Valorization of a food industry orange waste as biostimulant plant growth: use of vibrational spectroscopy to early access their chemical composition

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Orange peel is one of the highest wastes obtained from the orange processing industry. These wastes contain a balanced amount of sugar, cellulose, pectin's and hemicellulose, as well as an interesting amount of bioactive compounds. Such composition increases the interest of this product with biological activities in different food and non-food application. Some of the application of the citrus waste include food additive, prebiotic, pectin source, polyphenol, dietary fiber, or essential oil. Nitrogen fertilizers are applied in most of the agricultural crops since soils didn't have enough available N to crop needs. In addition, the manufacture of N fertilizers is high energy consuming, since the Haber-Bosch process used to capture de atmospheric N_2 into NH_3, has an energy foot print of 12.1 kWh kg^{-1} of NH_3-N. So, the recovery of nitrogen from food industry wastes or livestock effluents is now a relevant approach to contribute for the circularity of the nutrients in agriculture, and also to save natural resources. The process used to recover N was by the gas-permeable membrane (GPM) technology. This GPM technology recovered the N of the effluent by its volatilization in the form of NH_3 and recovered it at an acidic H_2SO_4 solution in the form of NH_4. During this process, other volatile organic compounds can also cross the membrane and be recovered in the acidic solution. The presence of low amounts of organic matter has been detected in the acidic solution, and it can have a beneficial effect on crop development. So, the early chemical characterization of this liquid N fertilizer can help to a better understanding about its potential agronomic effect. This work aimed at evaluate the accuracy of the FT-RAMAN spectroscopy to the early characterization of the chemical composition of a liquid N recovered fertilizer. The effluent used in this work to recover N was obtained by the co-digestion of an orange peel effluent from an orange juice food-industry mixed with pig slurry. This N recovered solution (N-rec) was used as the N source to fertilize triticale (×*Triticosecale* Wittmack, var. Misionero), and its effect on the biomass production was compared with the use of a mineral nutritive solution (Hoagland – Hoag) and a control treatment (water – W) with any fertilization.

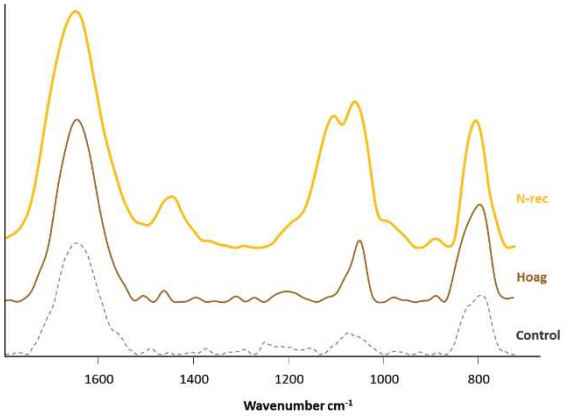

Figure 1: Raman spectra of aqueous fertiliser solution with and without orange waste. (adapted from 2)

The spectral results acquired with FT-RAMAN (Figure 1) showed that the liquid N recovered fertilizer is rich in bioactive compounds namely phenolic compounds, sugars and organic acids, compared with the Hoag or the W treatments. At the end of the experiment the biomass of the triticale increased 29% compared with the Hoag treatment. These results highlighted the agronomic value of this liquid N bio-based fertilizer. In addition, the results highlighted the role of the organic compounds from the N-rec solution as potential biostimulants, which can be early assessed by the FT-RAMAN spectroscopy.

Funding: This work has been funded by the National Institute of Research and Agro-Food Technology (INIA) and co-financed with FEDER funds (PID2019-106148RR-C41) and for the EU Program INTERREG V-A Spain—Portugal (POCTEP) 2014–2020 (Project 0745_SYMBIOSIS_II_3_E). This work has been also funded by National Funds through FCT—Foundation for Science and Technology under the Projects [UIDB/00681/2020] [CERNAS-IPCB] and UIDB/00239/2020 [CEF].

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