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A Systematic Review of Metal-Organic Framework(MOF)-based Nanocomposites and their application in Photocatalytic Degradation of Pharmaceutical Compounds

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INTRODUCTION & AIM

The growing concern about the emergence of ***pharmaceutical products*** in ***aquatic environments***, with concentrations ranging from ng/L to µg/L, which may pose health risks for both human and aquatic life, highlights the need for ***efficient and sustainable water treatment*** technologies.

Photocatalytic Degradation is an advanced oxidation process (AOP) that utilizes light and a photocatalyst to drive pollutant degradation. It is known as an environmentally friendly, sustainable, and energy saving technique where solar energy is harnessed by photocatalysts to degrade pollutants.

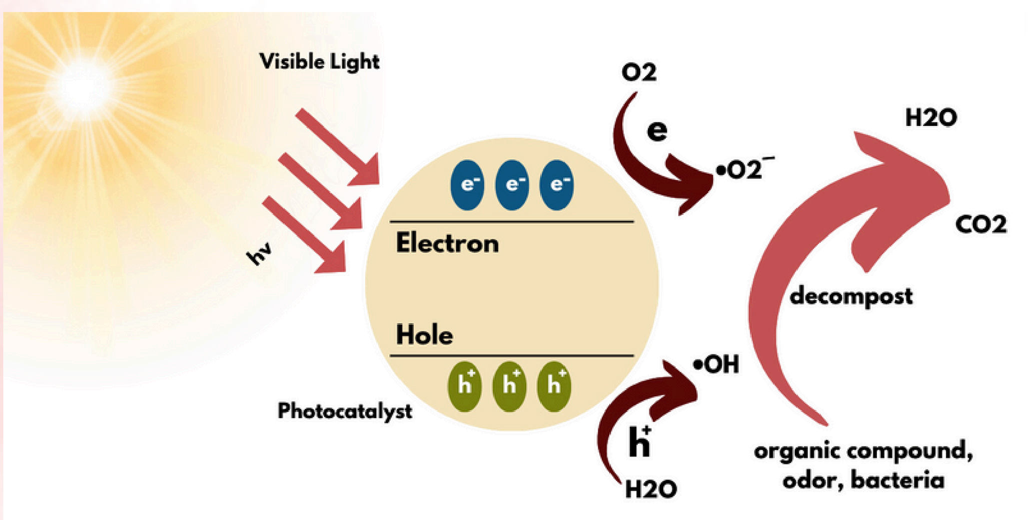

Figure 1. Photocatalytic Degradation Mechanism

METHODOLOGY

The systematic literature review protocol posed by Kashem et al. is used in this review article where the process of collecting and screening data is shown in the figure below.

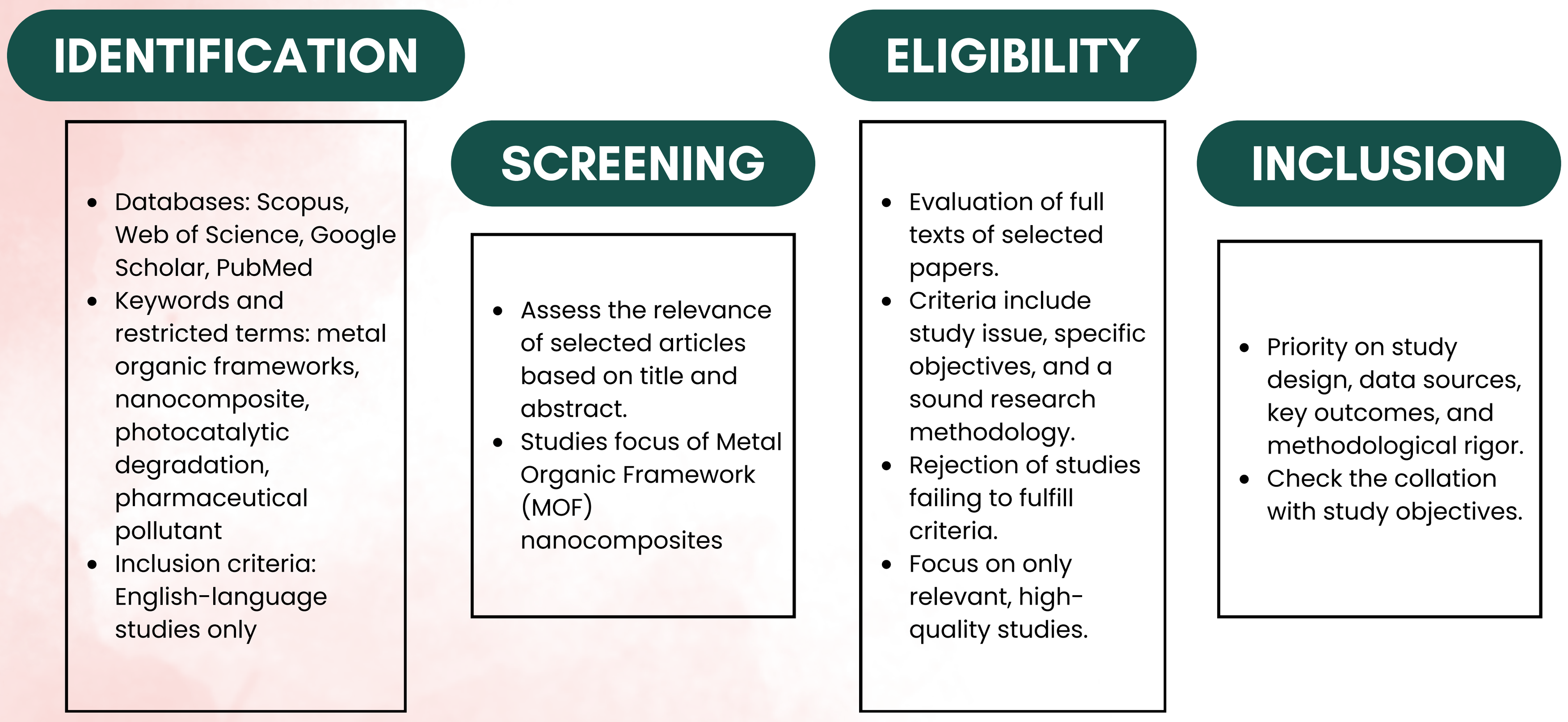

Figure 2. Flowchart of Systematic Literature Review

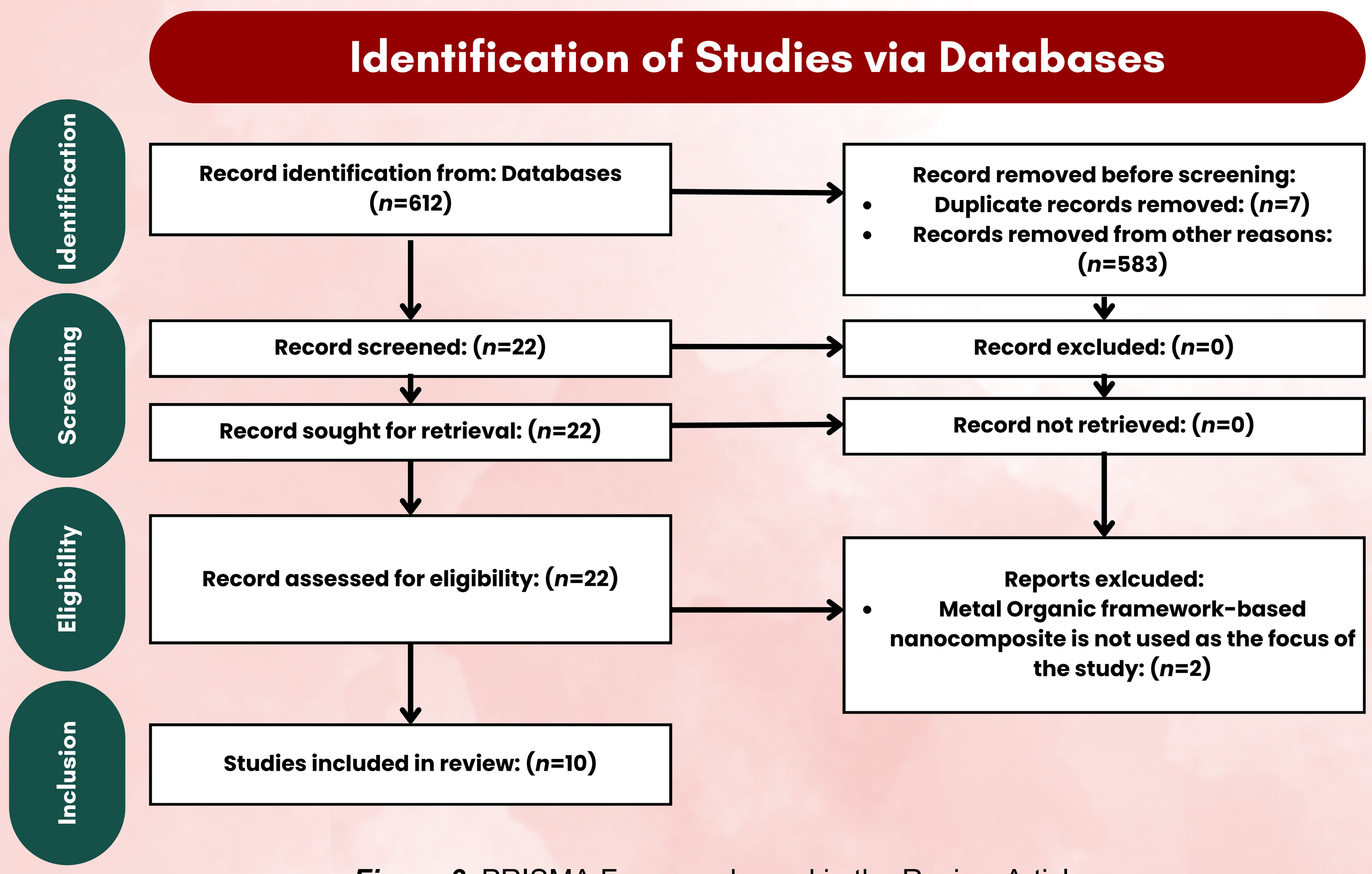

Figure 3. PRISMA Framework used in the Review Article

RESULTS & DISCUSSION

The intriguing properties of metal-organic frameworks (MOFs) such as significant surface area, flexible porosity, numerous pores, versatile functionality, compatibility with biological systems, and high efficiency in drug delivery, have attracted researchers to extensively explore the development of MOFs. Consequently, there is a growing interest in their application across a range of fields, particularly in their use in the photocatalytic degradation of emerging pharmaceutical pollutants.

MOF	Synthesis Method	Pollutant	Light Source	Degradation Efficiency and Time
MIL-53(Fe)	Solvothermal	Tetracycline Hydrochloride	Visible light (420 nm ≤ λ ≤ 780 nm)	99.7% in 80 mins
MIL-53(Al)/ZnO	Hydrothermal	Amoxicillin	Visible light (λmax = 510 nm)	100% in 60 mins
Fe_3O_4@MIL-53(Fe)	Hydrothermal/ Calcination	Ibuprofen	Visible light (λ > 420 nm)	99% in 60 mins
Diatomite-supported Hydroxyl-modified UIO-66(Zr)	Solvothermal/ Calcination	Sulfamethoxazole	Visible light (λ > 420 nm)	93.8% in 120 mins
FeCo-MOF	Solvothermal	Acetaminophen	Sunlight (75,000 – 80,000 lux)	97.4 % in 180 mins
		2,4-dichlorophenoxyacetic acid		79.8 % in 180 mins
Fe_3O_4@MIL-100(Fe)	Microwave	Diclofenac	Visible light (λ > 420 nm)	99.4% in 180 mins
MIL-125(Ti) mixed linker/g-C_3N_4	Ultrasonication/ Solvothermal	Cefixime	UV-vis light (320 nm ≤ λ ≤ 780 nm)	98% in 120 mins
MIL-100(Fe)/HAp	Ultrasonication/Bio mimetic	Metformin	Ultraviolet light (λmax = 460 nm)	82.25% in 120 mins
Co-MOF	Facile synthesis	Ofloxacin	Visible light (λ > 420 nm)	96.2% in 10 mins
CuxO/MOF	Carbonization	Ciprofloxacin	Visible light (λ = 465 ± 40 nm)	92% in 120 mins

Table 1. Summary of MOF-based nanocomposites as photocatalysts for the photocatalytic degradation of pharmaceutical products

Presented in ***Table 1*** are the studies that discussed various approaches and methods to enhance the photocatalytic degradation of pharmaceutical pollutants using metal-organic frameworks (MOFs) and their composites. The table also depicts the difference in photocatalytic degradation performances with varying light source and time.

CONCLUSION

- Research efforts should be directed towards enhancing the structural robustness of these nanocomposites, ensuring their stability under diverse environmental conditions and sustained exposure to photocatalytic processes.
- It is essential to establish the capability of these materials to undergo multiple cycles of photocatalytic degradation while maintaining their photocatalytic efficiency to reduce operational costs and environmental impact.
- Further investigation on the scalability and economic feasibility of these photocatalysts in various pilot-scale systems is much needed.

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