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Review Article

A systematic review on *Hammada scoparia* medicinal plant: Phytochemicals, traditional uses and biological activities

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Abstract: Medicinal plants have played an important influence in the development of human society; they were always at the forefront of all cultures and civilizations as a source of medicine. Medicinal plants are considered rich sources of secondary compounds, and many modern medications are derived from them. *Hammada scoparia* is a medicinal plant that belongs to the Chenopodiaceae family. It is currently found in North Africa (Morocco, Algeria, Libya, and Egypt) and has many medicinal properties used as folk medicine. The present research discusses the phytochemical components and biological activities of *Hammada scoparia*. The corresponding data were collected from various online databases, new research, and published resources. Different secondary compounds from the species have been documented, including flavonoids, tannins, alkaloids, terpenoids, and saponins. Pharmacological research has demonstrated that the major bioactives have antimicrobial, antioxidant, cytotoxic, and antimalarial activities and anticancer, reno-protective, and hepatoprotective effects. In conclusion, this study provides much information about the interests of vegetal species: *Hammada scoparia*.

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1. INTRODUCTION

Herbal medicine is among the most important branches of ethnomedicine everywhere in the world; it is mainly composed of phytochemicals that assist individuals in recovering and enhancing physiological equilibrium (Laib & Djahra, 2022). Plants are generally used to isolate several medications and formulations to treat various diseases. Screening medicinal plants for bioactive components is required as a base for advanced pharmacological research (Balasundari & Boominathan, 2018). The biological activities of medicinal plants are due to natural products and many kinds of secondary metabolites such as flavonoids, tannins, phenols...etc. *(Djahra et al.*, 2018).

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The Chenopodiaceae family is frequently used in traditional medicine and is involved in people's everyday lives (Gelin *et al.*, 2003). It has 98 genera and about 1400 species. They are frequently found in desert areas, semi-deserts, salt marshes, coastal or inland saline, and ruderal environments. Many Chenopodiaceae species are important components of dry or ruderal habitats (Heklau *et al.*, 2012). *Hammada scoparia* is a Chenopodiaceae family species ;it is well-known for its therapeutic properties in traditional North African medicine, such as cancer, hepatitis, inflammation, and obesity prevention (Ezzeddine *et al*., 2016). Considering the value of natural substances in reducing the severity of diseases, the present study focuses on the traditional applications of *Hammada scoparia* and advances in botany, phytochemistry, and pharmacology of this plant.

2. METHODS

To provide a comprehensive phytochemical and ethnopharmacology review on *Hammada scoparia* species, the corresponding data were collected from various online databases: Pubmed (https://pubmed.ncbi.nlm.nih.gov/), Google Scholar (https://scholar.google.com), Scopus (https://www.scopus.com/), Science Direct (http://www.sciencedirect.com/) Elsevier (https://www.elsevier.com/en-xm), Springer (https://www.springer.com/gp) (date of access: 15 September 2021 and revisited on 21 May 2022), and those published resources (Thesis and books) have been systematically reviewed.

The research strategy used in this paper consisted of combining the following keywords: biological activities, antifungal, antimicrobial, antioxidant, wound healing, and mainly, the scientific name "*Hammada scoparia / Haloxylon scoparium*" or the common name "Remth" followed by the desired domain of research (such as Pharmacology or Phytochemistry, etc.), (*Hammada scoparia* and phytochemistry, e.g.).

3. RESULTS and FINDINGS

3.1. Synonyms and Nomenclatures

Hammada scoparia (Pomel) Iljin = (*Haloxylon scoparium* (Pomel) Bge. = *Haloxylon articulatum ssp. scoparium* (Pomel) Batt. = *Arthrophytum scoparium* (Pomel) Iljin) (Bouaziz *et al.*, 2016; Édouard *et al.*, 2010), It is known as "rimth" in Algeria (Taïr *et al*., 2016).

3.2. Taxonomic Classification

Kingdom: Plantae-plants, Planta, Vegetal, plants; Subkingdom: Tracheobionta; Phylum: Spermatophytes; Superdivision: Angiosperms; Division: Magnoliophyta; Class: Magnoliopsida; Subclass: Caryophyllidae; Order: Caryophyllales; Family: Chenopodiaceae; Genus: *Hammada*; Species: *Hammada scoparia* (Pomel) Iljin (Boucherit *et al*., 2018)

3.3. Botanical Discerption

Hammada scoparia (Figure 1) is a medicinal plant that belongs to the Chenopodiaceae family. It is a grey-brown, woody, small shrub that dries to a dark brown or blackish color (El-Shazly & Wink, 2003), varies in form, having a maximum height of 1 m (Hafidha *et al*., 2017). This plant has articulated leaves and solitary and clustered flowers at the tops of the branches, with a vertical and lateral root structure that helps to preserve and protect the soil from erosion (Boucherit *et al*., 2018).

Figure 1. *Hammada scoparia* species (Benkherara *et al*., 2021 ; Lachkar *et al*., 2021; Ozenda, 2004), respectively.

3.4. Ecology and Distribution

This plant grows in salty soils and prefers an arid or semi-arid environment. It is currently found in North Africa (Morocco, Algeria, Libya, Egypt), Lebanon, Syria, Palestine, Western Sahara, southern Spain, and portions of Iran and Türkiye (Karous *et al*., 2020; Nounah *et al*., 2019).

3.5. Mineral Content

The aerial part of *Hammada scoparia* contains significant quantities of Iron, Potassium, Magnesium, Phosphorus, and Sodium, according to mineral content analyses (Table 1). Copper, Calcium, and Strontium are all found in reasonable quantities. Selenium and Zinc are found in trace amounts (Lachkar *et al.*, 2021).

Table 1. The mineral content of *Hammada scoparia***.**

Mineral elements	*Content in mg/kg of dry matter*
Iron	60909.00
Potassium	27452.10
Magnesium	10059.90
Phosphorus	1125.39
Sodium	1054.65
Copper	438.93
Calcium	313.29
Strontium	280.23
Selenium	3.00
Zinc	3.00

3.6. Ethnomedicinal Uses

Hammada scoparia is widely used in traditional medicine in North Africa (Table 2) to prevent many diseases, such as hepatitis, inflammation, and obesity (Ezzeddine *et al*., 2016). Several traditional applications have revealed that extracts of *Hammada scoparia* have anti-cancer and anti-diabetic properties (Bouaziz *et al*., 2016; Boulanouar *et al*., 2013; Hamza *et al*., 2019; Saidi *et al*., 2015; Taïbi *et al.*, 2020). This species commonly treats diseases, such as decoction, infusion, or cataplasm. It treats hypertension, dermatitis, food poisoning, scabies, injury healing, and gastroenteritis (Eddouks *et al*., 2002; El-Hadri, 2019; Karous *et al*., 2020).

Table 2. Ethnomedicinal uses of *Hammada scoparia*

Disease treated	*Plant part*	*Mode of preparation & administration*	*Country practiced*	*Reference*
Diabetes	Aerial parts	Infusion	Morocco	(Lamchouri *et al*., 2012)
	Flowers, leaves	Decoction	_	(Sabrina *et al*., 2014)
Inflammations & wounds	Aerial parts	Powder mixed with oil of olive by external use	Morocco	(Eddouks *et al*., 2002)
Gastric problems	Aerial parts	_	Algeria	(El-Hadri, 2019)
Scorpion stings and snakebites	Aerial parts	_	Algeria	(Boucherit *et al*., 2018 ; Kharchoufa *et al*., 2020)
Mouth diseases & toothache	Leaves	Infusion/ Decoction	_	(Kharchoufa *et al*., 2020)
Scars	Bark	Powder	_	(Bouaziz *et al*., 2016)
Scabies	Aerial parts	Infusion applied locally	Tunisia	(Karous *et al*., 2020)
Appetizer	Aerial parts	Infusion took orally	Tunisia	
Liver cancer	Aerial parts	Decoction	_	(Taïbi *et al*., 2020)
Thyroid disorders	Aerial parts	Powder mixed with honey	Algeria	(Taïbi *et al*., 2021)
Mould	Fruits, branches	Powder mixed with grease	Algeria	(Boulanouar *et al*., 2013)

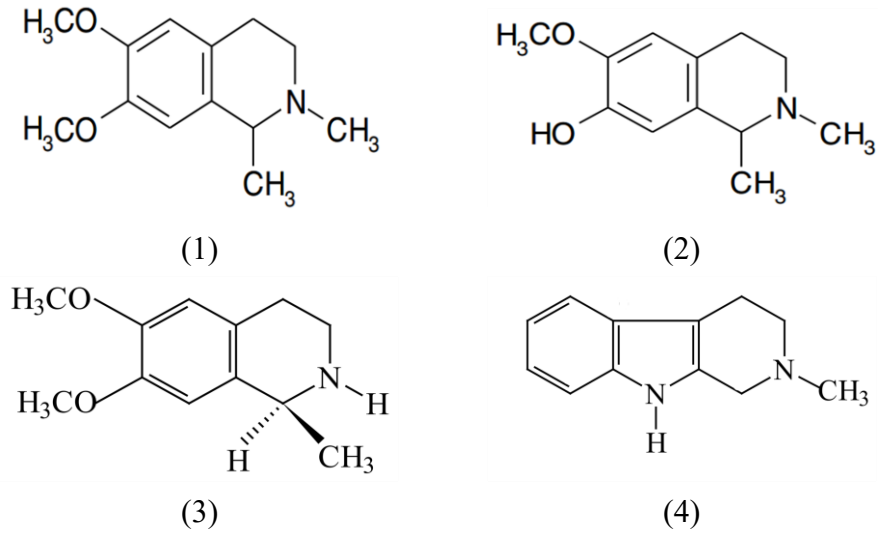
3.7. Phytochemical Constituents

The phytochemical constituents of *Hammada scoparia* have been extensively researched, and the structures of major bioactive molecules have been determined. It is a plant that is especially high in alkaloids and flavonoids. In Figure 2, the structure of the main *Hammada scoparia* alkaloids is presented. Table 3 shows the main compounds that were extracted and identified.

Table 3. Phytochemical compounds identified from *Hammada scoparia.*

Class	*Compound*	*Plant Part*	*Reference*
Alkaloids	Carnegine (1)	Leaves	(Bouaziz *et al*., 2016)
	N-methylisosalsoline (2)		
	Salsolidine (3)	Aerial parts	(El-Shazly & Wink, 2003)
	β-carboline (4)		
Flavanols triglycerides	Isorhamnetin 3-O-β-D xylopyranosyl-(1""3")-α L-rhamnopyranosyl-(1"' 6")-β-D galactopyranoside.	Leaves	(Salah *et al.*, 2002)
	Isorhamnetin 3-O-β-D apiofuranosyl-(1"'2") [α L-rhamnopyranosyl-(1""6")] -β-D galactopyranoside		
	Isorhamnetin3-O-α-L rhamnopyranosyl-(1"'2") [α-L rhamnopyranosyl-(1""6")] -β-D Galactopyranoside		
Flavone	Chrysoeriol	Stems	(Chao *et al*., 2013)
Phenol	Catechol		
Phenolic Acids	Coumaric Acid		
	Cinnamic Acid		
	Caffeoylquinic Acid		
	Catechic acid	Aerial parts	(Benkherara *et al*., 2021)
	Syringic acid		
	Vanillic acid		
	Benzoïc acid		

Figure 2. Structure of major *Hammada scoparia* Alkaloids.



3.8. Biological Activity

The biological activity of the species investigated is shown in Table 4. This section collects published in vitro experimental findings for *Hammada scoparia* species to explain traditional usage and promote future studies on species demonstrating potential in vitro activity.

Table 4. Biological activities of *Hammada scoparia*.

Activity	*Plant part*	*Reference*
Antioxidant	Aerial parts	(Boulanouar *et al*., 2013)
	Leaves & stems	(Bouaziz *et al*., 2016 ; Nounah *et al*., 2019)
Antidiabetic	Aerial parts	(Benkherara *et al*., 2021; Zerriouh, 2014)
Antimicrobial	Leaves & stems	(Bouaziz *et al*., 2016 ; Nounah *et al*., 2019)
	Aerial parts	(Fatehi *et al*., 2018 ; Lamchouri *et al*., 2012)
Antileukemic	Leaves	(Bourogaa *et al*., 2011)

3.8.1. Antioxidant activity

According to research, phenolics are potent scavengers of free radicals and can effectively prevent various diseases (Kamatou *et al*., 2008). Studies demonstrate that areal parts of the plant are an excellent source of polyphenols. The hydroalcoholic extract of *Hammada Scoparia* leaves had excellent antiradical activity (Nounah *et al*., 2019). There was a linear relationship between total phenol content and antioxidant capacity in the evaluated extracts (Bouaziz *et al*., 2016). The extract of *Hammada scoparia* shows antioxidant activity mainly due to reduction and chelation capabilities and sweeping peroxyl radicals (Boulanouar *et al*., 2013).

3.8.2. Antibacterial activity

The use of natural compounds to control infections has been practiced for centuries. Plant exudates and their constituents are one source of natural substances exhibiting antibacterial action (Licá *et al*., 2018). *Hammada scoparia* (leaves and stems) extracts inhibited Gram-positive and Gram-negative bacteria, with average inhibition zones ranging from 8 to 30 mm.

The hydroethanolic extract had the highest antibacterial activity, followed by the methanolic and dichloromethane extracts. *Hammada scoparia* alkaloid extract was effective, with MIC and MBC values ranging from 0.125 to 0.5 mg/ml and 0.25–2 mg/ml, respectively (Bouaziz *et al*.,

2016). The extracts had high anti-bacterial activity against *Citrobacter freundii* and *Acinetobacter baumanii*. The stem extracts were more active against bacteria strains than the leaf extracts, with inhibition zone diameters ranging from 7 to 20 mm for the stem extracts and 7 to 13 mm for the leaf extracts (Nounah *et al*., 2019).

3.8.3. Antidiabetic activity

Hammada scoparia aerial part extract has potential antidiabetic activity. The probable top three extracts demonstrating efficient α-amylase inhibition are Methanolic crude extract, total Flavonoids, and total Alkaloids. *Hammada scoparia* components might be a valuable source of new diabetes drugs used to treat postprandial hyperglycemia with minimal side effects (Benkherara *et al*., 2021; Zerriouh, 2014).

3.8.4. Antileukemic activity

In the search for substances that might reduce cell adhesion-mediated drug resistance (CAM-DR), researchers investigated the effect of *Hammada scoparia* extracts on adherent or suspended leukemic cells. Results demonstrate that *Hammada scoparia* flavonoid fraction and its constituent rutin stimulate apoptosis, particularly in adherent leukemic cells, and reduce CAM-DR (Ezzeddine *et al*., 2016).

4. DISCUSSION

The present research discussed the phytochemical components and biological activities of *Hammada scoparia*. This medicinal species is rich in different secondary compounds, which have been documented, including flavonoids, tannins, alkaloids, terpenoids, and saponins. These compounds are given the plant's broad range of biological activities. Pharmacological research has demonstrated that the major bio-actives have antimicrobial, antioxidant, cytotoxic, and antimalarial activities and anticancer, reno-protective, and hepatoprotective effects. It is thought that the plant is an excellent natural source of secondary metabolites and might be employed in several fields: cosmetics, technology and nanotechnology, nutrition, and alternative medication in the future.

5. CONCLUSION

The results of the present study revealed that NaF stress caused a decrease in chlorophyll and protein contents, and an increase of H_2O_2, catalase, and GSH levels in *X. parietina* correlating with increasing exposure time and/or increasing concentrations of NaF. Furthermore, the obtained results show that C_b is more affected than C_a, and that high concentration of fluorine disturbed the detoxification system, resulting in total glutathione decomposition.

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Declaration of Conflicting Interests and Ethics

The authors declare no conflict of interest. This research study complies with research and publishing ethics. The scientific and legal responsibility for manuscripts published in IJSM belongs to the authors.

Authorship Contribution Statement

Chaima Benine: Investigation, Data collection, Software, Formal Analysis, and Writing - original draft. **Ali Boutlelis Djahra:** Visualization, Methodology and Supervision. **Laiche Ammar Touhami**: Supervision and Validation. **Abdelkrim Rebiai**: Methodology.

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