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Synthesis and Characterization of Chrysin-4'-Sulfonic Acid: A Step Toward Metal Ion Coordination Complexes of Sulfonated Flavonoids

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Abstract: Chrysin (5,7-dihydroxyflavone) is a naturally-occurring flavone, part of a larger group of plant pigments, known for their avid biological activity. Many flavones can form quinones or coordinate metal ions, thus enabling participation in redox reactions within the plant photorespiratory system and providing protection against ultraviolet radiation. These properties support their broad pharmacological use. Flavonoids are recognized for their potent antioxidant properties, validated in both *in vivo* and *in vitro* studies. They are associated with protective effects against bacterial and viral infections, cardiovascular diseases, cancers, and age-related disorders. In plants, they serve as secondary metabolites and antioxidants under stress conditions, localizing in mesophyll cell nuclei and regions rich in reactive oxygen species, while concurrently modulating growth regulators, such as auxins.[1,2]

Introduction

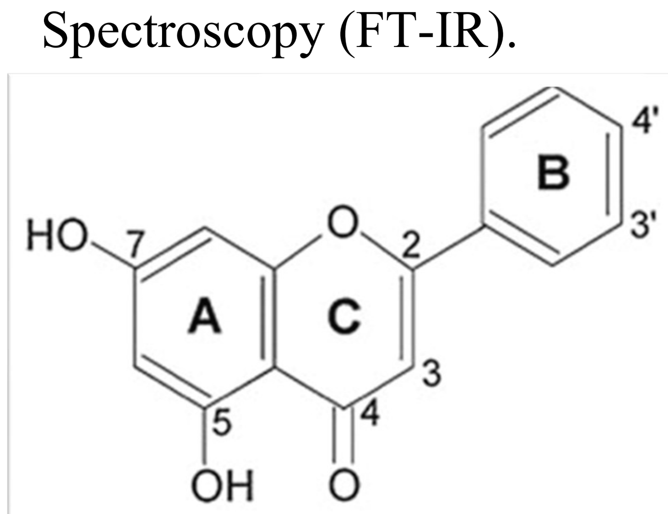
Fig. 1: Flavonoids in plants

Among the most studied natural plant flavones are chrysin, quercetin, and naringin, including their sulfonated forms (**Fig. 1**). Native flavones typically suffer from poor water solubility, a limitation potentially remedied through sulfonation, which enhances their solubility and potential bioavailability for pharmaceutical use (**Fig. 2**). While sulfonated derivatives of other flavones have been documented, no sulfonated form of chrysin has been previously reported, thus highlighting a gap in the field.[2,3] To address this issue, our Laboratory initiated a research effort focused on the synthesis and study of sulfonated chrysin derivatives. Chrysin was selected for sulfonation, using concentrated sulfuric acid under reflux (135–145 °C), yielding chrysin-4'-sulfonic acid (chrysin-4'-SO_3H). Sodium chloride was then added to purify the emerging derivative from sulfuric acid, ultimately affording the chrysin-4´-sulfonic acid sodium salt.

Fig. 2: Various natural products with their healing properties[4]

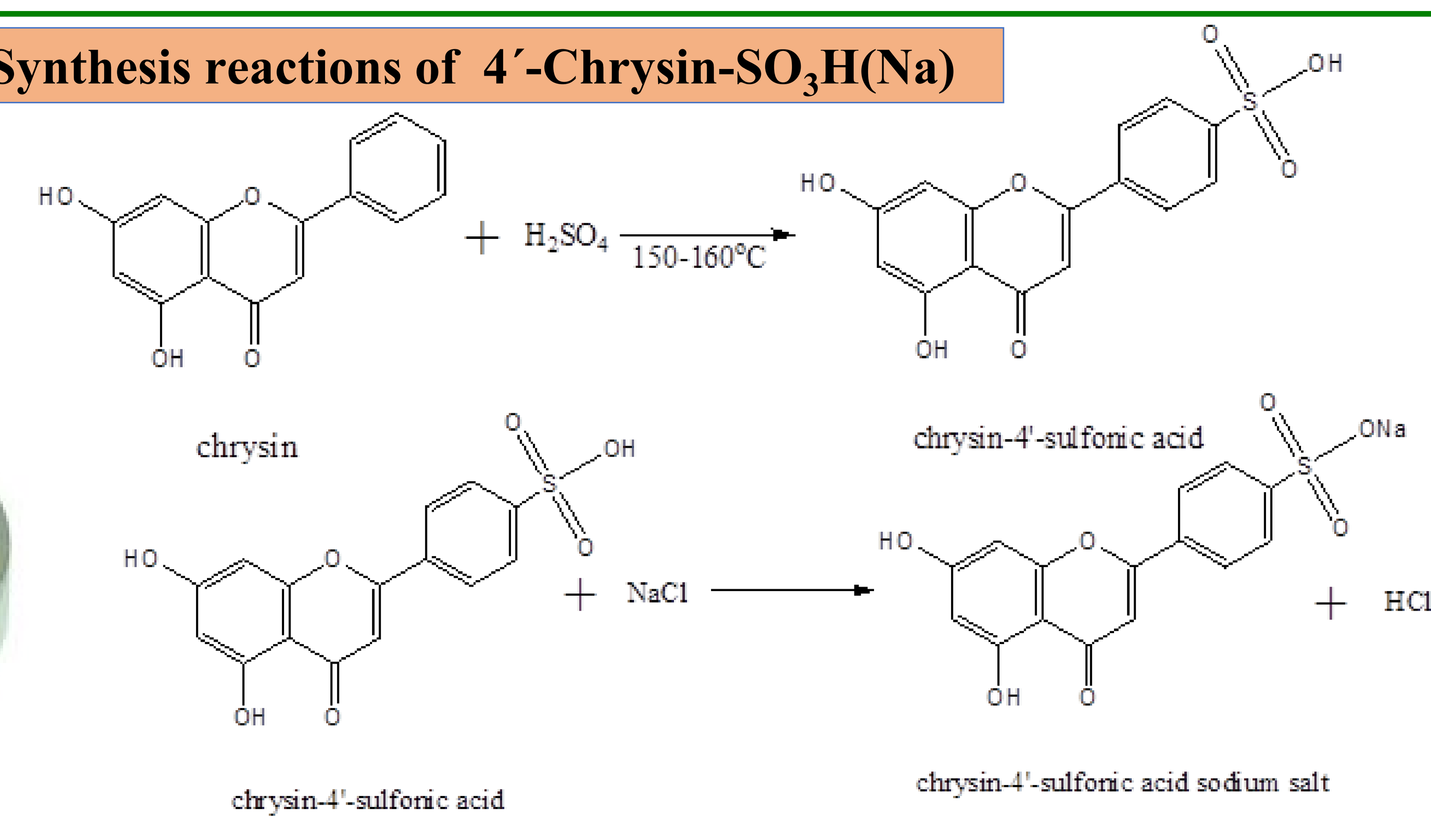
Materials and methods

Materials: Chrysin, Sulfuric acid, Sodium chloride.
Reaction technique: Magnetic stirring with heating at 135–145 °C for 48 h.
Physicochemical Characterization: Elemental analysis, Fourier Transform Infrared Spectroscopy (FT-IR).



Chrysin

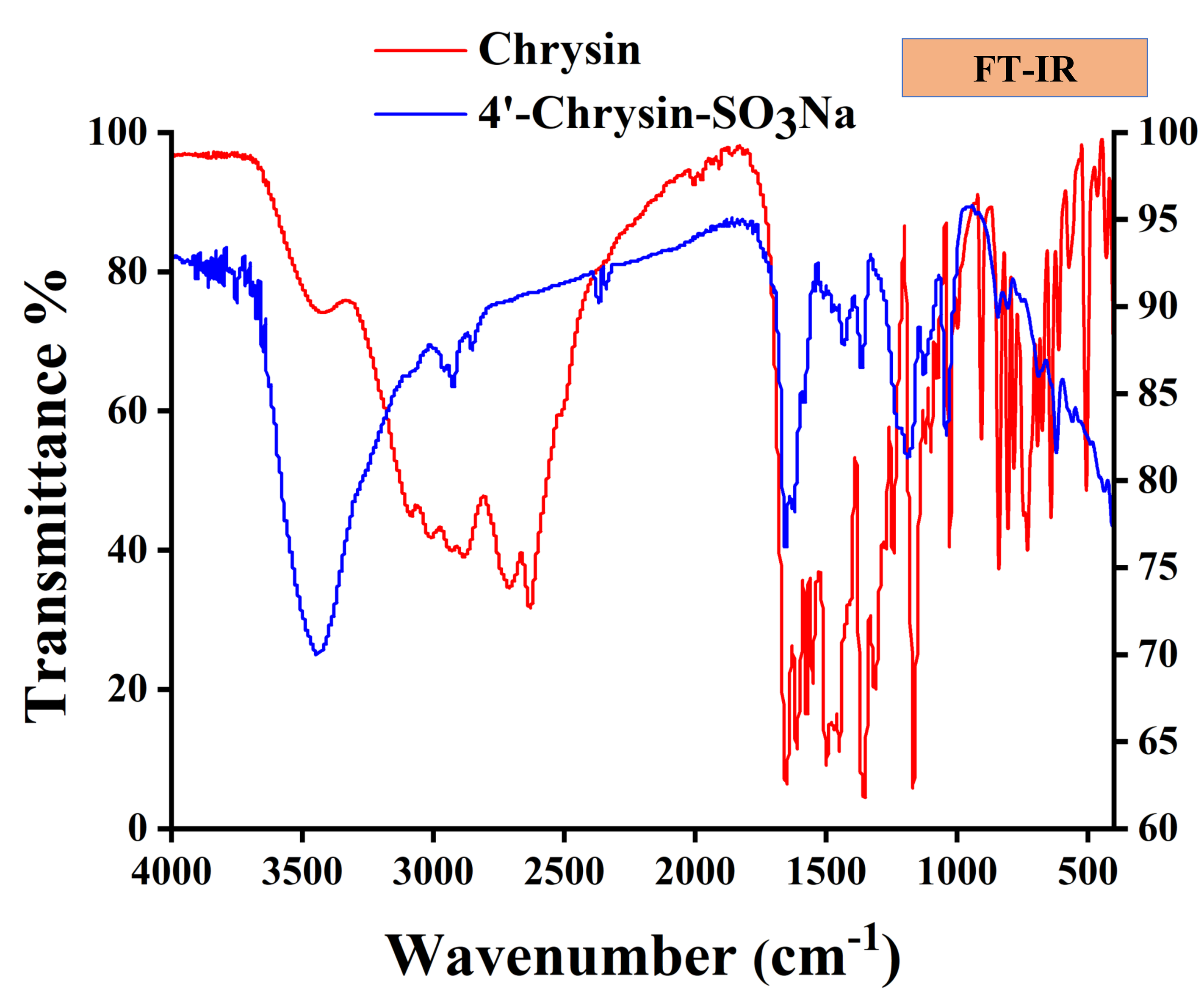
Synthesis reactions of 4´-Chrysin-SO_3H(Na)



Results and Discussion

The product (**Fig. 3**) was characterized by elemental analysis, and FT-IR spectroscopy. The FT-IR spectrum shows a resonance peak at 1656 cm^{-1}, which is considered to be characteristic for the presence of the sulfonate group (**Fig. 4**). This peak appears in Chr-4′-SO_3Na and does not appear in the spectrum of pure chrysin. Although repeated crystallization attempts did not yield single crystals suitable for X-ray analysis, the reaction was deemed successful from the physicochemical point of view. Parallel efforts are ongoing to develop metal ion complexes of sulfonated chrysin. While isolation of stable final products is still underway, preliminary findings are quite promising. Overall, flavonoids, like chrysin, represent a highly valuable class of bioactive molecules, with expanding relevance in both pharmaceutical development and synthetic bioinorganic chemistry.

Fig. 3: The final product chrysin-4'-SO_3H sodium salt



Conclusions

- A novel sulfonated derivative of chrysin (chrysin-4'-sulfonic acid) was successfully synthesized through a sulfonation method, using concentrated sulfuric acid as the sulfonating agent.
- The sulfonated chrysin exhibited improved water solubility compared to the parent molecule, maintaining structural integrity as verified by FT-IR.
- FT-IR analysis confirmed the successful introduction of the sulfonic acid group via the emergence of strong absorption bands associated with the –SO_3H group.
- This work lays the foundation for the further investigation of sulfonated flavonoids in combination with lanthanide ions, widely used in disease theranostics.

Literature

[1]. S. Kumar, A.K. Pandey. (2013). Scientific World Journal, 2013(1) 1-16.

[2]. J. Pusz, B. Nitka, S. Wolowiec. (2001). Polish Journal of chemistry, 75(6) 795-801.

[3]. S. Gao, Y. Zhang, L. Wang, Y. Tang, B. Hu, H. Zhang. (2020). Chemistry, Medicine 190-196.

[4]. Y.C. Cheng, T.S. Li, H.L. Su, P.C. Lee, H.D. Wang, Molecules 25(21) (2020) 5051.