

The Chemical Compounds of *Retama monosperma*

Subjects: **Integrative & Complementary Medicine**

Contributor: Adil El Yadini , Youssef Elouafy , Ehsan Amiri-Ardekani , Mina Shafiee , Amirhosein Firouzi , Najmeh Sasani , Asaad Khalid , Ashraf N. Abdalla , Saad Bakrim , Ching Siang Tan , Khang Wen Goh , Long Chiau Ming , Abdelhakim Bouyahya

Retama monosperma L. (Boiss.) or *Genista monosperma* L. (Lam.), known locally as “R’tam”, is a spontaneous and annual herb that belongs to the Fabaceae family. It is native to the Mediterranean regions, specifically in the desert areas and across the Middle Atlas in Morocco. This plant has been extensively used in folk medicine and it is rich in bioactive compounds, including polyphenols, flavonoids, and alkaloids.

Retama monosperma L.

medicinal plant

extract

1. Introduction

Retama monosperma L. (Boiss.) or *Genista monosperma* L. (Lam.), known locally in the popular Arabic name as “R’tam” ^[1], is a spontaneous, abundant, and annual herb that belongs to the family of Fabaceae. It is endemic to the west of the Mediterranean basin, such as the Canary Islands, Portugal, Italy, southwest Spain, Macaronesia, North Africa, and northern Egypt ^[2]. In Morocco, it is situated in the desert areas and across the Middle Atlas and in several Moroccan natural forests ^[3]. It has a large geographic distribution and represents a potential for use in the stability of dunes and the revegetation of desert ecosystems, and is occasionally cultivated as an ornamental herb, especially in Mediterranean climates ^[4]. For many years, plants have been used by humans for medicinal and nutritional purposes in the food industry and other applications ^{[5][6][7][8]}. In recent decades, they have drawn significant interest and represent a largely untapped source of novel and effective drugs to overcome resistance to the treatment of a wide spectrum of diseases or to be used as alternatives to different organic and non-organic chemical products due to their significant bioactivities ^{[9][10]}. In Morocco, medicinal herbs have always been linked to both traditional and cultural practices ^{[11][12]}.

R. monosperma is considered one of the medicinal plants rich in bioactive compounds, including alkaloids, polyphenols, flavonoids, fatty acids, and condensed tannins, as proved by several studies ^{[3][13][14][15][16]}. It has been extensively used in folk medicine in a wide range of countries; for example, used as an effective antihelmintic, disinfectant, and abortifacient and also to treat skin damages and cicatrization ^[3].

R. monosperma has attracted considerable interest due to its wide range of pharmacological properties, including antioxidant ^[17], anti-aging ^[3], antibacterial ^[18], antifungal ^[19], anti-inflammatory, antiproliferative, and antitumoral ^{[3][11][20]}, as well as antileukemic activities ^[21]. The principal alkaloids of *R. monosperma* are retamine, sparteine,

dehydrosparteine, ammodendrine, N-methylcytisine, cytisine, isolupanine, and anagryrine [22], flavonoids such as genistein, quercetin, 6-methoxykaempferol, and kaempferol [16], fatty acids from the seeds' hexane extract, such as myristic, pentadecylic, oleic (omega-9), linoleic (omega-6) and linolenic (omega-3) [23]. It was found that *R. monosperma* exhibited an anti-aging effect that could enhance the expression of genes that play a role in wound healing and skin regeneration, such as sirtuin 1 (SIRT1) and SIRT3 in the HaCaT human keratinocyte cell line [3]. In addition, this plant showed potent antimicrobial effects and could be used to formulate medicinal plants for the management of various infectious conditions. It has been reported that hexane and dichloromethane extracts of seeds showed a very significant ($\varnothing > 14$ mm) antibacterial effect against *Bacillus sp* and *E. coli*, while the ethyl acetate extracts of the stems and the flowers exhibited very significant activity on *Salmonella sp* [18]. As an antifungal activity, alkaloids of *R. monosperma* play a significant role in the reduction of *C. albicans* and *C. tropicalis* growth. Furthermore, previous investigations have proven that *R. monosperma* has a promising anti-inflammatory effect; it is suggested that this species could be an option for developing an herbal medicine for inflammatory bowel disease due to its ability to reduce the production of pro-inflammatory cytokines such as COX-2 and iNOS [23]. Moreover, the findings of certain investigations have demonstrated that *R. monosperma* extracts showed beneficial antitumoral effects on human cervical adenocarcinoma cell lines (HeLa and SiHa) proliferation and apoptosis [3]. In addition to this, *R. monosperma* can be a candidate for traditional use as an antileukemic plant because it has been revealed to contain several unsaturated fatty acids, particularly linoleic acid, which is considered to be beneficial in cancer [24]. Concerning the antioxidant activity of *R. monosperma*, it has been observed to exert powerful effects against oxidative stress-mediated pathological processes, which are attributed to the presence of flavonoids in ethyl acetate extracts of seeds, more specifically [17]. The literature in the previous year's reports contains a number of reviews on the phytochemistry and biological functions of several bioactive compounds of different parts of *R. monosperma*, but comprehensive investigations focusing on their health benefits are missing. This calls for further coordination on the state of knowledge to analyze the full potential pharmacological effects of the main bioactive compounds of different parts of this Mediterranean plant to better understand its benefits to human health and explore its clinical applications and pharmaceutical industries.

2. Chemical Composition

The chemical compounds of *R. monosperma* are rich in bioactive constituents belonging to different chemical classes, such as terpenoids, flavonoids, phenolic acids, fatty acids, and alkaloids. **Table 1** shows the chemical composition of *R. monosperma* according to plant parts.

Table 1. Chemical composition of *R. monosperma*.

Part of the Plant	Extract	Major Component	Ref
Stems	Methanol Dichloromethane n-Butanol	Polyphenols Flavonoids Condensed tannins	[13][14]

Part of the Plant	Extract	Major Component	Ref
	Ethyl acetate Chloroform	Alkaloid: <ul style="list-style-type: none">RetamineSparteineDehydrosparteineAmmodendrineN-Methylcytisine	
	Methanol	<ul style="list-style-type: none">Cytisine17-OxosparteineIsolupanine5,6-DehydrolupamineAnagryneLupanine	[15][17][18][19][22][25]
Flower	Methanol	Polyphenols Flavonoids Condensed tannins Alkaloids	[13][14]
	Dichloromethane	Polyphenol Flavonoid Tannins	[14]
	Toluene	Polyphenol Flavonoid Condensed tannins	[13]
	Diethyl ether	Polyphenol Flavonoid: <ul style="list-style-type: none">Genistein,Taxifolin	[3]

Part of the Plant	Extract	Major Component	Ref
Seeds		<ul style="list-style-type: none">Quercetin,6-methoxykaempferolKaempferol	
		Polyphenols Flavonoids Condensed tannins	[13][14]
	Methanol	Alkaloid: <ul style="list-style-type: none">N-methylcytisine,Dehydro-cytisine,Cytisine,5,6-Dehydrolupanine,ThermopsineAmmodendrineAnagryne	[13][15][17][18][19][25][26] [27]
	n-Butanol	Polyphenols Flavonoids Condensed tannins	[13]
	Hexane	Fatty Acids: <ul style="list-style-type: none">Myristic acidPentadecylic acidPalmitic acidPalmitoleic acidMargaric acidStearic acid	[2][21][23][28]

Part of the Plant	Extract	Major Component	Ref
		<ul style="list-style-type: none">Oleic acid (Omega 9)Linoleic acid (Omega 6)Linolenic acid (Omega 3)Arachidic acidBehenic acidLignoceric acidLauric acidTricosanoic acidPalmitoleic acidPentadecanoic acid	
	Dichloromethane	Polyphenols Flavonoids Tannins	[14]
	Ethyl acetate	Polyphenol Flavonoid <ul style="list-style-type: none">TaxifolinGenistein,Quercetin,6-methoxykaempferolKaempferolCondensed tannins	[3][13][14][15]
		Mineral: Al, Ba, Cd, Cu, Fe, Mg, Pb, Zn, Mn, Ca, K, Na,	[21][23]

Part of the Plant	Extract	Major Component	Ref
Leaves	Methanol	P	
		Alkaloid:	
		• Sparteine	
		• Dehydrosparteine	
		• β-Isosparteine	
		• Ammodendrine	
		• N-Methylcytisine	[15][17][18][25]
		• Cytisine	
		• 17-Oxosparteine	
		• Isolupanine	
		• 5,6-Dehydrolupamine	
		• Anagryne	
		α-Linolenic acid	
		Sterols:	
	Hexane	• Campesterol	
		• Stigmasterol	[4]
		• β-Sitosterol	
	Ethyl acetate	Ethyl palmitate Phenol: (2,4-Ditertbutylphenol)	[29]
	n-Butanol	Methyl palmitate Methyl 7-octadecenoate Alkaloid: (Sparteine) Phenol: (Carvacrol)	[29]
	Dichloromethane	Alkaloid: • Anagryne	[30]

Part of the Plant	Extract	Major Component	Ref
Branches	NaOH 4%	<ul style="list-style-type: none">Sparteine	
		Monosaccharides:	
		<ul style="list-style-type: none">Rhamnose	
		<ul style="list-style-type: none">Arabinose	
		<ul style="list-style-type: none">Fucose	
		<ul style="list-style-type: none">Xylose	
		<ul style="list-style-type: none">Mannose	[31]
		<ul style="list-style-type: none">Glucose	
		<ul style="list-style-type: none">Galactose	[3][13][14][15][16][16][29]
		<ul style="list-style-type: none">Galacturonic Acid	[13][14]
Whole plant	Aqueous	Flavonoid:	
		<ul style="list-style-type: none">Daidzin	
		<ul style="list-style-type: none">Rutin	[29]
		<ul style="list-style-type: none">Genistin	[29]
		<ul style="list-style-type: none">Daidzein	[16]
		<ul style="list-style-type: none">Luteolin	
		<ul style="list-style-type: none">Apigenin	
		<ul style="list-style-type: none">Genisetein	

become an
the plants
to identify
ely, other
yphenols,
al., 2014
seeds [13],
methanol
the other
nosperma
analysis.
ol extract,
in 2013,
erma, and
genistein

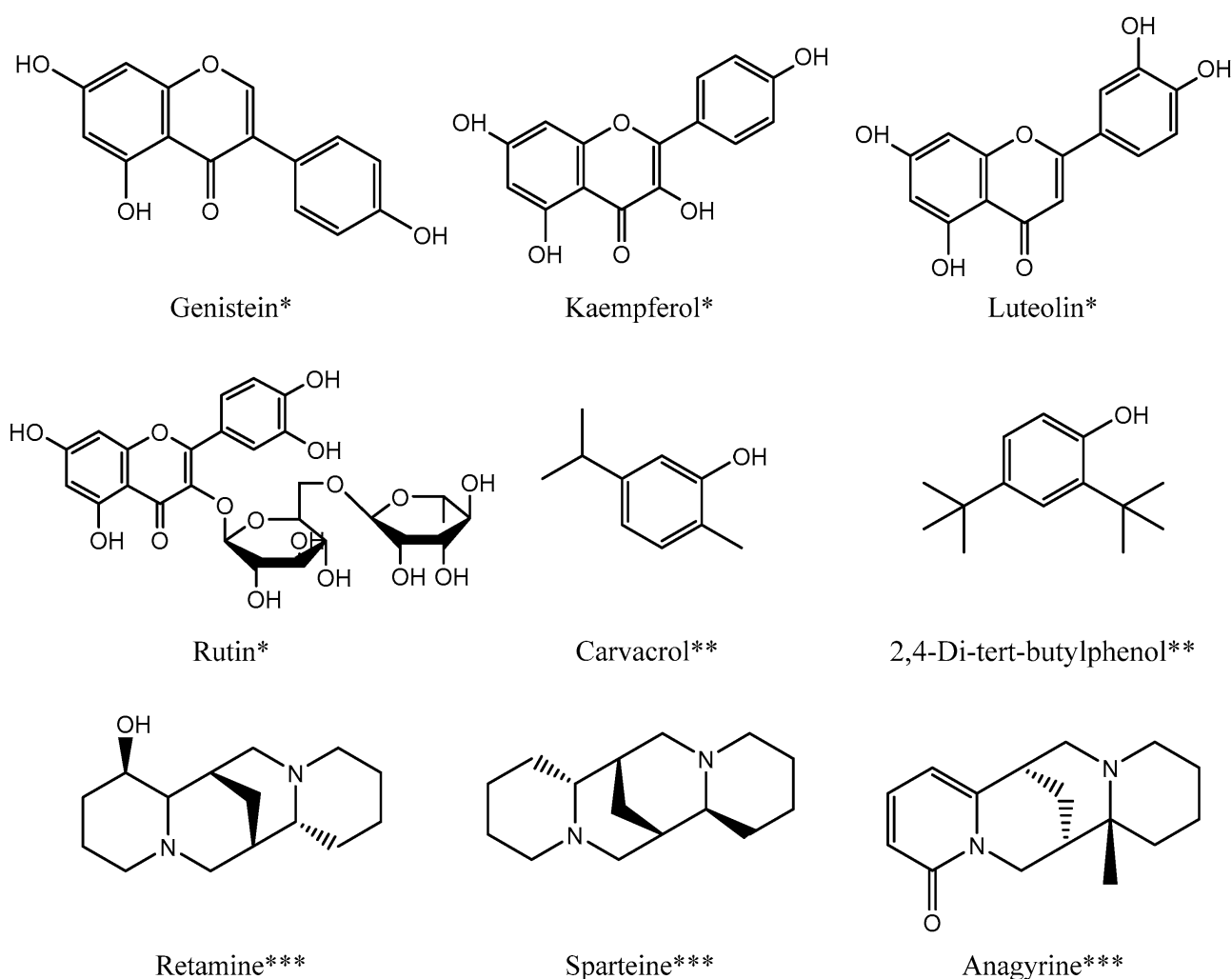


Figure 1. Some chemical structures of flavonoids (*), phenols (**), and alkaloids (***) were isolated from *Retama monosperma*.

2.2. Alkaloids

Alkaloids are a diversified structural group of natural products, and these molecules have a vast array of biological activities; many of them have significant pharmacological applications. In 1980, Antonio Salatino and Otto R. Gottlieb reported the presence of five quinolizidine alkaloids by GLC-MS in *Retama monosperma*, and these alkaloids are retamine, sparteine, anagryne, cytisine and N-methylcytisine [22]. In addition to these molecules, A. El-Shazly et al. isolated four other alkaloids in 1996, including ammodendrine, 17-oxosparteine, lupanine and 5,6-dehydrolupanine, from stems and seeds of *Retama monosperma* using CLC and GLC-MS [19].

Another study was conducted by N. Merghoub et al. in 2011 on the dichloromethane fraction of the *Retama monosperma* leaves, and the results led to revealed five known quinolizidine alkaloids as well as sparteine, L-methylcytisine, 17-oxosparteine, and lupanine and anagryne as a major alkaloid (Figure 1) [30]. In 2012, a study by Fdil et al. showed the presence of these alkaloids in the three parts of the methanolic extract of *Retama monosperma* (stems, leaves and seeds) with the identification of four new alkaloids, which are dehydrosparteine and isolupanine in the stems and leaves, dehydrocytisine in the seeds and β -isolupanine in the leaves [25], and

since then, several investigations have been carried out showing the presence of these alkaloids with different percentages depending on the part of the plant and/or the solvent used during extraction [15][17][18][26][29].

It is noted that in most cases, the seeds contain mainly cytosine, while in the stems and leaves, sparteine and anagyrine are the predominant alkaloids.

2.3. Fatty Acids

The fatty acids present in the lipid and hexane seeds and cladodes extracts of *R. monosperma* were analyzed using GC/MS. The results of the analysis are presented in **Table 1**, which shows the presence of oleic acid (Omega 9), linoleic acid (Omega 6), linolenic acid (Omega 3), arachidic acid, myristic acid, pentadecylic acid, palmitic acid, palmitoleic acid, margaric acid, stearic acid, behenic acid, lignoceric acid, lauric acid, tricosanoic acid, palmitoleic acid, and pentadecanoic acid [2][21][23][28].

References

1. Maghrani, M.; Michel, J.-B.; Eddouks, M. Hypoglycaemic Activity of Retama Raetam in Rats. *Phytother. Res.* 2005, 19, 125–128.
2. Benkhoulili, F.Z.; Moutawalli, A.; Benzeid, H.; Doukkali, A.; Zahidi, A. Retama Monosperma (L.) Boiss.: A Review of Its Uses in Traditional Medicine, Chemical Constituents, and Pharmacologic Activities. *Phytomed. Plus* 2022, 2, 100349.
3. Zefzoufi, M.; Fdil, R.; Bouamama, H.; Gadhi, C.; Katakura, Y.; Mouzdahir, A.; Sraidi, K. Effect of Extracts and Isolated Compounds Derived from Retama Monosperma (L.) Boiss. on Anti-Aging Gene Expression in Human Keratinocytes and Antioxidant Activity. *J. Ethnopharmacol.* 2021, 280, 114451.
4. Belayachi, L.; Aceves-Luquero, C.; Merghoub, N.; Bakri, Y.; Fernández de Mattos, S.; Amzazi, S.; Villalonga, P. Retama Monosperma N-Hexane Extract Induces Cell Cycle Arrest and Extrinsic Pathway-Dependent Apoptosis in Jurkat Cells. *BMC Complement. Altern. Med.* 2014, 14, 38.
5. Bouyahya, A.; Abrini, J.; Et-Touys, A.; Bakri, Y.; Dakka, N. Indigenous Knowledge of the Use of Medicinal Plants in the North-West of Morocco and Their Biological Activities. *Eur. J. Integr. Med.* 2017, 13, 9–25.
6. Bourais, I.; Elmarrkechy, S.; Taha, D.; Mourabit, Y.; Bouyahya, A.; el Yadini, M.; Machich, O.; el Hajjaji, S.; el Boury, H.; Dakka, N.; et al. A Review on Medicinal Uses, Nutritional Value, and Antimicrobial, Antioxidant, Anti-Inflammatory, Antidiabetic, and Anticancer Potential Related to Bioactive Compounds of *J. Regia. Food Rev. Int.* 2022, 1–51.

7. Elouafy, Y.; el Idrissi, Z.L.; el Yadini, A.; Harhar, H.; Alshahrani, M.M.; al Awadh, A.A.; Goh, K.W.; Ming, L.C.; Bouyahya, A.; Tabyaoui, M. Variations in Antioxidant Capacity, Oxidative Stability, and Physicochemical Quality Parameters of Walnut (*Juglans regia*) Oil with Roasting and Accelerated Storage Conditions. *Molecules* 2022, 27, 7693.
8. Elouafy, Y.; el Yadini, A.; el Moudden, H.; Harhar, H.; Alshahrani, M.M.; Awadh, A.A.A.; Goh, K.W.; Ming, L.C.; Bouyahya, A.; Tabyaoui, M. Influence of the Extraction Method on the Quality and Chemical Composition of Walnut (*Juglans regia* L.) Oil. *Molecules* 2022, 27, 7681.
9. Bouyahya, A.; Belmehdi, O.; Benjouad, A.; Ameziane El Hassani, R.; Amzazi, S.; Dakka, N.; Bakri, Y. Pharmacological Properties and Mechanism Insights of Moroccan Anticancer Medicinal Plants: What Are the next Steps? *Ind. Crop. Prod.* 2020, 147, 112198.
10. Benrahou, K.; Doudach, L.; Mrabti, H.N.; el Guourrami, O.; Zengin, G.; Bouyahya, A.; Cherrah, Y.; Faouzi, M.E.A. Acute Toxicity, Phenol Content, Antioxidant and Postprandial Anti-Diabetic Activity of *Echinops spinosus* Extracts. *Int. J. Second. Metab.* 2022, 9, 91–102.
11. Benbacer, L.; Merghoub, N.; el Btaouri, H.; Gmouh, S.; Attaleb, M.; Morjani, H.; Amzazi, S.; el Mzibri, M. Antiproliferative Effect and Induction of Apoptosis by *Inula viscosa* L. and *Retama monosperma* L. Extracts in Human Cervical Cancer Cells. In *Topics On Cervical Cancer With An Advocacy For Prevention*; Rajkumar, R., Ed.; IntechOpen: London, UK, 2012; ISBN 978-953-51-0183-3.
12. Bouyahya, A.; el Omari, N.; Elmenyiy, N.; Guaouguaou, F.E.; Balahbib, A.; Belmehdi, O.; Salhi, N.; Imtara, H.; Mrabti, H.N.; El-Shazly, M.; et al. Moroccan Antidiabetic Medicinal Plants: Ethnobotanical Studies, Phytochemical Bioactive Compounds, Preclinical Investigations, Toxicological Validations and Clinical Evidences; Challenges, Guidance and Perspectives for Future Management of Diabetes Worldwide. *Trends Food Sci. Technol.* 2021, 115, 147–254.
13. Belmokhtar, Z.; Harche, M.K. In Vitro Antioxidant Activity of *Retama monosperma* (L.) Boiss. *Nat. Prod. Res.* 2014, 28, 2324–2329.
14. el Hamdani, N.; Zefzoufi, M.; Derhali, S.; el Abbouyi, A.; el Khyari, S.; Mouzdahir, A.; Sraidi, K.; Harjane, T.; Fdil, R. Preliminary Phytochemical Analysis and Antibacterial Potential of Organic Extracts from Aerial Parts of *Retama monosperma*. *J. Mater. Environ. Sci.* 2018, 2508, 1889–1898.
15. Belmokhtar, Z.; Kaid-Harche, M. An Overreview on Phytochemical Composition and Biological Activities of *Retama monosperma* L Boiss. (Fabaceae). *PhytoChem. BioSub. J.* 2016, 10, 701–731.
16. González-Mauraza, H.; Martín-Cordero, C.; Alarcón-De-La-Lastra, C.; Rosillo, M.A.; León-González, A.J.; Sánchez-Hidalgo, M. Anti-Inflammatory Effects of *Retama monosperma* in Acute Ulcerative Colitis in Rats. *J. Physiol. Biochem.* 2013, 70, 163–172.

17. el Hamdani, N.; Filali-Ansari, N.; Fdil, R.; el Abbouyi, A.; el Khyari, S. Antifungal Activity of the Alkaloids Extracts from Aerial Parts of *Retama monosperma*. *Res. J. Pharm. Biol. Chem. Sci.* 2016, 7, 965–971.
18. Fdil, R.; Tourabi, M.; Derhali, S.; Mouzdahir, A.; Sraidi, K.; Jama, C.; Zarrouk, A.; Bentiss, F. Evaluation of Alkaloids Extract of *Retama monosperma* (L.) Boiss. Stems as a Green Corrosion Inhibitor for Carbon Steel in Pickling Acidic Medium by Means of Gravimetric, AC Impedance and Surface Studies. *J. Mater. Environ. Sci.* 2018, 9, 358–369.
19. El-Shazly, A.; Ateya, A.M.; Witte, L.; Wink, M. Quinolizidine Alkaloid Profiles of *Retama raetam*, *R. sphaerocarpa* and *R. monosperma*. *Zeitschrift für Naturforschung C* 1996, 21–30, 301–308.
20. Abdelmadjide, S.; Mounir, A.; Atef, C.; Nadia, Z.; Neji, B. Phytochemical Study, Antioxidant and Antimicrobial Activities of Flavonoids and Diethyl Ether Extracts from Leaves and Seeds of Medicinal Plant of Algeria Flora: *Retama monosperma* (L.) Boiss. *PONTE Int. Sci. Res. J.* 2020, 76, 42–52.
21. León-González, A.J.; Navarro, I.; Acero, N.; Muñoz Mingarro, D.; Martín-Cordero, C. Genus *Retama*: A Review on Traditional Uses, Phytochemistry, and Pharmacological Activities. *Phytochem. Rev.* 2018, 17, 701–731.
22. Salatino, A.; Gottlieb, O.R. Quinolizidine Alkaloids as Systematic Markers of the Papilionoideae. *Biochem. Syst. Ecol.* 1980, 8, 133–147.
23. el Hamdani, N.; Fdil, R. Evaluation of Fatty Acids Profile and Mineral Content of *Retama monosperma* (L.) Boiss. of Morocco. *J. Mater. Environ. Sci.* 2015, 6, 538–545.
24. Lee, K.W.; Lee, H.J.; Cho, H.Y.; Kim, Y.J. Role of the Conjugated Linoleic Acid in the Prevention of Cancer. *Crit. Rev. Food Sci. Nutr.* 2005, 45, 135–144.
25. Fdil, R.; el Hamdani, N.; el Kihel, A.; Sraidi, K. Distribution of Alkaloids in the Aerial Parts of *Retama monosperma* (L.) Boiss. in Morocco|Distribution Des Alcaloïdes Dans Les Parties Aériennes de *Retama monosperma* (L.) Boiss. Du Maroc. *Ann. De Toxicol. Anal.* 2012, 24, 139–143.
26. el Hamdani, N.; Fdil, R.; Tourabi, M.; Jama, C.; Bentiss, F. Alkaloids Extract of *Retama Monosperma* (L.) Boiss. Seeds Used as Novel Eco-Friendly Inhibitor for Carbon Steel Corrosion in 1 M HCl Solution: Electrochemical and Surface Studies. *Appl. Surf. Sci.* 2015, 357, 1294–1305.
27. el Guiche, R.; Tahrouch, S.; Amri, O.; el Mehrach, K.; Hatimie, A. Antioxidant Activity and Total Phenolic and Flavonoid Contents of 30 Medicinal and Aromatic Plants Located in the South of Morocco. *Int. J. New Technol. Res. IJNTR* 2015, 1, 263695.
28. Derhali, S.; el Hamdani, N.; Fdil, R.; Mouzdahir, A.; Sraidi, K. Chemical Composition of Essential Oils of *Retama monosperma* (L.) Boiss. from Morocco. *Res. J. Pharm. Biol. Chem. Sci.* 2016, 7, 2102–2106.

29. Abdelmadjide, S.; Atef, C. Qualitative and Quantitative Identification by GC/MS of the Main Compounds of Extracts Using Solvents of *Retama monosperma* from the Flora of Algeria. *PhytoChem. BioSub. J.* 2021, 15, 250.
30. Merghoub, N.; Benbacer, L.; el Btaouri, H.; Benhassou, H.A.; Terryn, C.; Attaleb, M.; Madoulet, C.; Benjouad, A.; el Mzibri, M.; Morjani, H.; et al. In Vitro Antiproliferative Effect and Induction of Apoptosis by *Retama monosperma* L. Extract in Human Cervical Cancer Cells. *Cell. Mol. Biol.* 2011, 57, 1581–1591.
31. Bokhari-Taieb Brahimi, H.; Aizi, D.E.; Bouhafsoun, A.; Hachem, K.; Mezemaze, R.; Kaid-Harche, M. Extraction and Analysis of Polysaccharides from Tissues of *Retama monosperma* Branches Extraction and Analysis of Polysaccharides from Tissues of *Retama monosperma* Branches. *S. Asian J. Exp. Biol.* 2019, 9, 214–221.

Retrieved from <https://encyclopedia.pub/entry/history/show/92852>