Metal-Organic Frameworks as Emerging Nanocarriers for Phytochemical Delivery in Health Applications

Amina Mukhtar Dirir[1] & Mayssa Hachem[2]
[1]Department of Chemistry, Khalifa University of Sciences and Technology, Abu Dhabi, 127788, United Arab Emirates
[2]Food Security and Technology Center, Khalifa University of Sciences and Technology, Abu Dhabi, 127788, United Arab Emirates
100065186@ku.ac.ae

Phytochemicals are plant-based bioactive molecules that provide defensive functions for plants against abiotic and biotic stresses imposed by the surrounding environment. The popularization of phytochemicals is mainly due to the recent epidemiological studies that established an inverse relationship between phytochemicals consumption, such as polyphenols, and the incidence of fatal diseases such as cancer. Phytochemicals possess a wide range of biological properties, including regulation of gene transcription, promoting the communication between gap junctions, and offering protection against various types of cancer, such as prostate and lung cancers. Due to their large size and polarity, many of these molecules cannot cross multiple barriers inside the human body, such as the blood-brain barrier, and they are vulnerable to enzymatic degradation inside the gastrointestinal tract. Therefore, conjugating these bioactive molecules with appropriate carriers is an attractive approach to preserving their bioactivity and gastrointestinal stability.

Metal-organic frameworks (MOFs) have attracted immense attention recently due to their prominent properties and versatile applications in several areas. MOFs are advanced coordination materials of metal ions/clusters and organic ligands [1]. MOFs exhibit profound characteristics such as tunable pore size and high surface area, making them an excellent candidate for various applications such as drug delivery, energy storage, and catalysis. Several recent studies have shown that phytochemicals' efficacy has been improved following their encapsulation with MOFs. These materials represent a promising solution to various phytochemical challenges, such as poor solubility and rapid degradation. Recent studies revealed that encapsulating phytochemicals such as curcumin, resveratrol, and gallic acid within MOF structures can significantly improve their stability and therapeutic efficacy [2,3].

References

[1] Fatima Zohra Zeggai, Zouhair Ait-Touchente, Khaldoun Bachari, Abdelhamid Elaissari, *Chemical Physics Impact*, 10 (2025) 100864.
[2] Tao Chen, Lihang Chen, Fengxian Luo, Yu Xu, Di Wu, Yanfei Li, Runan Zhao, Ziqi Hua, Jiangning Hu, *International Journal of Pharmaceutics*, 646 (2023) 123496.
[3] Yulu Chen, Kedong Tai, Peihua Ma, Jiaqi Su, Wenxia Dong, Yanxiang Gao, Like Mao, Jinfang Liu, Fang Yuan, *Food Chemistry*, 347 (2021) 128978.

Figures

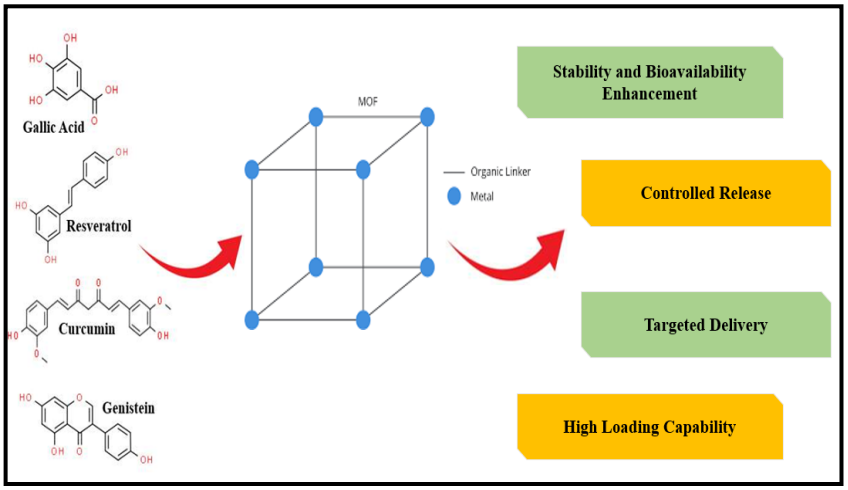

Figure 1: Schematic illustration showing MOF-based encapsulation of phytochemicals for enhanced stability and therapeutic effects.