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Introduction

Fruit and vegetables industry gives rise to large volumes of organic wastes, such as peels and seeds, whose quantity is foreseen to increase due to the rising public demand. This wasted material instead to represent a problem it can be regarded as an available by-product for the production of food additives or supplements with high nutritional value [1]. Additionally, the fresh-cut fruit and vegetables by-products can be used as a biomass resource for biofuel production [2]. The most promising alternative to incinerating these materials is digest it under anaerobic conditions to obtain an energy carrier gas (biogas/methane) and a treat flow to be applied as soil conditioner.

The present work intends to assess whether anaerobic digestion could be additionally used as a valorisation method of fresh-cut fruit and vegetables by-products, producing different valuable molecules for industrial applications.



Materials and Methods

A representative mixture of volumes of fruits and vegetables by-products (Mix), obtained daily in an industrial unit in Torres Vedras (Portugal), was anaerobically digested in admixture with the whey (Wh) and concentrated whey (Wh_c), produced in the neighboring dairy industry. Accordingly, different combinations of organic material were performed to be digested:

- Mix (unit 1),
- Mix and Wh (unit 2),
- Mix and Wh_c (unit 3).

Description of the anaerobic digester reactor and process

The potential of the production of the valuable high-added value biomolecules by means of anaerobiosis was assessed comparing the occurrence of phenolic compounds, antiradical activity (EC₅₀, half maximal effective concentration) and flavonols that are present into the substrates and in the digestate.

Samples	Phenolic content (g/l)	Antioxidant activity (EC50) (µg)	Flavonols content
Mix	0,191 ± 0,002	2,601 ± 0,137	-
Wh	0,12 ± 0,013	1,016 ± 0,211	-
Wh _c	0,29 ± 0,021	2,794 ± 0,181	-
Unit 1	0,055 ± 0,0036	0,318 ± 0,049	-
Unit 2	0,072 ± 0,0057	0,238 ± 0,096	0,6 ± 0,0121
Unit 3	0,065 ± 0,0022	0,194 ± 0,055	0,57 ± 0,0251

With regard to substrates, the mixture of by-products and the whey solutions presented the lowest concentrations of total, but the highest antiradical activity values, indicating that the industrial application of these substrates may be more interesting than the concentrate whey solution (Wh_c), which contains higher concentration of total phenols but lower antiradical activity. The presence of flavonols was not identified in any of the substrates under study. The digested substrates of units 1, 2 and 3 presented similar quantity of phenolic compounds but different potential in terms of antiradical activity. The highest antiradical activity was found in the units digesting vegetable by-products with a complementary effluent (units 2 and 3).

The simultaneous presence of flavonols compounds in digestate of these units that were not detected in the initial substrates, indicate that they have been produced during the anaerobic digestion process.

Our data demonstrated that anaerobic digestion could be used to valorise fresh-cut fruit and vegetables by-products though the production of the valuable molecules for the food, cosmetic and pharmaceutical industry.

[1] D. Pleissner and C.S.K. Lin. Valorisation of food waste in biotechnological processes. Sustainable Chemical Processes. 2013, 1: 21-26..

[2] R.A.D. Arancon, C.S.K. Lin, K.M. Chan, T.H. Kwan and R. Luque. Advances on waste valorization: new horizons for a more sustainable society. Energy Science and Engineering. 2013, 1(2): 53–71.