LS can be added to obtain the same results, or this product can be used for larger rubber products which are produced at lower temperatures with slower vulcanization reactions. Further research will be conducted with different amounts of LS and leaching tests will be performed.

Keywords: *Faxonius limosus*, invasive species, biosorbents, heavy metals, rubber production,

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Acknowledgments: This research was supported by the Science Fund of Republic of Serbia, #GRANT No. 7417. "Reducing the negative impact of invasive crayfish *Faxonius limosus* in the Danube by smart exploitation of their meat and shells" DANUBEcare