DEVELOPMENT OF INNOVATIVE PROCEDURES OF EXTRACTION AND CHARACTERISATION OF ACTIVE INGREDIENTS FROM BOTANICALS GROWN BY ALTERNATIVE METHODS

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ABSTRACT

Synthetic dyes production raised some pollution problems concerning both the synthesis and the dyeing process of textiles. Indigo is a natural dye, widely employed in the textile industry, that can be extracted from plants like *Isatis Tinctoria* without the use of organic solvents [1]. Other applications of indigo are in the field of semiconductors, or to create some derivatives like Tyrian Purple [2].
The aims of my PhD project are to develop a quality control procedure for the production process of indigo, to characterize the final product and the precursors present in the plant, and to optimize the cultivation parameters using an innovative vertical grow system.
Today the production of natural indigo follows some steps: freshly harvested plants are let to macerate in water for about two days. After the removal of the plants, $Ca(OH)_2$ is added to precipitate the pigment, which is then separated from the liquid phase by decantation. After the addition of some HNO_3 to bring pH near the neutrality, the indigo paste is dried and grinded to obtain the final product. The composition of the resulting indigo powder is not completely known, since only the 5% of the total weight is represented by coloured molecules like indigotin and indirubin. These are two conformational isomers, showing two different absorption spectra in the visible region. During my PhD, several spectroscopic techniques will be used to characterize both the solid indigo powder, such as NIR or Raman, and the solutions of the dissolved powder. In this last case, electrochemistry could represent a valid alternative, since both indigotin and indirubin present two reducible functional groups [3]. Moreover, since the reduced form of indigo is soluble in water, the electrochemical reduction could be an eco-friendlier alternative to the traditional use of chemical reductant like dithionite. Chemometrics will also be employed to have a quality control on different batches produced. The characterisation and quantification of the main precursors of indigo present in the plant, indican, isatan A and isatan B [4], will be helpful in order to establish the correct moment to cut the plant. Since these compounds are not coloured or electrochemical active, HPLC will be mainly used. In the same optic, HPLC will be also use to monitor some reaction intermediates that are formed during the maceration step to understand when stop the process. The valorisation of the waste products of the extraction processes will constitute an important part of the project as well.
As regards the growing methods for the plants, both the conventional open field cultivation and the innovative indoor cultivation procedure called vertical farming will be employed. In the vertical farming, all the vegetative phases of the plant can be studied and optimized to obtain the maximum concentration possible of indigo precursors, and factors like temperature, light or nutrient can be modulated to increase the growing period of the plant.
In the final part of the PhD project, all the data collected will be used to optimize the process on a semi-industrial scale.

REFERENCES

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