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Extraction of chlorophylls from the aerial parts of carrots (*Daucus Carota* L.) for the development of alternative natural colorants

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The food industry has a great interest in the use of wastes and by-products that are not used by the industrial food sector from which they are originated, since they cause economic losses and high environmental pollution. For being a rich source of nutrients and bioactive compounds, such as chlorophylls, some bio-residues can find application as natural food colorants. These molecules have potential to be used in the development of functional foods and nutraceuticals, allowing the enrichment of a product with benefits for human health. In this context, two types of extraction were performed from the aerial parts of carrot, where the parameters involved in each extraction method were varied to maximize the extraction yield of chlorophylls: in maceration, the extraction time and solvent, and in ultrasound-assisted extraction, the power and solvent. On the other hand, in order to prioritize environmentally friendly processes, green solvents (water, 90% ethanol, and hexane) were used. Extractions were performed protecting the samples from light and the results were obtained using a newly developed chromatographic method through high performance liquid chromatography (HPLC) coupled to a diode array detector (DAD) and mass spectrometry (MS).

Ultrasound-assisted extraction allowed a higher recovery of chlorophylls than maceration (**Figure 1**), with ethanol revealing a higher extraction capacity than the other solvents. The extractions using 400, 200, and 100 W of power allowed concentrations of 110.4±0.4, 36.60±0.02, and 29.7±0.1 µg/mL, respectively. Chlorophyll a was common to all extracts, being the only compound detected in the 100 W extraction. With increasing power, a higher extraction of compounds was evidenced, specifically chlorophyll b (at 200 and 400 W) and pheophytin a (at 400 W). Chlorophylls were not detected in quantifiable concentrations in the hexane extracts with the US technique. As for the extractions with maceration and ethanol as solvent, the 60 min extraction allowed the extraction of a total amount of chlorophyll of 12.11±0.03 µg/mL, while the 120 min extraction extracted 10.77±0.03 µg/mL. Chlorophyll b and pheophytin a were more abundant in the extraction performed for 60 min, while the chlorophyll derivative was detected in a higher concentration in the extraction performed for 120 min. Compared to water and hexane, ethanol allowed the extraction of higher amounts of chlorophylls. This study can serve as a basis for further research on the best conditions for the extraction of chlorophylls with high coloring capacity; on the other hand, it was demonstrated that the aerial parts of carrots have great potential to be used as sources of natural pigments not only in the food industry, but also in other industrial fields.

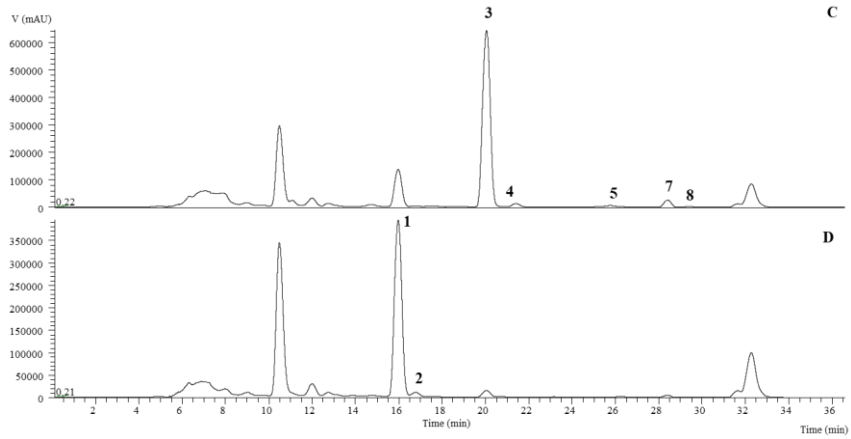

Figure 1: Chromatogram of the phenolic profile, recorded at 430 nm (A) and 470 nm (B), of the ethanolic extract of the aerial part of carrot, obtained from the US extraction using 400 W.

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