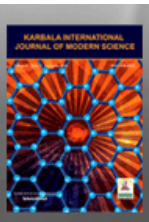

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In vitro antioxidant, anti-inflammatory, and photoprotective activities of aqueous extract of the endemic plant Hammada scoparia L. from Algeria

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Keywords

Hammada Scoparia; Phenolic Compounds; Antioxidant; Anti-inflammatory; Photoprotective

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RESEARCH PAPER

In Vitro Antioxidant, Anti-inflammatory, and Photoprotective Activities of Aqueous Extract of the Endemic Plant *Hammada Scoparia* L. from Algeria

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Abstract

This study aimed to analyze the chemical profile and evaluate the biological activities of the aqueous extract of *H. Scoparia*, an endemic plant found in Southeastern Algeria. The aqueous extract was subjected to phytochemical screening, RP-HPLC, and FT-IR analysis. The anti-inflammatory activity was examined using the protein denaturation method, and the photoprotective activity was evaluated using UV−Visible spectrophotometry. The antioxidant activity was assessed using ABTS, DPPH, and FRAP assays. The study found the presence of various secondary metabolites such as polyphenols, tannins, and saponins. This study suggests that *H. Scoparia* extract has the potential as a natural source of bio-actives for developing drugs. The extract exhibited significant antioxidant activity. The study revealed that H. Scoparia extract demonstrated excellent photoprotective activity against UV, and significant biological activities in vitro.

Keywords: *Hammada scoparia*, Phenolic compounds, Antioxidant, Anti-inflammatory, Photoprotective

1. Introduction

Hammada scoparia is an endemic plant belonging to the Chenopodiaceae family, and it is generally considered a potential source of therapeutic drugs. This species is also known for its medicinal properties and is employed in folk medicine [1]. *H. scoparia* is commonly used in traditional medicine in North Africa to prevent various diseases, including hepatitis, inflammation, and obesity [2]. Numerous drugs are developed from herbs, which are based on plants and bioactive components qualified to treat diseases [3].

Phenolic compounds produced from plant materials have recently been discovered to substitute synthetic antioxidants since the former are known as green medicine and are safe for health management [4]. Phenolic constituents in medicinal plants have significant importance from different perspectives, such as discovering products with pharmacological potential, and/or antioxidant activity [5].

The human skin serves as the most sensitive organ. Acne, pigmentation, and sunburn marks are all caused by frequent skin exposure to the biological environment [6]. Regular and constant sunscreen application can be harmful due to adverse effects such as dermatitis, skin cancer, and melanoma. Synthetic sunscreens products are also incapable of completely protecting skin from ultraviolet radiation; as a result, sunscreen formulas incorporating bioactive substances derived

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from plants are frequently being researched [7]. Sunscreens having natural substances such as polyphenols, phenolic acids, and triterpenoids have been shown to neutralize oxidative agents and avoid UV radiation damage [8].

Inflammation is a normal fundamental physiologic response that assists the body in defending itself from illness, wounds, poisonous substances, allergies, and other harmful stimuli. Many of these chronic diseases may be caused by excessive and chronic inflammation [9,10]. Present medications for the treatment of pain and inflammation are either narcotics, non-narcotics, or corticosteroids, all these drugs have side effects. However, many plant products have been used for a long period with few adverse and side effects [11]. This study aims to investigate the phenolic substances present in the aqueous extract of the aerial part of *H. scoparia* growing in the Algerian desert and assess its biological activities as an antioxidant, anti-inflammatory, and SPF activity.

2. Material and methods

2.1. Plant material

The aerial parts of the *H. Scoparia* were gathered in November 2021, in Southeastern Algeria precisely in the province of Biskra, and a voucher specimen with the accession number EH-189 has been placed in the departmental herbarium. The plant material was identified by Professor Hammel Tarek (Department of Biology, Faculty of Science, University of Badji Mokhtar – Annaba, Algeria). The aerial part was washed with flowing water to remove dust. Then, it was dried, powdered, and stored for further use.

2.2. Crude extract preparation

Fifty grams of powdered *H. Scoparia* was soaked in 500 mL of distilled water over one night at ambient temperature. Wattman paper was used to filter the mixture, and the residues were macerated for another two days with the same solvent. The filtrates were collected and concentrated with rotatory vapor under low pressure and a temperature of 40 °C. The yield was calculated, and the extract was stored for further investigation. *H. Scoparia* aqueous extract percentage yield was 24% w/w of initial raw material [12].

2.3. Qualitative analysis

The detection of secondary metabolites, including polyphenols, flavonoids, tannins, saponins, terpenoids, alkaloids, and steroids was explored using universal qualitative phytochemical screening assays according to Sofowora [13], Trease and Evans [14], and Harborne [15].

2.4. Quantitative analysis

2.4.1. Quantitative colorimetric analysis

2.4.1.1. Total phenolics content (TPC). TPC of the *H. Scoparia* extract was calculated using the colorimetric Fo-lin-Ciocalteu technique, as described by Singleton et al. (1999) [16]. In summary, 200 µl of extract and 1 mL of Folin dilution reagent (1:10) were mixed. After 5 min, 800 µl sodium carbonate (7.5% w/v) was added. After 60 min of incubation, the absorbance was measured at 765 nm. For calibration, gallic acid solutions with concentrations ranging from 20 to 200 µg/mL were used for blotting the curve of standard absorbance and the amounts in the samples, and a dose–response linear regression was created. TPC was measured and represented as mg gallic acid equivalent/g dry extract using gallic acid as standard.

2.4.1.2. Total flavonoid contents (TFC). The estimation of TFC of *H. Scoparia* aqueous extract was quantified by the typical colorimetric experiment using $AlCl_3$ as a reagent and quercetin as standard. For calibration, quercetin solutions with concentrations ranging from 20 to 200 µg/mL were used to blot the curve of standard absorbance and the amounts in the samples, a dose–response linear regression was created. Total flavonoids were quantified in mg of quercetin equivalents per g of the dry extract [17].

2.4.1.3. Total tannins content (TTC). The estimation of TTC of the aqueous extract was done according to Schofield et al. (2001) [18] using the vanillin-HCl method. In a 1:1 ratio, the extract was combined with the reagent's vanillin 4% (w/v) and HCl 8% (v/v). Absorbance was measured at 500 nm using catechin as the reference. For calibration, catechin solutions with concentrations ranging from 20 to 200 µg/mL were used for blotting the curve of standard absorbance and the amounts in the samples, and a dose–response linear regression was created. The results were expressed as mg catechin equivalents/g dry extract.

2.5. Qualitative analysis with RP-HPLC

Reverse-phase high-performance liquid chromatography and scanning instruments were used to identify the active components. RP-HPLC with a

UV–Visible detector (Shimadzu LC20 AL) was used to investigate the presence of phenolic content in the crude extract. Shim-pack VP-ODSC18 (4,6 mm, 250 mm, 5 m) analytical column, UV–Vis detector SPD 20 A, and universal injector (Hamilton 25 l) were all incorporated into the system (Shimadzu). Non-polar aliphatic residues were used in the RP-HPLC experiments, and the mobile phase was made up of a gradient elution of acetonitrile and acetic acid (0.1%). The flow rate employed in this study was 1 mL/min, and the injection volume was 450 mL. The sample and standard injection volumes were 20 µl, and the monitoring wavelength was 268 nm. Various substances were determined by comparing their UV absorption and retention time to standards.

2.6. Fourier transforms infrared characterization (FTIR)

The FT-IR spectrum was obtained using a spectrophotometer (Shimadzu-00463 model), the resolution was 4 cm^{-1}, and 64 coadded scans were in the spectral range (400–4000 cm^{-1}). The FT-IR spectrum validates the organic functional group and surface chemistry.

2.7. Antioxidant activity

2.7.1. ABTS radical scavenging assay

The ABTS* free radical scavenging method was used to determine the reducing power of the aqueous extract of *H. Scoparia* [19]. The stock solution was made by combining 7 mM ABTS and 2.4 mM potassium persulfate. This reagent was refrigerated for at least 16 h. The reagent was diluted with 50% ethanol before use. The samples with various concentrations (6.25, 12.5, 25, and 50 µg/mL) were mixed with 1 mL of ABTS solution, and the absorbance was determined at 734 nm after 7 min of incubation, and then the percentage of ABTS inhibition was calculated using the following formula:

$$\text{ABTS}_{\text{inhibition}}\ (\%) = [(A_{\text{Control}}\text{-}A_{\text{Sample}})/\ A_{\text{Control}}] \times 100$$

2.7.2. DPPH radical scavenging assay

The method for evaluating the DPPH scavenging activity of H. Scoparia aqueous extract was adapted from a previously published protocol [19] and modified by Suresh et al. [20]. Briefly, 1 mL of 0.1 mM DPPH dissolved in methanol was mixed with various concentrations (25, 50, 100, and 150 µg/mL) of the extract. A control was prepared by mixing 1 mL of methanol with 1 mL of DPPH, while ascorbic acid was used as a standard. The mixture was incubated in the dark for 30 min, after which the absorbance was measured at 517 nm using a UV–Vis spectrophotometer. The following equation was used to calculate the percentage of DPPH inhibition:

$$\text{DPPH inhibition}\ (\%) = [(\text{AControl-ASample})/\ \text{AControl}] \times 100$$

2.7.3. Ferric-reducing antioxidant power (FRAP) assay

The FRAP assay was used to determine the total antioxidant capacity of H. Scoparia aqueous extract. The extract concentrations of 50, 100, 150, and 200 µg/mL were mixed with 1250 µl of 1% (m/v) potassium ferricyanide and 1250 µl of 0.2 M phosphate buffer (pH 7). The reaction mixture was incubated for 30 min at 50 °C. Next, 1250 µl of 10% (m/v) TCA was added to the mixture, which was then centrifuged at 6500 rpm for 10 min. The supernatant was collected, and 1250 µl of distilled water and 250 µl of ferric chloride reagent were added to it. The absorbance was measured at 700 nm [21].

Ferric-reducing antioxidant power (FRAP) values were calculated using the following formula:

$$\text{FRAP values} = \left[\mathbf{100} - (A_{Control} \times \mathbf{100}) \,/\, A_{Sample}\right]$$

2.8. Anti-inflammatory activity

To study the potential anti-inflammatory effects of H. Scoparia extract, the albumin denaturation assay was utilized as described in Ref. [22], with Aspirin® serving as a control. To perform this assay, a reaction mixture of 500 µl of various concentrations of H. Scoparia extract or the standard (ranging from 100 to 500 µg/mL) and 700 µl of phosphate-buffered saline (pH 6.4) was combined with 500 µl of fresh egg albumin. The reaction mixture was then incubated for 15 min at 27 ± 1 °C. Denaturation of albumin was induced by heating the mixture in a hot bath at 70 °C for 10 min. After cooling, the absorbance at 660 nm was measured using distilled water as a blank. The experiment was carried out in triplicate. The inhibition percentage of egg Albumin denaturation was calculated using the following formula:

$$\text{Albumin Inhibition}\ (\%) = [(\text{ASample-AControl})/\ \text{AControl}] \times 100$$

2.9. Photoprotective activity

The effectiveness of *H. Scoparia* aqueous extract against UV rays was assessed in vitro using UV–Visible spectrophotometry to determine the sun protection factor (SPF). The SPF was calculated based on the method described by Aida et al. [23], by measuring the difference between the spectroscopic readings of the aqueous extract (500 μg/mL) in the range of 290 nm–320 nm, using the following formula:

$$\mathbf{SPF}_{\text{Spectrophotometric}} = \mathbf{CF} \times \sum_{\lambda 290}^{\lambda 320} \boldsymbol{EE}(\boldsymbol{\lambda}) \times \boldsymbol{I}(\boldsymbol{\lambda}) \times \boldsymbol{Abs}(\boldsymbol{\lambda}) \mathbf{CF} \times \sum_{\lambda 290}^{\lambda 320} \mathbf{EE}(\boldsymbol{\lambda}) \times \mathbf{I}(\boldsymbol{\lambda}) \times \mathbf{Abs}(\boldsymbol{\lambda})$$

where CF: correction factor (= 10); EE: erythemal effect spectrum; I: solar intensity spectrum; Abs: absorbance of the sample. The results obtained were compared with the categories of sunscreens mentioned in Table 6, according to Schalka et al. [24].

2.10. Statistical analysis

The mean values of the quantified phytochemicals were correlated with the IC_{50}/EC_{50} of the free radical scavenging experiments using correlation and Principal Component Analysis (PCA). Using Minitab LLC 2022, regression, correlation, and PCA were performed.

3. Results

3.1. Screening for phytochemicals

The phytochemical test results demonstrate the extract's richness in several active ingredients. The chemical contents of *H. Scoparia* include polyphenols, tannins, flavonoids, alkaloids, saponins, glycosides, and steroids (Table 1).

3.2. Quantitative colorimetric analysis

The total phenol and flavonoid content were calculated using the following equations based on the calibration curve: ($y = 0.0103x + 0.0561$; $R^2 = 0.997$) for total phenol and ($y = 0.0112x - 0.0227$; $R^2 = 0.9934$) for total flavonoid in comparison with standards equivalent: gallic acid (mg GAE/gE) and quercetin (mg QE/gE) respectively.

Similarly, total tannin content was calculated by Catechin equivalent (mg CE/gE) using the following 'equation, based on the calibration curve ($y = 0.0018x - 0.0097$; $R^2 = 0.9994$). The results are represented in Table 2.

3.3. Qualitative RP-HPLC analysis

The number of phytochemicals of *H. Scoparia* aqueous extract was identified using RP-HPLC-UV analysis. Nine phenolic compounds were found out of 57 peaks (Fig. 1). HPLC analysis revealed that chlorogenic acid was the most abundant with an amount of (792.6517424 μg/gE), followed by Naringin with a moderate quantity of (550.2554311μg/gE), Rutin, Vanilic Acid, Quercetin, p-coumaric acid, and caffiec acid were also detected in *H. Scoparia*. The results are presented in Table 3.

3.4. FTIR analysis

The FTIR spectrum was used to determine the functional group of the active component based on the most significant value of the transmission band in the infrared radiation spectrum. The results indicate the most significant FTIR peak values and their functional groups of the aqueous extract of *H. Scoparia* (Fig. 2).

FT-IR spectra indicated the presence of phytochemicals from *H. Scoparia* aqueous extract. Fig. 2 shows the FT-IR spectra, the highest peak at 3281.813cm-1 attributed to Hydroxy group O–H stretch (broad), Where alcohols and phenols are in the medium and large infrared expansion vibration. The strong bands at 1620.844 cm-1 corresponded to the Alkenyl C]C stretch.

3.5. Antioxidant activity

3.5.1. ABTS radical scavenging assay

The ABTS• scavenging assay results demonstrate that the increase in antioxidant activity is proportional to the concentration increase. The IC_{50} values in Table 4 revealed that *H. Scoparia* aqueous extract has a significant radical scavenging capacity compared to the standard.

Table 1. Phytochemical constituents of Hammada scoparia aqueous extract.

Hammada scoparia constituents						
Phytochemicals	*Phenols & Tannins*	*Flavonoids*	*Alkaloids*	*Saponins*	*Glycosides*	*Steroids*
Aqueous extract	+	+	+	+	+	+

"-" Absent "+" Present.

Table 2. Total phenolic, flavonoid, and total tannins content of H. Scoparia aqueous extract.

Assay	Total phenol content (mgEGA/gE)	Total flavonoid content (mgEQ/gE)	Total tannin content (mgEC/gE)
Amount	141.61 ± 0.53	67.88 ± 0.71	54.47 ± 0.86

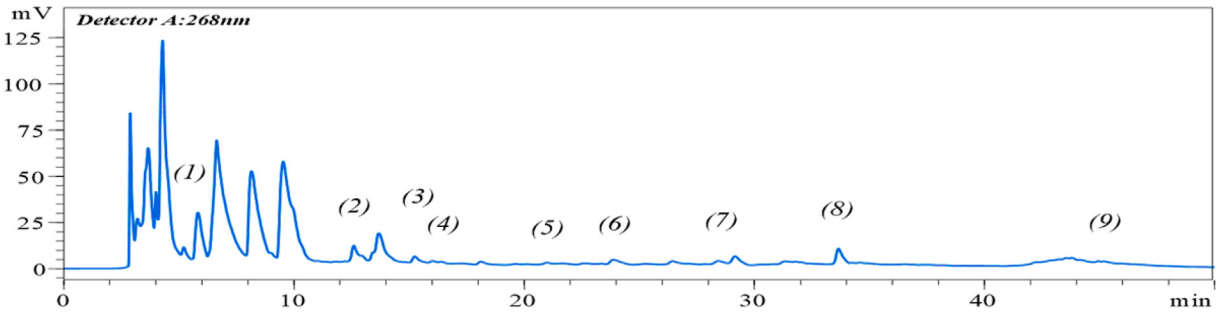

Fig. 1. RP-HPLC-UV chromatogram of H. Scoparia aqueous extract.

3.5.2. DPPH radical scavenging assay

The antioxidant activity of *H. Scoparia* aqueous extract was determined using the DPPH scavenging assay. The IC_{50} values of the antioxidant activity of *H. Scoparia* are reported in Table 4, compared to the ascorbic acid as a standard.

3.5.3. Ferric-reducing antioxidant power (FRAP) assay

The FRAP assay was performed to evaluate the reducing power capacity of *H. Scoparia* aqueous extract compared to the ascorbic acid as standard. The results demonstrated that *H. Scoparia* extract exhibited concentration-dependent reducing power; as sample concentration increased, reaction mixture absorbance elevated, resulting in greater reduction efficiency. The results in Table 4 indicate the high reducing activity which is comparable to Ascorbic acid standard.

3.6. Anti-inflammatory activity

The anti-inflammatory assay of *H. Scoparia* extract was tested by detecting the inhibition of heating-induced denaturation of egg Albumin. The results show that the extract and standard drug have shown the dose-dependent ability for protein denaturation inhibition. Fig. 3 demonstrates that the aqueous extract of *H. Scoparia* has an anti-inflammatory potential comparable to that of Aspirin® with a *p*-value = 0.007 which is very significant. Where the Aqueous extract revealed a very efficient activity in the percentage of inhibition of 50% of protein denaturation (Table 5) with IC_{50} = 251.64 µg/mL, in an interval between 3.4% and 52.32%. Aspirin®, used as a control, showed IC_{50} = 154.97 µg/mL.

3.7. Photoprotective activity

The SPF value is a marker that must be given in cosmetics and personal care products since it influences its potency in protecting against sunlight and skin irritation. The SPF value is determined by its capacity to absorb, reflect, or disperse the sun's rays. The sunscreen products can be categorized into four categories, as mentioned in Table 6, based on their SPF values [23]. The results of the SPF assay confirmed the capacity of *H. Scoparia* aqueous extract to protect the skin from ultraviolet (UV) radiation Table 7.

As shown in the results obtained from this investigation, *H. Scoparia* extract has a high efficacy as a sunscreen with an SPF value of more than 30

Table 3. Concentrations and retention times of phenolic compounds identified in H. Scoparia extract.

Peak	Class	Phenolic compound	Retention Time R_T (min)	*Equation (regression curve)*	*Concentration (µg/g extract)*
(1)	Hydroxybenzoic acid	Gallic Acid	05.290	$y = 54681x$	187.9153637
(2)	Hydroxycinnamic acid	Chlorogenic Acid	13.392	$y = 21665x$	792.6517424
(3)	Hydroxybenzoic acid	Vanilic Acid	15.531	$y = 65077x$	456.7512332
(4)	Hydroxycinnamic acid	Caffiec Acid	16.277	$y = 84066x$	138.4911855
(5)	Hydroxybenzoic acid	Vanilin	21.460	$y = 58930x$	93.92838961
(6)	Hydroxycinnamic acid	*p*-Coumaric Acid	23.817	$y = 49495x$	307.8573593
(7)	Flavonols	Rutin	28.370	$y = 28144x$	493.8246163
(8)	Flavonones	Naringin	34.788	$y = 19379x$	550.2554311
(9)	Flavonols	Quercetin	45.047	$y = 45378x$	439.8607255

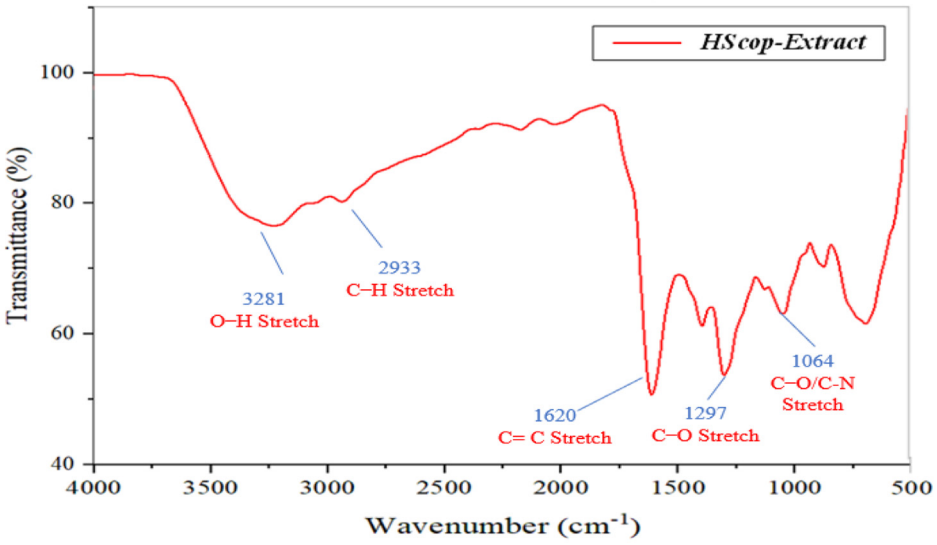

Fig. 2. The infrared spectrum of Hammada scoparia aqueous extract.

(Table 7). *H. Scoparia* may be included in herbal cosmetics due to this value. This efficiency has become probably related to the presence of phenolic components.

3.8. Principal Component Analysis (PCA) and clustering analysis

The phytochemical compounds and biological assay values of *H. Scoparia* have been analyzed using PCA. This statistical analysis aimed to identify if there are any correlations (Phytochemicals/Assays), and also, the type and the intensity of these correlations. According to this analysis (Fig. 4), the PCA biplot shows how the PC effectively correlate with the input variables, also the correlations between the various assays and phytochemicals. The first principal component (PC1) strongly correlates with five original variables: TPC, TFC, ABTS, FRAP, and anti-inflammatory assay, with loadings of 0.747, 0.975, 0.972, 0.966, and 0.926, respectively (Table 8). The second principal component (PC2) reflected the TTC, DPPH radical scavenging activity, and SPF assay with loadings of 0.999, 0.798, and 0.806 (Table 8).

Fig. 4 showed a good correlation between different phytochemical components: TPC, TTC, and various assays: ABTS, FRAP, SPF, and Anti-inflammatory assays; this analysis confirms that those

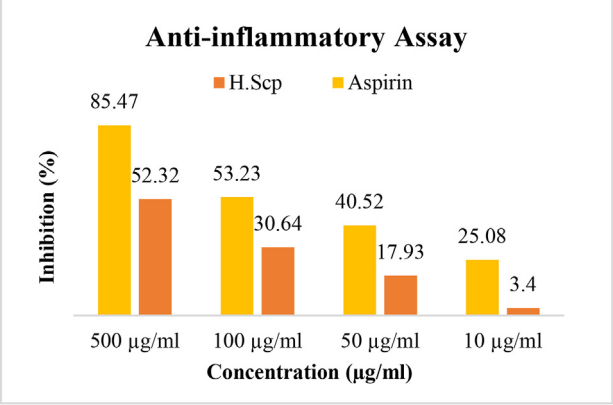

Fig. 3. Inhibition rates of Albumin denaturation at different concentrations of H. Scoparia extract and Aspirin Standard.

assays are strictly correlated, chiefly through the phytochemical values. Oval forms in (Fig. 4a) clustered the different variables of *H. Scoparia* into two classes. Analysis of dendrogram clusters (Fig. 4b) discriminates a clear structure of two main clusters.

4. Discussion

Phenolic compounds are usually found in plant components such as leaves, stems and barks, flowers, and fruits, The polyphenols are confirmed

Table 4. IC_{50}/EC_{50} values of the antioxidant assays of Hammada scoparia extract and Ascorbic Acid.

Sample	ABTS Radical Scavenging Assay IC_{50} (µg/mL)	DPPH Radical Scavenging Assay IC_{50} (µg/mL)	FRAP Ferric Reducing Antioxidant Power Assay EC_{50} (µg/mL)
H. Scoparia	66.28 ± 0.96	85.75 ± 0.61	124.04 ± 1.66
Ascorbic acid	10.27 ± 0.58	27.46 ± 0.84	16.92 ± 1.02

Table 5. IC_{50} values of the anti-inflammatory assay of H. scoparia aqueous extract and Aspirin Standard.

Sample	Inhibition of protein denaturation Assay IC_{50} µg/mL)
H. scoparia	251.64 ± 1.09[a]
Aspirin ®	154.97 ± 0.87

[a] Indicate *p*-value <0.05 vs. Aspirin by T-test.

Table 6. Categories of sunscreens based on the value of the SPF.

Protection Level	SPF Value
Maximum	>50
High	30–50
Medium	15–30
Low	02–15

Table 7. SPF values of H. scoparia aqueous extract.

λ (nm)	EE × I (normalized)	Extract	
		Abs	SPF
290	0,0150	3186	0,477
295	0,0817	3237	2644
300	0,2874	3245	9328
305	0,2780	3273	9100
310	0,1864	3269	6093
315	0,0837	3220	2695
320	0,0180	3186	0,573
Total	**0,9502**	–	**30,91**

as a natural antioxidant [25]. However, *H. Scoparia* is one of the species with high TPC contents in its aerial part. TPC in this analysis was higher (141,61 ± 0,53 mgEGA/gE) than those published in a previous study by bougraa et al. 2014 (62.290 ± 0.078 mgEGA/gE) on *H. Scoparia* collected in Tunisia [26];

Table 8. Correlations between variables and Components.

Variable	Component	
	1	2
TPC	**0.747**	0.664
TFC	**0.975**	–
TTC	–	**0.999**
ABTS	**0.972**	–
DPPH	0.603	**0.798**
FRAP	**0.966**	–
SPF	0.591	**0.806**
Anti-infl	**0.926**	0.377

and lower than the results of benkhrara et al. 2021 study (336.756 ± 0.855 mgEGA/gE) in the same region of this study [27]. This variance in results could be due to the species' environmental conditions or to the differences in the region or the extraction methods used [28].

The RP-HPLC analysis results revealed 57 peaks and nine of those peaks were found to be different phenolic compounds, especially chlorogenic acid and Naringin was the most abundant in the aqueous extract of *H. Scoparia* species. These results corroborate the studies by benkhrara et al. 2021 [28], which obtained 44 peaks and identified 18 phenolic compounds, and observed the presence of Gallic acid with high amounts followed by Catechic acid in the aqueous extract of this species.

This study showed the potent antioxidant activity of *H. Scoparia* aqueous extract in ABTS and DPPH free radical scavenging assay, and FRAP chelating activity assay, highlighting that *H. Scoparia* presented the highest activity at 66.28 µg/mL for the ABTS assay. To maximize the benefits of

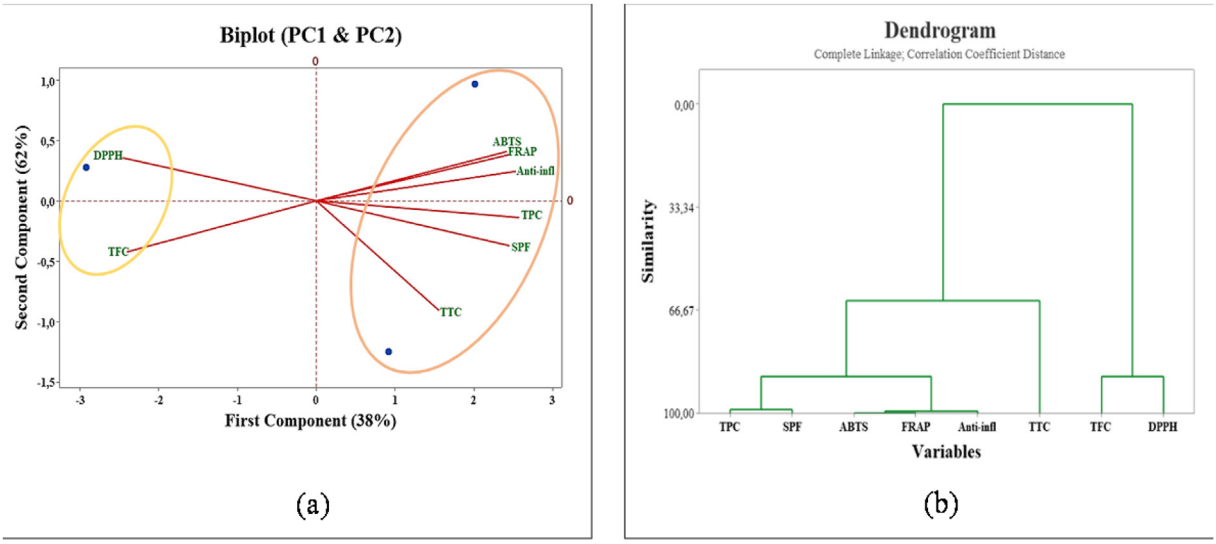

Fig. 4. (a) Biplot of Principal components analysis (PC1 and PC2); (b) dendrogram comparing measured phytochemical composition and biological assay values of H. Scoparia.

antioxidants from any source, it is valuable for using a variety of assays when estimating total antioxidant activity, the potent antioxidant activity of *H. Scoparia* due to the increased concentration of flavonoids and phenolic acids, which are known to serve as co-factors for enzymes and be involved in the processes of chelating activity and free-radical scavenging [29].

The results of the antioxidant assays are very high compared to the study carried out by Drioiche et al. (2019) [30] that evaluated extracts of the same species from Morroco using DPPH assay, and very similar to the study of Nounah et al. (2019) [31], that evaluated the assay of ABTS = 63,683 ± 0,645 μg/mL. The results also revealed that *H. Scoparia* extract has possible use as a treasured source of components with significant antioxidant potential [32,33].

Sun protection factor assay demonstrates elevated value. According to Macheix et al. (2005) [34], practically all flavonoids, especially flavones, and flavanols, have a high UVB absorption capacity. For example, spraying p-coumaric acid on the skin before or after sunlight can help relieve UV-induced irritation and maintain a skin tone uniform [35]. SPF in this assay was higher than those shown in the study of Gheraissa et al. (2022), which evaluated the SPF on the extract of specie from the same family of *H. Scoparia* [36].

The anti-inflammatory assay showed promising results for the *H. Scoparia* aqueous extract, indicating its potential as an effective source of anti-inflammatory drugs. This source can be inhibiting the eggs' Albumin denaturation-heat-inducing. The extract contains several phenolic compounds, including gallic and p-coumaric acid, which are known for their strong anti-inflammatory properties. Additionally, the extract contains high levels of alkaloids and saponins, both of which have been shown to have anti-inflammatory effects [37,38].

5. Conclusion

In this study, this plant was investigated because it provides interesting phytochemicals with in vitro assays of the biological activities of *H. Scoparia* (L.) growing in the Algerian desert. The aerial part phytochemical compounds of *H. Scoparia* have significant antioxidant, anti-inflammatory, and Photoprotective potential. As a result, this species is an excellent source of pharmacological drugs that might be used depending on their bioactive diversity as well as a broad range of potential benefits on nutritional and human health. However, further research is needed, especially *in vivo* antioxidant, anti-inflammatory, and sun protection factor studies, to support its usage as a natural source of antioxidants to prevent the advancement of many diseases.

Conflict of interest

There are no conflicts of interest declared by the authors.

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