BIOCHAR PERFORMANCES AS DRUG-CARRIER OF BIOACTIVE MOLECULES USED FOR INTESTINAL DESEASE TREATMENT

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Main theme and proposed section: Bio-char applications: soil amendments, adsorbents, catalysts, fillers for composites, electronic applications

The aim of the study is the production and the characterization of a custom-made biochar in order to develop a novel drug-carrier with the function of delivering mono- and diacyl-glycerols of butyrate (BMDG) within the human intestine.

Butyrate has been described as a tumor-suppressive metabolite as it can act by modulating genetic instability and gene expression through methylation and histone acetylation in colonocytes and inducing apoptosis in cancer cells. Biochar represents a cheap alternative to the commercial active carbons already used as drug deliverer, and, moreover, as opposed to active carbons, does not need to be activated, reducing the energy cost of production. In general, the innovative solution proposed in this project is to adopt the biochar as a safe, inexpensive, and renewable carrier for the described BMDG compound.

The goal is to obtain a combined molecule that can synergistically link the benefits of butyrate intake to the intrinsic benefits that biochar can bring to the intestine, such as the ability of biochar to modify the intestinal pH thus contributing to alter the intestinal microbiome composition towards a profile associated with improved tumor suppression. The advantage of the use of this novel molecule, indeed, is related to the expected increased efficacy of the biochar-BMDG molecule compared to butyrate alone in terms of colorectal cancer (CRC) prevention and therapy, providing additional value in combining the properties of molecules used in human nutraceutics (butyrate) and char, thus representing a non-invasive and promising approach for CRC.
RE-CORD selected ligno-cellulosic feedstock for biochar production to obtain proper characterization in terms of physical and chemical features which can describe the subsequent absorption of the target compound. Biochar performances were compared with that of purchased activated carbons, produced to be suitable for adsorption of a wide range of low to higher molecular weight impurities, having a deeply developed mesoporous structure (with pore width between 2 and 50 nm). Biochars and activated carbons were assessed in terms of both BMDG retention and release in order to evaluate the effective intake of the target compound when delivered by one carrier or the other. Release tests were carried out both in water and in a simulated intestinal fluid produced in the laboratory, in order to reproduce the human intestine environment and chemical dynamics.

Assessed biochars showed weaker absorption performances against BMDG solution, but, on the other hand, they exhibited higher release behavior, displaying up to 100 percent release towards the adsorbed product, increasing the utilization efficiency of the active ingredient. The tested biochar conformed to European Pharmacopoeia standards, which are referred to the activated carbons.

A key aspect of this project is understanding the most suitable feedstock selection to produce a biochar with appropriate physical and chemical characteristics to optimize retention and release processes in order to create a more cost-effective, renewable and efficient tailor-made drug-carrier.