Enzymatic treatment for Fungal biodegradation of procyanidins extracted from coffee-pulp waste

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Abstract

Currently, some research groups are interested in the development of technological alternative to reduce and valorize cheap agro-industrial wastes with high generation volumes and undervalued biological potential, as is the case of coffee pulp, which has been used for composting, animal feed, biofuels, obtaining chemical products have been reported, however, the lack of a sustainable alternative means that its use is still limited, probably for the limited advances in the detoxification process, due coffee pulp is rich en condensed tannins (procyanidins) and caffeine. Procyanidins have hydroxyl groups, chiral carbons, interflavanic bonds that make them reactive molecules, that is, they can form bonds with other molecules such as proteins and carbohydrates. These compounds can inhibit fungi and bacteria, however there are filamentous fungi that are not inhibited, mainly some aspergilli. *Aspergillus niger* strains are generally recognised as safe (GRAS), they can use PCs as a carbon source for the production of enzymes involved in degradation and/or biotransformation processes. Degradation refers to the complete loss of the compound (PC), while biotransformation indicates the modification of the compound. This occurs by enzymatic action or a chemical agent, where procyanidins react with other molecules, allowing the formation of new molecules with differences in their structure and properties. Microbial degradation could become a key solution for the valorization of coffee pulp, as well as an alternative method to degrade macromolecules to structurally less complex and toxic compounds and could contribute to the removal and clean-up of ecosystems.

The zero-waste approach has allowed the valorization of by-products from the food industry. Currently, coffee pulp is the target of research on extraction, purification, and alternative uses. Research on fungal degradation of procyanidins has emerged as an avenue for efficient utilization of these by-products. In this study, the degradation or biotransformation of procyanidin was evaluated, comprising three steps: first, the extraction and partial purification of procyanidins from the coffee pulp. The second part consisted of the production of the potential procyanidin-degrading enzyme by submerged fermentations with *Aspergillus niger* GH1, and in the third step, the enzymatic extracellular extract was evaluated in a model system with commercial procyanidin C1. The biodegradation/biotransformation results reveal new compounds formed, including a

final compound with *m/z* of 289, possibly a monomeric molecule such as catechin or epicatechin. The identification of the compounds by HPLC-MS allowed confirmation of procyanidin C1 depletion at the described assay conditions, which could be used to understand proposed biodegradation pathways for future studies. Furthermore, these results confirm that *A. niger* GH1 is able to degrade and biotransform Procyanidin C1.