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Life Cycle Assessment of alternative production strategies for genistein and its glucosyl derivative to be employed in the modulation of angiogenesis of hepatocellular cancer

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PURPOSE OF THE ABSTRACT

Several epidemiologic studies suggested a strong correlation between a soybean (Glycine max L.; Leguminosae) rich diet and a significantly lower incidence of several diseases, including certain types of cancer, the latter being attributed to the high content of genistein, GEN (i.e. 4',5,7-trihydroxyisoflavone or 5,7-dihydoxy-3-(4-hydroxyphenyl)chromen-4-one), the major isoflavone found in soy-based foods [1].
Particularly, hepatocellular cancer arises from chronic inflammation-related fibrosis. Among the molecules that are upregulated from inflammatory cells, contributing to angiogenesis and fibrosis, Angiopoietin-2 (ANGPT2) plays a key role [2]. At this regard, GEN demonstrated the ability to control ANGPT2 signaling thus modulating in vitro angiogenesis. Therefore, a fine tuning of GEN uptake and bioavailability, through modulation of its physico-chemical features (e.g. glucosylation), may provide innovative anti-angiogenic therapies with benefits for cancer chemoprevention and treatment.
In view of the above mentioned potential human health benefits of pure GEN and its glucosyl derivative 7-G-GEN, a holistic assessment of the environmental impacts associated to the obtainment of these chemical compounds results of paramount importance from a green chemistry perspective to pursue an always more sustainable development. The present work aims at assessing the environmental impacts associated to alternative preparation procedures of such phytochemicals, through the application of Life Cycle Assessment (LCA) methodology. Particularly their direct chemical synthesis [3] as well as their extraction from natural sources [4] have been accurately quantified and compared from an environmental sustainability perspective to establish the greener alternative. Moreover, the potential benefits of GEN and 7-G-GEN on human health has been also considered in the whole assessment (similarly to what performed for further phytochemicals [5]), by modifying the impact assessment method, thus comprising GEN into a newly created dedicated impact category, with a negative characterization factor, belonging to the Human Health damage category. At this regard the fundamental input data for the development of the characterization factor, have been obtained from the results of in vitro tests. Normalization operations have been performed to refer the newly developed damage assessment factor to typical drugs employed for hepatocellular cancer treatment.
This work relies within a wider research project titled ?Flow-dependent regulation of Angiopoietin-2 and the role of Genistein in modulating the angiogenic potential and immunomodulation abilities of mesenchymal stem cells isolated from dental pulp? (AGAPI), financed by the University of Modena and Reggio Emilia (Italy).

FIGURES

FIGURE 1

FIGURE 2

KEYWORDS

LCA | environmental sustainability | phytochemicals | human health

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