Extended Abstract

New Controlled-Release Fertilizers with Keratin-Based Coating from Chicken Waste Feathers [†]

Eliza-Gabriela Mihăilă ^{1,2}, Victor Alexandru Faraon ¹, Mălina Deşliu-Avram ¹,
Constantin Neamţu ¹, Diana Constantinescu-Aruxandei ^{1,*} and Florin Oancea ^{1,*}

¹ National Institute for Research & Development in Chemistry and Petrochemistry–ICECHIM, 060021 Bucharest, Romania; mihaila.eliza.gabriela@gmail.com (E.-G.M.); victor.faraon@icechim.ro (V.A.F.); malina.desliu.avram@icechim.ro (M.D.-A.); titi.neamtu@icechim.ro (C.N.)

² Power Engineering Faculty, University Politehnica Bucharest, 060042 Bucharest, Romania

* Correspondence: Diana.C.Aruxandei@gmail.com (D.C.-A.); florin.oancea@icechim.ro (F.O.)

[†] Presented at the 16th International Symposium “Priorities of Chemistry for a Sustainable Development” PRIOCHEM, Bucharest, Romania, 28–30 October 2020.

Published: 10 November 2020

Keywords: keratin; NPK fertilizer; DES; controlled nutrient release

Circular economy systems employ minimizing the use of resource inputs and generation of waste, pollution and CO₂ emissions. The new EU regulation [1] advises on the use of urea-based fertilizers and allows only biodegradable coatings in order to be eco-friendly. In this work, we developed an NPK fertilizer coated with keratin from chicken feather waste. 1. Keratin extraction: several methods [2] for obtaining keratin were investigated: (i) solubilisation in natural deep eutectic solvents (NaDESs), (ii) microwave extraction, (iii) extreme pH, (iv) aqueous thermal hydrolysis and (v) enzymatic hydrolysis. 2. Fertilizer formulation: a granular (2–4 mm) NPK-type fertilizer was prepared with a longitudinal oscillator mixer with variable amplitude and granulated using a lab-scale rotating pan granulator. 3. Keratin application: two types of keratin application were tried: using the Wurster method [3] on a fluidized bed granulator and other trials using the same granulator. 4. Leaching tests: the last part was the leaching testing using a Behr system, adapted after [4,5]. The working conditions were 1680 h, 3 mL/h. The eluent was pumped into the soil cartridge, and the liquid eluate was analysed for N, P and K content (%). The classical methods for keratin extraction—extreme pH and aqueous thermal hydrolysis—had much higher extraction yields than the greener ones (NaDES and microwave extractions), at least 100% higher. At 200 °C, keratin from feathers was over 90% extracted in an aqueous solution. It was observed that the coated fertilizers had increased nitrogen content, comparative to the untreated sample. The first fertilizer formulation, N/P/K 1/1/1 with keratin coating, released the highest N content, 0.3%, almost three times higher than the uncoated fertilizer. During the first half of the leaching period, the N and K concentrations were at the highest values, with higher values for the coated fertilizers, indicating controlled macronutrient release. Higher concentrations of N and K were released from the coated fertilizers, P concentration remaining the same. The obtained fertilizer could be used for efficient controlled macronutrient release.

Acknowledgments: The work on this paper was supported by Project SECVENT no. 81/2016 “Sequential processes of closing the side streams from bioeconomy and innovative (bio)products resulting from it”, subsidiary contract no. 2040/2017.

References

1. European Union. Regulation 2019/1009, 2019. (EU) of the European Parliament and of the Council of 5 June 2019 Laying Down Rules on the Making Available on the Market of EU Fertilising Products and Amending Regulations (EC) No 1069/2009 and (EC) No 1107/2009 and Repealing Regulation (EC) No 2003/2003. OJ L 170, 25.6.2019. pp. 1–114. Available online: <http://data.europa.eu/eli/reg/2019/1009/oj> (accessed on 6 October 2020).
2. Sinkiewicz, I.; Śliwińska, A.; Staroszczyk, H.; Kołodziejka, I. Alternative Methods of Preparation of Soluble Keratin from Chicken Feathers. *Waste Biomass Valorization* **2017**, *8*, 1043–1048, doi:10.1007/s12649-016-9678-y.
3. Srivastava, S.; Mishra, G. Fluid Bed Technology: Overview and Parameters for Process Selection. *Int. J. Pharm. Sci. Drug Res.* **2010**, *2*, 236–246.
4. Naka, A.; Yasutaka, T.; Sakanakura, H.; Kalbe, U.; Watanabe, Y.; Inoba, S.; Sato, K. Column percolation test for contaminated soils: Key factors for standardization. *J. Hazard. Mater.* **2016**, *320*, 326–340, doi:10.1016/j.jhazmat.2016.08.046.
5. Wu, L.; Liu, M. Preparation and properties of chitosan-coated NPK compound fertilizer with controlled-release and water-retention. *Carbohydr. Polym.* **2008**, *72*, 240–247, doi:10.1016/j.carbpol.2007.08.020.

Publisher’s Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

© 2020 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).