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Apple and Pomegranate Waste Extracts by Hydrodynamic Cavitation for Vegan and Gluten-Free Cookies Fortification

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Abstract

Nowadays, a big challenge is to reduce food waste, creating a circular economy within food cultivation and processes, to reduce costs and environmental impact. Focus was made on two fruit wastes: damaged apples (*Malus Domestica sp.*) and pomegranate peels (*Punica granatum sp.*). Apple is the main produced fruit in Italy (2.3 million t/y), with a harvesting loss of 230 thousand t/y, due to diseases or not conformed appearance. Instead, pomegranate waste is represented by the peel, discarded after juice production. Due to their chemical composition, both wastes are well known for nutraceutical and technological applications. Apples are a well-known source of pectin, which can act like technological agents, but lately studies on their phenolic content are gaining interest. On the contrary, pomegranate peel's main peculiarity is the high presence of phenol compounds, and new studies are pointing out its good amount of pectin. In order to exploit the potential of these wastes, an extraction is needed. Hydrodynamic Cavitation (HC) is a "green" and low temperature extraction process that requires water, good for scale up. The aim is to propose functional and "green" food additives, useful for improvement of nutraceutical and technological properties of baking products. Vegan and gluten-free cookies with HC extracts from apple and pomegranate waste were chosen for this study. Cookie samples were prepared as follow: control recipe (CON); with apple extract substituted to 5% and 10% of flour + sugar (M05 and M10); with pomegranate peel extract substituted to 5% and 10% of flour + sugar (B05 and B10); without the 5% and 10% of flour + sugar (S05 and S10). Physical (weight, spread ratio, colour, texture), chemical (total phenolic content, antioxidant power as IC50) and sensory analysis were carried out immediately after production (t0) and after one month of simulated home storage (t1). Cookies samples were statistically different in spread ratio ($p < 0.001$), with higher values at higher extract concentrations. Moreover, B05 and B10

were harder ($p < 0.05$) than all the other samples. These characteristics were respectively influenced by the free sugar content and the fiber/pectin content of the extract. Total phenolic compound and antioxidant power were significantly higher ($p < 0.001$) in B05 and B10 than all the other samples. In particular, B05 and B10 had higher antioxidant power than M05, M10, and CON, while S05 and S10 scored the lowest values. Total phenolic content and IC50 values were not statistically significant during conservation, indicating an antioxidant stability of cookies. Trained panel evaluated cookies with apple extract as “sweet”, “sour”, “fruity”, “vanilla aroma”, “caramel aroma”, and pomegranate peel cookies as “bitter”, “astringent”, “fruity”, “whole aroma”, “toasted”. In conclusion, the HC extract from apples is more functional for technological proprieties, since it improved aspect and sensory characteristics. Instead, HC extract from pomegranate peel resulted more functional for nutraceutical proprieties, due to high antioxidants presence, but its use should be limited, due to the bitterness.

Keywords: Hydrodynamic Cavitation, apple by-product, pomegranate by-product, cookies fortification

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