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Review Article

A review of Moroccan medicinal plants used in the treatment of inflammation

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Abstract

Inflammation is a mechanism that occurs against aggressive agents such as infections, wounds, pollens, autoimmune diseases, and tissue damage. Morocco has traditionally used herbal remedies to treat many illnesses, including inflammation. The objective of this study was to describe the Moroccan medicinal plants used in inflammation treatment. This systematic review examines ethnobotanical studies published in English and French in the literature as well as the pharmacological studies that assess anti-inflammatory activity *in vitro* and *in vivo*, from databases (Scopus, Web of Science, Science Direct, and Springer). The research was carried out until August 2021. In ethnobotanical surveys, 100 medicinal plants were identified, which belonged to 52 families of which the most often cited are Lamiaceae with 18 species, followed by Apiaceae (13 species) and Asteraceae (10 species). The most used plants to treat inflammation in Morocco are: *Coriandrum sativum* L, *Caralluma europaea* (Guss.) Nebr., *Opuntia ficus-indica* (L.) Mill., *Capparis spinosa* L., *Anacyclus pyrethrum* (L.) Lag, *Ajuga iva* (L.) Schreb., *Thymus atlanticus* (Ball) Pau, *Thymus saturejoides* Coss, *Thymus zygis* L., *Lawsonia isermis* L. and *Rosmarinus officinalis* L. This review highlighted Moroccan medicinal plants used in traditional medicine to treat inflammation. Many of this plant species require additional pharmacological, and clinical studies to verify which plants are effective in treating inflammation.

Keywords: anti-inflammatory; inflammation; Moroccan; medicinal plants; systematic review; traditional medicine

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Introduction

Inflammation is a response to harmful stimuli, such as infections, injuries, allergens, autoimmune conditions, and tissue damage (Konstantopoulos, 2005; Ribaldone *et al.*, 2018). Inflammation is characterized by warmth, edema, pain, redness, and impaired function of affected tissues (Chen *et al.*, 2018; Ferrero-Miliani *et al.*, 2007). According to its course, inflammation is divided into acute, and chronic. Acute inflammation is an innate, primary reaction that occurs mainly over a short time due to tissue damage (Suzuki, 2019). If not stopped in time, the inflammation will develop into a chronic phase leading to cancer (Abdalla *et al.*, 2020), Alzheimer's disease, cardiovascular disease, and type 2 diabetes (Nishimura *et al.*, 2009; Pahwa *et al.*, 2021; Saltiel and Olefsky, 2017). To treat these conditions, nonsteroidal anti-inflammatory drugs are the most widely used drugs to alleviate pain, and inflammatory symptoms (Bribi *et al.*, 2015). Secondary metabolites like flavonoids, terpenoids, alkaloids, tannins, coumarins, and essential oils are considered alternative traditional herbal remedies (Guimarães *et al.*, 2012; Lima *et al.*, 2013; Srinivasan *et al.*, 2001). Morocco (Figure 1) is known for its climate diversity, and richness in medicinal plants, many of which are used to treat inflammation (Amrati *et al.*, 2021; Benayad *et al.*, 2014; Bouhlali *et al.*, 2016; Bouyahya *et al.*, 2021; Derouich e*t al.*, 2020; El Azhary *et al.*, 2017; El Kharraf *et al.*, 2021; Hmidani *et al.*, 2019; Jawhari *et al.*, 2020; Kebbou *et al.*, 2019; Khouya *et al.*, 2015, 2020; Manouze *et al.*, 2017; Mechchate *et al.*, 2021; Moutia *et al.*, 2016; Zouhri *et al.*, 2017) Not witstanding its importance, there are no reviews on anti-inflammatory activity in Morocco. In this context, the purpose of this first research is to identify ethnobotanical studies that can reveal plants used to treat inflammation in different regions of Morocco. On the other hand, to identify articles referring to the pharmacological evaluation of these plants in experimental inflammation.

Materials and Methods

Web of Science, Scopus, Science Direct, and Springer search engines were explored using terms related to the following subject areas: Ethnobotanical/ethnomedicinal studies reporting on medicinal plants used for traditional inflammation treatment in Morocco, Moroccan medicinal plants, inflammation, and medicinal plants in Morocco, inflammation, and treatment with medicinal plants in Morocco, the anti-inflammatory activity of plants of Morocco (Figure 1).

The electronic databases were assessed between June/2021 and August/2021. This systematic research was carried out according to PRISMA (Moher *et al.*, 2016). Two investigators identified and examined the resulting papers for relevance based on their titles, and abstract.

Plant names, and families are confirmed through data available on site (*www.theplantlist.org*). Microsoft Excel is used for statistical data analysis.

Figure 1. Map of Morocco

Results and Discussion

Study selection

A total of 8964 relevant articles are identified by two researchers from an electronic database search. Of these, 4637 are from Web of science, 3528 Springer, 494 from Scopus, 305 from Science Direct. After removing duplicates by consulting the associated titles, and abstracts, a total of 171 articles are retrieved for full text review. After a detailed review of each article, 97 articles are excluded, and 74 articles are retrieved including 23 ethnobotanical articles, 51 pharmacology papers (Figure 2).

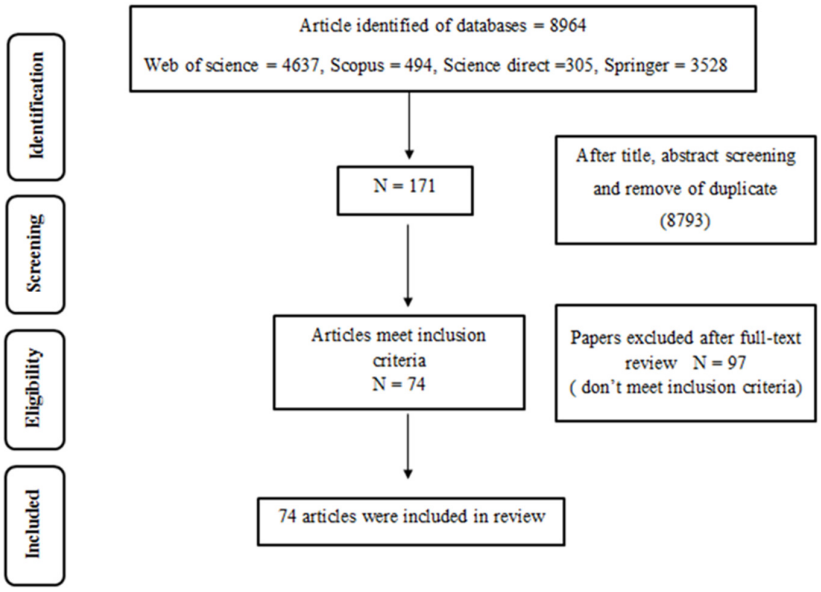

Figure 2. Flowchart for systematic literature search

Ethnobotanical studies

100 plant species belonging to 52 botanical families are inventoried in this study (Table 1). The most represented families are Lamiaceae with (18 species), Apiaceae (13 species), Asteraceae (10 species), Leguminoseae, Oleaceae, Rutaceae (4 species each), Amaranthaceae, Brassicaceae, Compositae, and Solanaceae (3 species each), Amaryllidaceae, Anacardiaceae, Asparagaceae, Cucurbitaceae, Euphorbiaceae, Fabaceae, Fagaceae, Lauraceae, Papaveraceae, Rosaceae, Salicaceae, Urticaceae, Verbenaceae, Zingiberaceae (2 species), and Apocynaceae, Araceae, Aristolochiaceae, Asclepiadaceae, Boraginaceae, Cactaceae, Capparaceae, Caryophyllaceae, Combretaceae, Cupressaceae, Ericaceae, Gentianceae, Geraniaceae, Jungladaceae, Liliaceae, Linaceae, Malvaceae, Myristicaceae, Myrtaceae, Nitrariaceae, Plantaginaceae, Pinaceae, Piperaceae, Poaceae, Pteridaceae, Ranunculaceae, Rhamnaceae, Zygophyllaceae (1 species each) (Figure 3). The prevalence of these families in medicinal plants is likely due to their abundance in Morocco's flora.

With regards to the most frequently used plants are, *Salvia officinalis* L. was mostly reported (7 mentions), *Opuntia ficus- indica* (L.) Mill. (6), *Rosmarinus officinalis* L. (6), *Ajuga iva* (L.) Schreb. (5), *Lavandula stoechas* L. (5), *Lawsonia inermis* L. (5), *Nerium oleander* L. (4), *Artemisia herba-alba* Asso (4), *Calendula officinalis* L. (4), *Allium cepa* L. (3), *Origanum vulgare* L. (3), *Mentha pulegium* L. (3), *Peganum hamala* L. (3), *Olea europaea* L. (3), *Plantago coronopus* L. (3), *Nigella sativa* L. (3), The species recorded are shown in Table 1.

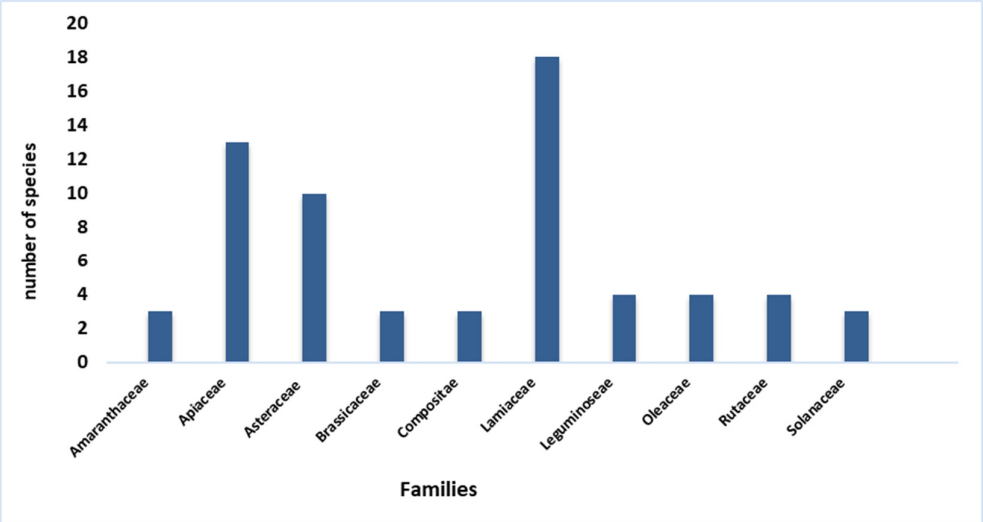

Figure 3. Moroccan medicinal plants families used to treat inflammation

Plant parts

The leaves, flowers, roots, seeds, whole plant, and aerial parts are commonly used to treat inflammation. The leaves are the most used part of the plant (39.33%), which are followed by flowers (13.33%), root (10.67%), seed (9.33%), and the whole plant (8.67%). Fruits, Stem, Bulb, and Rhizome are also presented with a low percentage (Figure 4). The researchers suggest that the leaves are frequently used in herbal medicine as they are easily obtainable (Bouyahya *et al*., 2017).

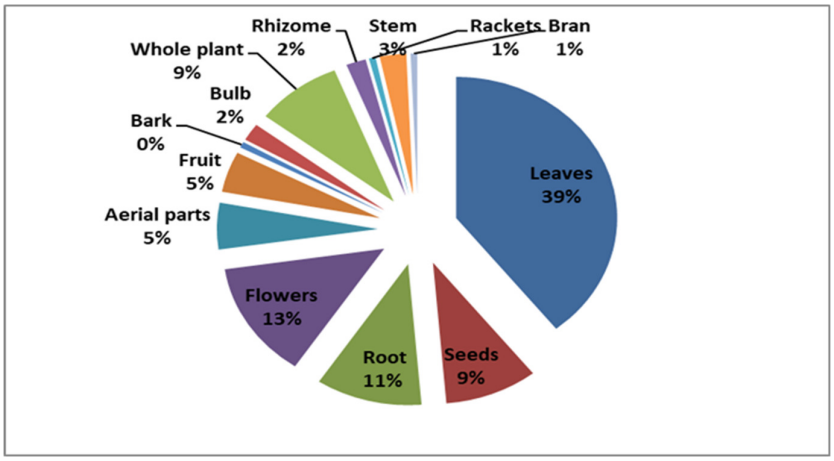

Figure 4. Percentage use of different plant parts against inflammation

Preparation methods and route of administration

The most commonly used methods traditionally for the treatment of inflammation are decoction (n = 71), infusion (n = 25), powder (n = 22), and cataplasm (n = 12). Other less reported preparation methods include maceration (n = 5), and Raw (n = 1). The percentage of use of the different preparation methods is presented in Figure 5.

The majority of anti-inflammatory preparations are taken orally (60%), followed by local application (24.44%), Mouthwash (10.37%), and much less by another external route, and inhalation (5.18%) (Figure 6). However, the oral route of administration allows a rapid physiological effect to promote the effective action of the herbal remedy.

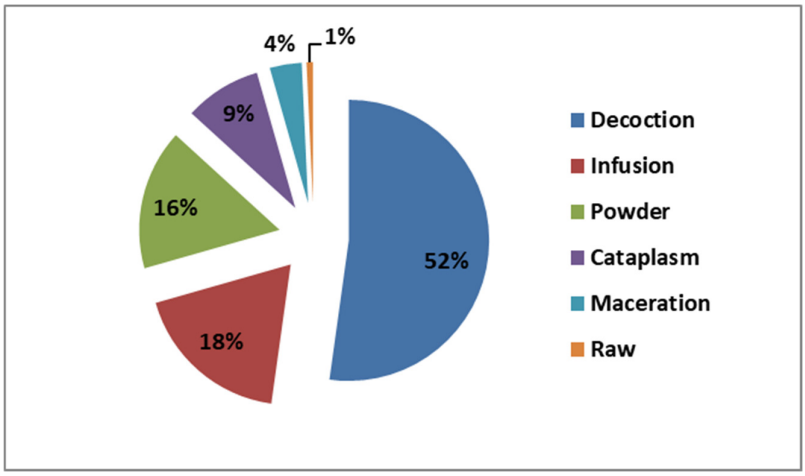

Figure 5. Percentage use of various preparations methods of plants against inflammation

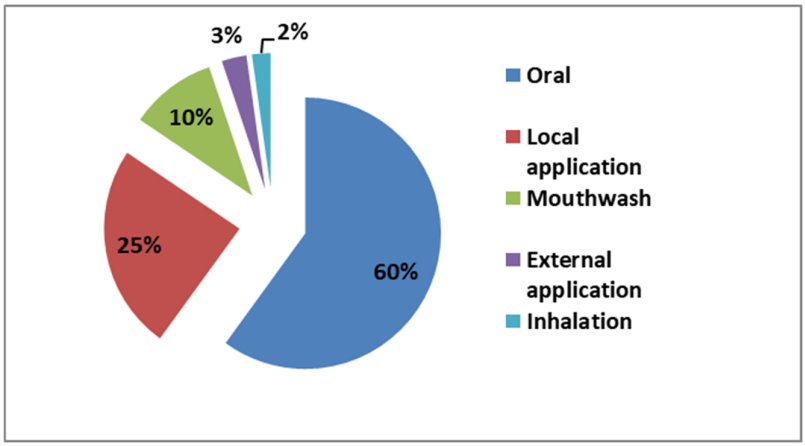

Figure 6. Percentage various modes of administration of plants against inflammation

Moroccan medicinal plants used traditionally to treat inflammation diseases

A survey was conducted between March and April 2018 in Rabat, Morocco to gather information on plants with anti-inflammatory properties. The survey results showed that there are three types of plants from two families, Asteraceae, and Lamiaceae. The most commonly used plants are *Artemisia herba-alba* Asso (chih), *Salvia officinalis* L. (Sâlmiya) and *Rosmarinus officinalis* L. (azir) (Skalli *et al*., 2019). Another study which was carried out also in same region by Salhi *et al*. (2019) demonstrates the importance of medicinal plants use by local populations in the skin burns treatment. The results identified 36 species belonging to 23 families, and 35 genera used in the skin burns treatment in the region. According to the authors, the most frequently used in the inflammation treatment are: *Linum usitatissimum* L., *Lawsonia inermis* L and *Plantago coronopus* L.

In Casablanca city (Morocco), an ethnobotanical study identified 9 medicinal plants, divided into 8 families. They are reported for the traditional treatment of inflammation in Morocco. These are: *Pistacia lentiscus* L., *Calamintha officinali*, *Mentha suaveolens* Ehrh., *Cinnamomum verum* J.Presl, *Eucalyptus globulus* Labill., *Adiantum capillus-veneris* L., *Nigella sativa* L., *Populus nigra* L and *Urtica urens* L (Zougagh et al., 2019).

An ethnobotanical study was conducted among 785 people from the region of The Ksar Lakbir (located at the southwestern limit of the Rif area, Morocco) identified 19 species belonging to 12 botanical families. The species used are *Anabasis aretioides* Moq. & Coss. ex Bunge, *Cachrys libanotis* L., *Kundmannia sicula* (L.) DC., *Thapsia garganica* L., *Brassica nigra* (L.) Koch., *Saponaria officinalis* L., *Artemisia herba-alba* Asso, *Carlina gummifera* (L.) Less. , *Citrullus colocynthis* (L.) Schrad., *Euphorbia falcata* L., *Juglans regia* L., *Ajuga iva* (L.) Schreb., *Lavandula stoechas* L., *Origanum majorana* L., *Mentha rotundifolia* (L.) Huds., *Salvia verbenaca* L., *Melilotus indicus* (L.) All., *Fraxinus angustifolia* Vahl, and *Cynodon dactylon* (L.) Pers. (Merzouki et al., 2000).

A survey was conducted in collaboration with herbalists in the province of Marrakech to identify medicinal plants used to treat inflammation. The most commonly used plant species identified was *Quercus ilex* L.(Ouarghidi *et al*., 2013). In Imouzzer Ida Outanane region (south-western Morocco), a survey was carried out to take stock of the main medicinal plants used in traditional medicine to treat inflammation. The results obtained made it possible to identify 15 medicinal plants used against inflammation. The most cited herbs for treating inflammation are: *Thapsia transtagana* Brot., *Periploca angustifolia* Labill., *Artemisia herba-alba* Asso, *Dittrichia viscosa (L.) Greuter*, *Warionia saharae* Benth. Coss., *Lavandula stoechas* L., *Mentha pulegium* L., *Rosmarinus officinalis* L., *Salvia officinalis*, *Myristica fragrans* Houtt., *Phillyrea angustifolia* L., *Nigella sativa* L., *Ruta montana* L., *Alpinia officinarum* Hance, *Zingiber officinale* Rosc. The leaves of plants are

the most commonly used parts of plants. Decoctions, and infusions are the most common preparation methods in traditional medicine. (Saadi *et al*., 2013).

According a survey conducted among herbalists and users of medicinal plants to treat inflammation in the zaer region (Western Morocco), seven plant species belonging to six botanical families have been identified. The species were *Coriandrum sativum* L., *Asparagus officinalis* L., *Opuntia ficus- indica* (L.) Mill., *Ajuga iva* (L.) Schreb., *Origanum vulgare* L., *Peganum hamala* L., *Olea europaea* L (Lahsissene and Kahouadji, 2010). In the same vein, another ethnobotanical survey of the local population of the Taounate province (Northern Morocco) indicated that a total of 11 plant species from 8 families in the region are used to treat inflammation. Among these listed species, four types are the most cited: *Lavandula stoechas* L., *Rosmarinus officinalis* L., *Salvia officinalis*, *Plantago coronopus* L. (El-Hilaly *et al*., 2003).

In the Eastern region of Morocco, an ethnobotanical study identified 148 medicinal plants, divided into 60 families. Eleven are reported for the traditional treatment of inflammation in Morocco. These are: *Nerium oleander* L., *Borago officinalis* L., *Brassica napus* L., *Saponaria officinalis* L., *Ricinus communis* L., *Laurus nobilis* L., *Cassia senna* L., *Peganum hamala* L., *Citrus sp.*, *Citrus sinensis* (L.) *Osbeck*, *Salix alba* L. (Jamila & Mostafa, 2014). Also an ethnobotanical survey conducted by Ziyyat et al (Ziyyat *et al*., 1997) which reports ten plants used as anti-inflammatory remedies in different regions oriental of Morocco, among which *Peganum hamala* L., *Urtica dioica* L. and *Arbutus unedo* L. are the most used. A study by Zouhri et al (Zouhri and Aarab, 2018) in Targuist (North Morocco) reports that 90 plant species were cited in 3,500 questionnaires for the treatment of inflammation. Five plants are most frequently used: *Calendula officinalis* L, *Opuntia ficus-indica* (L.) Mill, *Malva sylvestris* L., *Plantago coronopus* L. and *Datura stramonium* L. Investigation shows that the seeds, and leaves are the part of the plant most commonly used in herbal preparations. Also, in the Northern region of Morocco (region of Bouhachem Natural Regional Park), an ethnobotanical study identifies 101 medicinal plants used in the treatment of diseases. The most cited herbal remedies used for their anti-inflammatory effects are *Hammada scoparia* (Pomel) Iljin, *Allium cepa* L., *Allium sativum* L., *Ammi visnaga* (L.) Lam., *Nerium oleander* L., *Aristolochia baetica* L., *Artemisia herba-alba* Asso, *Cynara humilis* L., *Scolymus hispanicus* L., *Brassica oleracea* L., *Opuntia ficus- indica* (L.) Mill., *Ajuga iva* (L.) Schreb., *Cinnamomum verum* J. Presl, *Anthyllis cytisoides* L ., *Lawsonia inermis* L., *Fraxinus excelsior* L., *Triticum durum* Desf., *Urtica dioica* L. (Bachar *et al*., 2021). Similarly, another ethnobotanical survey was conducted from July 1st, 2016 to July 30th, 2018 on the population of the Rif, in the Northern Morocco indicates that a total of 13 species belonging to 11 families of plants are used to treat inflammation. Namely: *Dysphania ambrosioides* (L.) Mosyakin & Clemants, *Rhus pentaphylla* (Jacq.) Desf, *Arisarum vulgare* O.Targ.Tozz, *Agave Americana* L., *Carlina gummifera* (L.) Less., *Dittrichia viscosa* (L.) Greuter, *Lactuca virosa* Habl., *Euphorbia falcata* L., *Quercus ilex* L., *Lawsonia inermis* L., *Glaucium flavum* Crantz, *Cedrus atlantica* (Endl.), *Capsicum frutescens* L. The results show that decoction, and infusion are the most common preparation methods (Chaachouay *et al*., 2022).

In the Rif region of Morocco, another ethnobotanical study conducted by Chaachouay et al. has identified five herbal remedies used in inflammation treatment. The plants used are *Arisarum vulgare* O.Targ.Tozz, *Carlina gummifera* (L.) Less., *Dittrichia viscosa* (L.) Greuter, *Lactuca virosa* Habl and *Cedrus atlantica* (Endl.) (Chaachouay *et al*., 2021). An analogous study by Bouyahya et al (Bouyahya *et al.*, 2017) in Ouezzane (North-West of Morocco) reports that eight plant species are cited for the management of inflammation. Three plants, *Ajuga iva* (L.) Schreb., *Lavandula stoechas* L. and *Salvia officinalis* are the most used.

In the province of Errachidia (southeastern Morocco), a survey was carried out to classify the plants traditionally used to treat inflammation. The authors have identified 194 species belonging to 69 families, of which 17 species were cited for the first time. The plants most commonly cited are *Nerium oleander* L., *Calendula officinalis* L. and *Cassia senna* L. (Eddouks *et al*., 2017). Similarly, an ethnobotanical study in the

same region identified 64 medicinal plants belonging to 33 families used in the treatment of diseases. The plants most cited for their anti-inflammatory effects are *Opuntia ficus-indica* (L.) Mill., *Lavandula stoechas* L., *Salvia officinalis* L. (Lahsissene and Kahouadji, 2010). Another ethnobotanical survey of the local population of the Zagora region (southeastern Morocco) indicates that a total of 7 species belonging to 7 plant families were used to treat inflammation. Among these identified species, three are the most cited as anti-inflammatory plants in this region, namely: *Carum carvi* L., *Terminalia chebula* Retz., *Allium sativum* (L.), *Lawsonia inermis* L., *Olea europaea* L., *Nigella sativa* L., *Zygophyllum gaetulum* (Emb. and Maire) (Boufous *et al*., 2017). While in the region of Meknès-Tafilalet (North-central Morocco), an ethnobotanical study was conducted to identify plants often used to treat inflammation include: *Cuminum cymimum* L., *Calendula officinalis* L., *Santolina rosmarinifolia* L., *Medicago sativa* L., *Trigonella foenum- graecum* L., *Pelargonium graveolens* L'Hér., *Lavandula angustifolia* Mill., *Origanum vulgare* L., *Mentha pulegium* L., *Rosmarinus officinalis* L., *Lawsonia inermis* L., *Papaver rhoeas* L., *Rosa centifolia* Mill., *Citrus aurantium* L. and *Verbena officinalis* L. (Fadil *et al*., 2015). Likewise, in the north-central region of Morocco (Fez), an ethnobotanical study reported that 75 species are divided into 41 families for the treatment of 34 diseases. Among these species, eight plants have anti-inflammatory effects: *Ajuga iva* (L.) Schreb., *Lavandula angustifolia* Mill., *Origanum vulgare* L., *Melissa officinalis*, *Mentha pulegium* L., *Rosmarinus officinalis* L., *Salvia officinalis*, *Thymus vulgaris* L. (Mikou *et al*., 2015).

The medicinal plants used to treat inflammation in El Hajeb province, according to a survey was carried out to show that the most important species is *Pimpinella anisum* L. (Ajebli *et al*., 2017). A field study in the central Middle Atlas (Morocco), 8 plant species belonging to 4 families were reported for the treatment of inflammation in the region. The most important are *Ammi visnaga* (L.) Lam., *Artemisia arborescens* (Vaill.) L., *Artemisia herba-alba* Asso., *Carlina gummifera* (L.) Less, *Matricaria chamomilla* L., *Origanum compactum* Benth, *Rubus ulmifolius* Schott and *Urtica urens* L (Najem *et al*., 2020). Ultimately an ethnobotanical survey by Mouhaddach et al (Lahsissene and Kahouadji, 2010) in different regions of Morocco during March, April, and June 2014 reported that *Opuntia ficus- indica* (L.) Mill. used for the inflammation treatment.

Pharmacological studies

According to the selection criteria that characterise the research direction, 51 studies on the anti-inflammatory activity of Moroccan medicinal plants are identified and classified in Table 2. These articles cover six different experimental models. Among them, 38 articles use *in vivo* models, and 13 articles use *in vitro* models. The plant extracts tested *in vitro* and *in vivo* have been successful in reducing the inflammation induced experimentally in animals. 56 plants are explored experimentally, namely: *Allium subvillosum* Salzm. ex Schult. & Schult.f., *Aphloia theiformis* (Vahl) Benn., *Ammodaucus leucotrichus* Coss., *Apium graveolens*, *Coriandrum sativum*, *Cuminum cyminum* L., *Petroselinum crispum* (Mill.) Fuss, *Petroselinum sativum* Hoffm., *Aphloia theiformis* (Vahl) Benn., *Caralluma europaea* (Guss.) N.E.Br., *Phoenix dactylifera* L., *Dipcadi serotinum* (L.) Medik., *Moricandia sinaica* (Boiss.) Boiss., *Opuntia ficus-indica* (L.) Mill., *Capparis spinosa* L., *Cistus ladanifer* L., *Cistus monspeliensis* L., *Cistus salviifolius* L., *Androcymbium gramineum* (Cav.) J.F. Macbr., *Anacyclus pyrethrum* (L), *Dittrichia viscosa* (L.) Greuter, *Lactuca sativa* L., *Kleinia anteuphorbium* (L.) Haw., *Allanblackia gabonensis* (Pellegr.) Bamps, *Garcinia mangostana* L., *Coriaria myrtifolia* L., *Tetraclinis articulata* (Vahl) Mast., *Erica arborea* L., *Euphorbia granulata* Forssk., *Albizia anthelmintica*, *Pelargonium graveolens* L'Hér., *Ajuga iva* (L.) Schreb., *Melissa officinalis* L., *Mentha pulegium* L., *Origanum compactum* Benth., *Rosmarinus officinalis* L., *Thymus atlanticus* (Ball), *Thymus broussonetii* Boiss., *Thymus maroccanus* Ball, *Thymus saturejoides* Coss, *Thymus vulgaris* L., *Thymus willdenowii* Boiss., *Thymus zygis* L., *Bauhinia reticulata* DC., *Bauhinia thonningii* Schum., *Lawsonia inermis* L., *Punica granatum* L., *Eugenia uniflora* L., *Syzygium aromaticum* (L.) Merr. & L.M. Perry, *Ziziphus lotus* (L.) Lam., *Rosa* × *damascena* Herrm., *Argania spinosa* (L.) Skeels, *Withania frutescens* (L.)

Pauquy, *Thymelaea hirsuta* (L.) Endl., *Thymelaea lythroides* Barratte & Murb. And *Tetraena gaetula* (Emb. & Maire) Beier & Thulin. The effects of untapped Moroccan plant species on inflammation need to be further investigated, in particular the mechanism of action of these plant extracts, in order to obtain additional data on the pharmacological effects of these plants. *Coriandrum sativum* L, *Caralluma europaea* (Guss.) Nebr., *Opuntia ficus-indica* (L.) Moulin., *Capparis spinosa* L., *Anacyclus pyrethrum* L, *Ajuga iva* (L.) Schreb., *Thymus atlanticus* (Ball) Pau, *Thymus saturesioides* Coss, *Thymus zygis* L., *Lawsonia inermis* L. and *Rosmarinus officinalis* L. are plants most commonly used to treat inflammation. These plants will be discussed in detail below.

Plants used most frequently for the inflammation treatment in Morocco

Coriandrum sativum L.

Coriandrum sativum L. (Kassbour) is a plant of the Apiaceae family, widely cultivated for its seeds (Nadeem *et al*., 2013). Kassbour seeds are a common species, and have a large number of documented traditional medicinal uses. They can be used to treat diabetes, kidney and heart problems, and gastrointestinal diseases (El-Hilaly *et al*., 2003; Es-Safi *et al*., 2020; Lahsissene and Kahouadji, 2010; Mechchate *et al*., 2021) and to fight worms, rheumatism and joint pain (Nadeem *et al*., 2013). The lipid-lowering effect of whole Kassbour seed has been studied (Chithra and Leelamma, 1999), mainly its effect on lowering blood sugar and increasing insulin release (Eidi and Eidi, 2009), and the effect of scavenging free radicals *(de Almeida Melo et al*., 2005) and anti-inflammatory activity (Shraddha and Anuradha, 2019). This activity has been studied *in vivo* (Mechchate *et al*., 2021), and *in vitro* (Derouich *et al*., 2020). Using Carrageenan-Induced Paw edema model, Mechchate et al (Mechchate e*t al*., 2021) reported that methanolic extract of *Coriandrum sativum* whole plant exhibited potent anti-inflammatory activity. At a dose of 25 mg / kg this extract exhibited a potent effect, revealing a higher inhibitory effect when compared with vehicle control in mice. Morever, Hydromethanolic extracts of *Coriandrum sativums* show nitric oxide inhibition with IC_{50} vaue of 218,63 ± 6.41 µg/mL (Derouich e*t al*., 2020).

Caralluma europaea (Guss.) N.E.Br.

Caralluma europaea (Guss.) N.E.Br. : (Eddaghmouss) is a wild medicinal plant belonging to the Apocynaceae family, widespread in many Mediterranean countries including Morocco, Algeria, Tunisia, Egypt, Jordan, Libya, Spain, and Italy (Dra *et al*., 2019). In traditional medicine, it is recommended to use the aerial parts of Eddaghmouss in the form of juice or powder mixed with honey or milk to treat inflammation, ulcers, diabetes, bacterial infections, antiulcer, antinociceptive, antihyperglycemic, antioxidant, and cytotoxic activities (Adnan *et al*., 2014; Amrati *et al*., 2021; Bellakhdar, 1997).

The anti-inflammatory effects of hydroethanol, n-butanol and fractions rich in polyphenols of this plant have been studied through paw edema induced by carrageenin. After 6 hours of treatment, the part rich in polyphenols is the best edema inhibitor, with an inhibition rate of 75.68% (Amrati *et al*., 2021). Furthermore, *Caralluma europaea* ethanol extract reduced xylene-induced edema by 62.04% at 100 mg / kg (Kebbou *et al*., 2019).

Opuntia ficus-indica (L.) Mill.

Opuntia ficus-indica (L.) Mill. (Lhindia) or cactus belongs to the Cactaceae family, This plant is native to Mexico, cultivated in arid and semi-arid regions of South, and Central America, and was introduced in North Africa (D'Aquino *et al*., 2017). The fig tree grows quickly, adapts well to poor soils, and requires low water consumption. In traditional folk medicine it's Cladodes, and its fruits are also used as a source of nutrients, and for the treatment of inflammatory, diabetes, stomach ulcers, and kidney disease, and antioxidant activity (Alimi *et al*., 2010; Feugang *et al*., 2006; Kaur, 2012). The anti-inflammatory effects of aqueous acetone

extract of this plant were studied through the inhibition of nitric oxide. *Opuntia ficus-indica* extract demonstrated potent NO inhibitory activity (90%) with IC_{50} value of 0.19 mg / mL (Benayad *et al*., 2014).

Capparis spinosa L.

Capparis spinosa L. (kabâr) is a medicinal plant of the Capparaceae family, native to the Mediterranean region. This plant is found in many parts of the world in North Africa, Italy, Central Asia and Greece *(Zarei et al*., 2021). In traditional medicine, the different parts of this plant are used to treat rheumatism, digestive diseases, headaches, toothaches, as well as diuretics, antihypertensives, and tonics (Tlili *et al*., 2010). Kabâr can be used as an antioxidant, antifungal, anti-hepatotoxic, and anti-inflammatory (Gadgoli and Mishra, 1999; Germanò *et al*., 2002). It also treats many illnesses, such as bronchitis, bronchial asthma, liver disease and tuberculosis.

The anti-inflammatory effect of *Capparis spinosa* was confirmed by ethanolic extracts of the leaves in a model of paw edema in mice. Capparis at 1.07 g / kg reduced inflammation by 73.44% (El Azhary *et al*., 2017). Aqueous extracts of *Capparis spinosa* have also showed an anti-inflammatory effect by the inhibition of the pro-inflammatory cytokine, IL-17 at 500 µg / ml (Moutia *et al*., 2016). This activity attributed to the presence of alkaloids, biologically active lipids, polyphenols, flavonoids, and glucosinolates in *Capparis spinosa (Rodrigo et al*., 1992), which are known for its bioactive properties.

Anacyclus pyrethrum L.

Anacylcus pyrethrum L., commonly known as Oud AL Attass, botanically classified in the Compositae family, is a plant native to North Africa (Mohamed Fennane and Oualidi, 2014). According to experts in traditional Moroccan medicine, Oud AL Attass is one of the medicinal plants used to relieve toothache, angina, salivary secretions (Abbas Zaidi *et al*., 2013; Doudach *et al*., 2012), neuralgia, paralysis, and the common cold (Bendjeddou *et al*., 2003). Other pharmacological, and biological properties are antimicrobial (Jalayer-Naderi *et al*., 2016), antidiabetic (Tyagi *et al*., 2011), antioxidant (Pahuja *et al*., 2013) and anti-inflammatory (Manouze *et al*., 2017; Rimbau *et al*., 1999).The authors attributed those differents activities to many chemical constituents in *Anacylcus pyrethrum* L., including alkaloids, reducing compounds, tannins, flavonoids, coumarins, and also saponins, and sesamin (Elazzouzi *et al*., 2014). In a recent study, Jawhari et al *(Jawhari et al*., 2020) have reported the anti-inflammatory effect of hydroalcoholic extract of *Anacylcus pyrethrum* L., in rats using carrageenin-induced paw edema test. The hydroalcoholic extract of the roots at a dose of 300 mg / mL significantly reduced inflammation by 96%. The active compounds of hydroalcoholic extract of the seeds are able to reduce inflammation by 96% at a dose of 500 mg / mL. A similar study shows a significant anti-inflammatory effect (62%) of aqueous extract of *Anacylcus pyrethrum* L. at a dose of 500 mg / kg by employing xylene-induced ear edema test on rats (Manouze *et al*., 2017).

Ajuga iva (L.) Schreb.

In Morocco *Ajuga iva* (L.,) Schreb is called "Chendgoura" and is a medicinal plant of the Lamiaceae (Bouyahya *et al*., 2020). This species is traditionally used in Morocco to treat assorted diseases, such as diabetes (Bouyahya *et al*., 2017; Lahsissene and Kahouadji, 2010). Biological studies on extracts, and volatile compounds of Chendgoura essential oil have shown that this plant has antiparasitic (Bellakhdar *et al*., 1991), antibacterial (Makni *et al*., 2013), antidiabetic (Fettach *et al*., 2019), anti-inflammatory (Taleb-Senouci *et al*., 2012), anticancer effects, antioxidants, and antihypertensives (El-Hilaly et al., 2004). While the dermatoprotective effect is studied by inhibiting the activity of elastase *in vitro*. The essential oils of the aerial parts have shown an IC_{50} value of 192.21 µg/mL (Bouyahya *et al*., 2021).

Thyme varieties

Thymus L, also known as "Ziitra or Azukni," is an aromatic plant from the Lamiaceae family that is native to North Africa, Europe, and Asia. It has been used for centuries in Morocco to treat various illnesses, including inflammatory diseases. Traditional medicine recognizes its many benefits, such as treating infections caused by bacteria, fungi, and parasites (Hosseinzadeh *et al*., 2015), relieving coughs, and increasing appetite (Jarić *et al*., 2015). *Thymus saturejoides* Coss, *Thymus atlanticus* (Ball), and *Thymus zygis* L. are species of Morocco (Ramchoun *et al*., 2012) that are known for their anti-inflammatory properties and are used in folk medicine (Bellakhdar *et al*., 1991).

Several studies have demonstrated the anti-inflammatory effect of aqueous thyme extracts using three models: mouse ear edema induced by croton oil, paw edema induced by carrageenin in rats, and albumin denaturation inhibition test. After 5 hours of treatment, at a dose of 50 mg / kg of *Thymus atlanticus* (Ball) the paw edema induced by carrageenin has been reduced by 3.74% ± 0.01% and 9.52% ± 0.04 % for *Thymus zygis* L. and *Thymus atlanticus* (Ball), respectively ($P < 0.001$) (Khouya *et al*., 2015). While after eight hours treatment, the aqueous extract significantly reduced the volume of croton oil-induced ear edema by 70.47%, 84.62% and 29.66% at 900 mg / ear for *Thymus zygis L*., *Thymus atlanticus* (Ball) and *Thymus saturejoides* Coss respectively (Khouya *et al*., 2015).

According to Hmidani *et al*. (2019), the order of albumin denaturation inhibition of the aqueous extracts was: *Thymus atlanticus* (Ball) (IC_{50} = 122.90 µg / mL), followed by *Thymus zygis* L. (IC_{50} = 133.25 µg / mL), and *Thymus saturejoides* Coss (IC_{50} = 181.42 µg / mL). In a recent study, Khouya and collaborators (Khouya *et al*., 2020) reported that aerial parts of *Thymus atlanticus* (Ball) have shown a 70% inhibition of paw edema induced by carrageenan at a concentration of 100 mg / kg of aqueous extract of *Thymus atlanticus* (Ball).

Lawsonia inermis L.

Lawsonia inermis L. (Family Lythraceae), commonly known as Lhena, is a medicinal plant widely cultivated around the world, and its leaves have many medicinal, and cosmetic uses (Rostkowska et al., 1998). Pharmacological studies have revealed that it can be used in the treatment and prevention of inflammation, diarrhea, diabetes and ulcers and other diseases. In addition, it has antioxidant, anticancer, antibacterial, antiparasitic, antifungal, analgesic and antipyretic effects (Rostkowska *et al*., 1998). Ineed, Zouhri *et al*. (2017) reported the anti-inflammatory effect of *Lawsonia inermis* L fixed oils on paw edema induced by carrageenan in rats. The results showed that *Lawsonia inermis* reduced inflammation by 90.30% at 0.1 mg / ml after five hours. The anti-inflammatory activity of the methanolic extract of the leaves of *Lawsonia inermis* was also studied by Bouhlali *et al*. (2016). They found that when the extract was administered at a dose of 200 µg/mL, it significantly reduced protein denaturation with an IC_{50} of 103.21 µg/mL.

Rosmarinus officinalis L.

Rosmarinus officinalis L. (Azir) is a medicinal, and aromatic plant of the Lamiaceae family, which is widely distributed in the Mediterranean region, but today it is cultivated all over the globe (Bendif *et al*., 2017; Karadağ *et al*., 2019). The leaves are used as a spice to flavor cooking in traditional medicine, and because of its healing properties (Prior *et al*., 1998), such as stomach diseases, respiratory diseases, diabetes and inflammatory diseases (Bakırel *et al*., 2008). Azir is also used to reduce anxiety and depression (Nematolahi *et al*., 2018), and for its antioxidant, and antibacterial properties (de Melo *et al*., 2011; González-Trujano *et al*., 2007).

The anti-inflammatory effect of *Rosmarinus officinalis* L. has been confirmed by the essential oil from the leaves in a lipoxygenase assay model. This plant reduced inflammation at a concentration of 4.21 mg/mL with an IC_{50} value of 0.548 ± 0.005 mg/mL (El Kharraf *et al*., 2021).

Table 1. Plants used in the inflammation treatment in Morocco, cited in ethnobotanical studies

Family	Scientific name	Common or local name	Part used	Preparation methods	Modes of administrations	Number of citations	References
Amaranthaceae	*Anabasis aretioides Moq. & Coss. ex Bunge*	Chajra limayhazharrih	Aerial parts	Decoction	Oral	1	(Merzouki *et al*., 2000)
	Dysphania ambrosioides (L.) Mosyakin & Clemants	Mkhinza	Leaves	Decoction	Oral	1	(Chaachouay *et al*., 2022)
	Haloxylon scoparium Pomel	Tirguelt	Seeds, Whole plant	Decoction	Local application	1	(Bachar *et al*., 2021)
Amaryllidaceae	*Allium cepa* L.	L'bssale	Bulb, Whole plant	Decoction and cataplasm	Oral or local application	3	(Bachar *et al*., 2021; Bouyahya *et al*., 2017; Salhi *et al*., 2019)
	Allium sativum L.	Toum	Bulb, Whole plant	Decoction, cataplasm	Oral or local application	1	(Bachar *et al*., 2021)
Anacardiaceae	*Pistacia lentiscus* L.	Drou	Leaves, Flowers	Decoction	Mouthwash	1	(Zougagh *et al*., 2019)
	Searsia pentaphylla (Jacq.) F.A Barkley	Tizgha	Leaves	Decoction	Oral	1	(Chaachouay *et al*., 2022)
Apiaceae	*Ammi visnaga* (L.) Lam.	Bouchnikha, khala	Seeds, Whole plant, Flowers	Decoction	Oral or Mouthwash	2	(Bachar *et al*., 2021; Najem *et al*., 2020)
	Artemisia arborescens (Vaill.) L.	Chiba	Leaves	Decoction	Mouthwash	1	(Najem *et al*., 2020)
	Carlina gummifera (L.) Less	Dad	Root	Decoction	Mouthwash	1	(Najem *et al*., 2020)
	Cachrys libanotis L.	Kollikh	Root	Decoction	Oral	1	(Merzouki *et al*., 2000)
	Carum carvi L.	NI	Seeds	Decoction	Oral	1	(Boufous *et al*., 2017)
	Coriandrum sativum L.	Qasbor	Leaves	Decoction	Oral	1	(Lahsissene and Kahouadji, 2010)
	Cuminum cymimum L.	Kamoun	Seeds	Maceration	Oral	1	(Fadil et al., 2015)
	Matricaria chamomilla L.	Babounj lahmir	Leaves, Flowers	NI	NI	1	(Najem *et al*., 2020)
	Pimpinella anisum L.	NI	Seeds	Decoction	Oral	1	(Ajebli *et al*., 2017)
	Kundmannia sicula (L.) DC.	Ziyata	Root	Decoction	Oral	1	(Merzouki *et al*., 2000)
	Thapsia garganica L.	Addaryas	Aerial parts	Infusion	Oral	1	(Merzouki *et al*., 2000)
	Thapsia transtagana Brot.	Deriass	Root	Decoction	Oral	1	(Saadi *et al*., 2013)
Apocynaceae	*Nerium oleander* L.	Dafla, Ariri , Alili	Leaves	Decoction	Oral	4	(Bachar *et al*., 2021; Eddouks *et al*., 2017; Jamila and Mostafa, 2014; Salhi *et al*., 2019)
Araceae	*Arisarum vulgare* O.Targ.Tozz	Irni	Whole plant	Decoction	Oral	2	(Chaachouay *et al*., 2022)
Aristolochiaceae	*Aristolochia baetica* L.	Berez'tem	Aerial parts, Whole plant	Powder	Oral	1	(Bachar *et al*., 2021)

Asclepiadaceae	*Periploca angustifolia* Labill.	Asellif	Leaves, Root	Decoction and powder	Local application	1	(Saadi *et al*., 2013)
Asparagaceae	*Agave Americana* L.	Sabra	Whole plant	Cataplasm	Local application	1	(Chaachouay *et al*., 2022)
	Asparagus officinalis L.	Sekoum	Root	Cataplasm	Local application	1	(Lahsissene and Kahouadji, 2010)
Asteraceae	*Artemisia herba-alba* Asso	Chih	Leaves, Whole plant	Infusion and decoction	Oral	5	(Bachar *et al*., 2021; Merzouki *et al*., 2000; Najem *et al*., 2020; Saadi *et al*., 2013; Salhi *et al*., 2019; Skalli *et al*., 2019)
	Carlina gummifera (L.) Less.	Addad	Whole plant	Decoction	Oral	3	(Chaachouay *et al*., 2022; Merzouki *et al*., 2000)
	Calendula officinalis L.	Jemra	Flowers	Powder	Local application	4	(Eddouks *et al*., 2017; Fadil *et al*., 2015; Salhi *et al*., 2019; Zouhri and Aarab, 2018)
	Cynara humilis L	Timta, Taymeth	Root, Whole plant	Powder	Local application	2	(Bachar *et al*., 2021; Salhi *et al*., 2019)
	Dittrichia viscosa (L.) Greuter	Magraman, Terrahla	Leaves	Decoction, infusion	Local application, Oral	3	(Chaachouay *et al*., 2022; Saadi *et al*., 2013)
	Lactuca virosa Habl.	Ahchlaf Nssem	Whole plant	Decoction	Oral	1	(Chaachouay *et al*., 2021)
	Santolina rosmarinifolia L.	Oue-zouaza	Flower, Leaves	Infusion	Oral	1	(Fadil *et al*., 2015)
	Scolymus hispanicus L.	Guernina	Rhizome	Infusion	Oral	1	(Bachar *et al*., 2021)
	Warionia saharae Benth. Coss.	Afessas	Leaves	Decoction	Local application	1	(Saadi *et al*., 2013)
Boraginaceae	*Borago officinalis L.*	Lahricha, Lisan attur	Leaves	Decoction	Oral	2	(El-Hilaly *et al*., 2003; Jamila and Mostafa, 2014)
Brassicaceae	*Brassica napus* L.	Laft	Root, Leaves	Decoction and maceration	Oral	1	(Jamila and Mostafa, 2014)
	Brassica nigra (L.) Koch.	Al khardal Lak'hal	Seeds	Cataplasm	Local application	1	(Merzouki *et al*., 2000)
	Brassica oleracea L.	Kroumb	Leaves	Cataplasm	Local application	1	(Bachar *et al*., 2021)
Cactaceae	*Opuntia ficus- indica* (L.) Mill.	El Hendia	Whole plant, rackets	Cataplasm	Oral and local application	6	(Bachar *et a*l., 2021; Lahsissene and Kahouadji, 2010; Salhi *et al*., 2019; Zouhri and Aarab, 2018)
Capparaceae	*Capparis spinosa* L.	Kebbar	Fruits	Decoction	Oral	2	(El-Hilaly *et al*., 2003; Ziyyat *et al*., 1997)
Caryophyllaceae	*Saponaria officinalis* L.	Sarghina, Tighighacht	Root, Seeds	Powder and decoction	Oral or external application	2	(Jamila and Mostafa, 2014; Merzouki *et al*., 2000)

Combretaceae	*Terminalia chebula* Retz.	Hlilaj khal	Fruits	Powder	Local application	1	(Boufous *et al*., 2017)
Compositae	*Anthemis tomentosa Boiss.*	Nouar el jenna	Flowers	Maceration	External application	1	(El-Hilaly et al., 2003)
Cucurbitaceae	*Bryonia dioica* L.	Enab dib	Root	Decoction	Oral	1	(El-Hilaly *et al*., 2003)
	Citrullus colocynthis (L.) Schrad.	Handal, Hdejja	Fruits	Decoction	Oral	2	(Merzouki *et al*., 2000; Ziyyat *et al*., 1997)
Cupressaceae	*Juniperus phoenicea* L.	Ar'ar	Stem	Powder	Oral	1	(Bouyahya *et al*., 2017)
Ericaceae	*Arbutus unedo* L.	Sasnou	Root	Powder	Local application	1	(Ziyyat *et al*., 1997)
Euphorbiaceae	*Euphorbia falcata* L.	Hayat annofos	Whole plant	Infusion	Oral	2	(Chaachouay *et al*., 2022; Merzouki *et al*., 2000)
	Ricinus communis L.	Lkharouaa	Leaves	Decoction	Inhalation	1	(Jamila and Mostafa, 2014)
Fabaceae	*Medicago sativa* L.	Fassa	Seeds	Infusion	Oral	1	(Fadil *et al*., 2015)
	Trigonella foenum-graecum L.	Halba	Seeds	Infusion	Oral	1	(Fadil *et al*., 2015)
Fagaceae	*Quercus ilex* L.	D'bagh ou Fernân	Root	Powder	Local application	2	(Chaachouay *et al*., 2022; Ouarghidi *et al*., 2013; Salhi et *al*., 2019)
	Vicia faba L.	Fûl	Leaves	Powder	Local application	1	(Salhi *et al*., 2019)
Gentianceae	*Centaurium erythraea* Rafn.	Korsat lhaya	Flowers	Maceration	Local application	1	(Bouyahya *et al*., 2017)
Geraniaceae	*Pelargonium graveolens* L'Hér.	Ifer laâtar	Flowers, leaves	Infusion	Oral	1	(Fadil *et al*., 2015)
Jungladaceae	*Juglans regia* L.	Asswak	Leaves	Infusion	Oral	1	(Merzouki *et al*., 2000)
Lamiaceae	*Ajuga iva (L.) Schreb.*	Chendgoura	Leaves	Decoction	Oral	5	(Bachar *et al*., 2021; Bouyahya *et al*., 2017; Lahsissene and Kahouadji, 2010; Merzouki *et al*., 2000; Mikou *et al*., 2015)
	Calamintha officinalis Moench	Manta	Leaves	Decoction	Mouthwash	1	(Zougagh *et al*., 2019)
	Lavandula angustifolia Mill.	Khzama	Flowers, Leaves	Decoction	Oral	2	(Fadil *et al*., 2015; Mikou *et al*., 2015)
	Lavandula multifida L.	Hlihla	Stem	Decoction	Oral	1	(El-Hilaly *et al*., 2003)
	Lavandula stoechas L.	Halhal	Flowers	Decoction	Oral	5	(Bouyahya *et al*., 2017; El-Hilaly *et al*., 2003; Lahsissene and Kahouadji, 2010; Merzouki *et al*., 2000; Saadi *et al*., 2013)
	Origanum compactum Benth	Zaatar tadlaoui	Leaves, Flowers	Decoction	Mouthwash	1	(Najem *et al*., 2020)

	Origanum majorana L.	Merdeddouch	Aerial parts	Infusion	Oral	1	(Merzouki *et al*., 2000)
	Origanum vulgare L.	Zâtar	Flowers, Leaves	Decoction	Oral	3	(Fadil *et al.*, 2015; Lahsissene and Kahouadji, 2010; Mikou *et al*., 2015)
	Marrubium vulgare L.	Merrîwut	Leaves	Powder	Local application	1	(Salhi *et al*., 2019)
	Melissa officinalis L.	Naanae souf	Leaves	Infusion	Oral	1	(Mikou *et al*., 2015)
	Mentha pulegium L.	Fliou	Flowers, Leaves	Infusion	Oral or inhalation	3	(Fadil *et al*., 2015; Mikou *et al*., 2015; Saadi *et al*., 2013)
	Mentha rotundifolia (L.) Huds.	Mchichtro	Arial parts	Infusion	Oral	1	(Merzouki *et al*., 2000)
	Mentha suaveolens Ehrh.	Timija	Leaves	Decoction	Oral	1	(Zougagh *et al*., 2019)
	Mentha spicata L.	Naenae	Leaves	Cataplasm	Local application	1	(Salhi *et al.*, 2019)
	Rosmarinus officinalis L.	Azir, yazir	Flowers, Leaves	Infusion	Oral	6	(El-Hilaly *et al*., 2003; Fadil *et al*., 2015; Mikou *et al*., 2015; Saadi *et al*., 2013; Skalli *et al.*, 2019)
	Salvia officinalis L.	Sâlmiya	Leaves	Maceration and infusion	Oral and local application	7	(Bouyahya *et al*., 2017; El-Hilaly *et al*., 2003; Lahsissene and Kahouadji, 2010; Mikou *et al*., 2015; Saadi *et al.*, 2013; Salhi *et al*., 2019; Skalli *et al*., 2019)
	Salvia verbenaca L.	Al'khiata	Aerial part	Powder	Local application	1	(Merzouki *et al*., 2000)
	Thymus vulgaris L.	Ziitra	Flowers	Infusion	NI	1	(Mikou *et al*., 2015)
Lauraceae	*Cinnamomum verum* J.Presl	L'Karfa	Bark	Infusion and decoction	Oral or mouthwash	2	(Bachar *et al.*, 2021; Zougagh *et al*., 2019)
	Laurus nobilis L.	Rend, Ouarkat sidna moussa	Leaves	Decoction	Oral	2	(Jamila and Mostafa, 2014; Ziyyat *et al*., 1997)
Leguminosae	*Anthyllis cytisoides* L.	Chtappa	Root	Decoction	Oral	1	(Bachar *et al.*, 2021)
	Cassia senna L.	Lsana	Leaves	Decoction	Oral	2	(Eddouks *et al.*, 2017; Jamila and Mostafa, 2014)
	Ceratonia siliqua L.	Kharoub	Seeds	Decoction	Oral	1	(Bouyahya *et al*., 2017)
	Melilotus indicus (L.) All.	Azroud	Leaves, Flowers	Infusion	Oral	1	(Merzouki *et al*., 2000)
Liliaceae	*Allium sativum* (L.)	NI	Bulb	Decoction	Oral	1	(Boufous *et al*., 2017)
Linaceae	*Linum usitatissimum* L.	Zariat al kettan	Seeds	Powder	Local application	1	(Salhi *et al*., 2019)

Lythraceae	*Lawsonia inermis* L.	L'hanna	Leaves	Powder and decoction	Local application or oral	5	(Bachar *et al*., 2021; Boufous *et al*., 2017; Chaachouay *et al*., 2022; Fadil *et al*., 2015; Salhi *et al*., 2019)
Malvaceae	*Malva sylvestris* L.	Khobbeza	Leaves	Cataplasm	Local application	1	(Zouhri and Aarab, 2018)
Myristicaceae	*Myristica fragrans* Houtt.	Lgouza	Seeds	Powder	Oral	1	(Saadi *et al*., 2013)
Myrtaceae	*Eucalyptus globulus* Labill.	Kalitus	Flowers, Leaves	Infusion and decoction	Oral or mouthwash	2	(Ziyyat *et al*., 1997; Zougagh *et al*., 2019)
Nitrariaceae	*Peganum hamala* L.	Lharmal	Stem, Seeds	Decoction	Oral	3	(Jamila and Mostafa, 2014; Lahsissene and Kahouadji, 2010; Ziyyat *et al*., 1997)
Oleaceae	*Fraxinus angustifolia* Vahl	Touzalt, Alssan Attir, Addardar	Leaves, Fruits	Powder	Local application	1	(Merzouki *et al*., 2000; Ziyyat *et al*., 1997)
	Fraxinus excelsior L.	Dardar	Leaves	Decoction	Oral	1	(Bachar *et al*., 2021)
	Olea europaea L.	Zebbûj, Zitoun	Leaves, Fruits	Powder and decoction	Oral and local application	3	(Boufous *et al*., 2017; Bouyahya *et al*., 2017; Lahsissene and Kahouadji, 2010)
	Phillyrea angustifolia L.	Benzemmour	Leaves	Decoction	Local application	1	(Saadi *et al*., 2013)
Papaveraceae	*Glaucium flavum* Crantz	Merzak Halabi	Flowers	Decoction	Oral	1	(Chaachouay *et al*., 2022)
	Papaver rhoeas L.	Bellamane	Flowers	Infusion	Oral	1	(Fadil *et al*., 2015)
Plantaginaceae	*Plantago coronopus* L.	L-messâssa, Rjal laghrab	Leaves	Powder	Local application	3	(El-Hilaly *et al*., 2003; Salhi *et al*., 2019; Zouhri and Aarab, 2018)
Pinaceae	*Cedrus atlantica* (Endl.)	Arz El Atlas	Leaves	Decoction	Oral	1	(Chaachouay et al., 2021)
Piperaceae	*Triticum durum* Desf.	Kam'h salb	Bran	Decoction	Oral	1	(Bachar *et al*., 2021)
Poaceae	*Cynodon dactylon* (L.) Pers.	Anjem	Rhizome	Decoction	Oral	1	(Merzouki *et al*., 2000)
Pteridaceae	*Adiantum capillus-veneris* L.	Ziata	Leaves	Decoction	Mouthwash	1	(Zougagh *et al*., 2019)
Ranunculaceae	*Nigella sativa* L.	Habba sawda, Sanouj	Seeds	Powder and decoction	Oral or mouthwash	3	(Boufous *et al*., 2017; Saadi *et al*., 2013; Zougagh *et al*., 2019)
Rhamnaceae	*Ziziphus lotus* (L.) Lamk.	Sadra	Leaves	Decoction	Oral	1	(Ziyyat *et al*., 1997)
Rosaceae	*Rosa centifolia* L.	Lward lbeldi	Flowers	Infusion	Oral	1	(Fadil *et al*., 2015)
	Rubus ulmifolius Schott.	Tût azzarb, Serrmû	Leaves	Decoction	Mouthwash	1	(Najem *et al*., 2020)
Rutaceae	*Citrus aurantium* L.	Range	Leaves	Decoction	Oral	1	(Fadil *et al*., 2015)
	Citrus sp.	Ouadmi	Root	Powder	Oral	1	(Jamila and Mostafa, 2014)
	Citrus sinensis (L.) Osbeck	Litchin	Leaves	Decoction	Oral	1	(Jamila and Mostafa, 2014)

	Ruta montana L.	Fidjel	Aerial part, Leaves	Decoction and cataplasm	Oral or local application	2	(Saadi *et al*., 2013; Ziyyat *et al*., 1997)
Salicaceae	*Populus nigra* L.	Safsaf	Leaves	Decoction	Mouthwash	1	(Zougagh *et al.*, 2019)
	Salix alba L.	Oud lma	Leaves	Decoction	Inhalation	1	(Jamila and Mostafa, 2014)
Solanaceae	*Capsicum frutescens* L.	Sudaniya, Flfel Har	Fruits	Cataplasm	Local application	1	(Chaachouay *et al*., 2022)
	Datura stramonium L.	Chdak jmal	Leaves	Cataplasm	Local application	1	(Zouhri and Aarab, 2018)
	Mandragora automnalis Bertol.	Bid el gul	Fruits	Raw	Oral	1	(El-Hilaly *et al.,* 2003)
Urticaceae	*Urtica dioica* L.	Horriga	Leaves	Decoction	Local application	2	(Bachar *et al*., 2021; Ziyyat *et al*., 1997)
	Urtica urens L.	Horiga elmelsa	Leaves	Decoction	Mouthwash	2	(Najem *et al*., 2020; Zougagh *et al*., 2019)
Verbenaceae	*Verbena officinalis* L.	Lwiza	Leaves	Infusion	Oral	1	(Fadil *et al*., 2015)
	Vitex agnus-castus L.	El kherwae	Leaves	Infusion	Oral	1	(El-Hilaly *et al*., 2003)
Zingiberaceae	*Alpinia officinarum* Hance	Khudenjal	Root	Decoction	Oral	1	(Saadi *et al*., 2013)
	Zingiber officinale Rosc.	Skinjbir	Rhizome	Decoction and Infusion	Oral	1	(Saadi *et al*., 2013)
Zygophyllaceae	*Zygophyllum gaetulum* (Emb. and Maire)	NI	Leaves, Stem	Powder and decoction	Oral or external application	1	(Boufous *et al.*, 2017)

Table 2. Anti-inflammatory activities of Moroccan medicinal plants used traditionally to treat inflammation

Family	Plant species	Local name	Parts used	Form of extract	Dose	Methods used	Therapeutic activity	Mechanism of anti-inflammatory activity	References
Amaryllidaceae	*Allium subvillosum* Salzm. ex Schult. & Schult.f.	Basilah	Bulbs	Hydroethanolic extract	300 µg/cm2	Carrageenan-induced Ear edema in mice	Antioxidant, anti-inflammatory effect	22 % inhibition at 300 µg/cm^2	(Moussaid *et al*., 2011)
Aphloiaceae	*Aphloia theiformis* (Vahl) Benn.	Mfandrabo	Leaves	Methanol extract	100-200 mg/kg	Carrageenan-Induced Paw edema in Rats	Immunomodulatory and Anti-inflammatory Activities	93 % inhibition at 200 mg/kg after 5h	(Hsoidrou *et al.,* 2014)
Apiaceae	*Ammodaucus leucotrichus Coss.*	Kamoun es-sofi	Seeds	Hydroethanolic Extract	100-200 mg/kg	Carrageenan-Induced Paw edema in Rats	Antidiabetic and Anti-Inflammatory Activities	84 % inhibition at 200 mg/kg after 6h	(Es-Safi, Mechchate, Amaghnouje, Jawhari, *et al*., 2020)
	Apium graveolens L.	Karafs	Stems and leaves	Hydromethanolic extract	20 - 1000 µg/mL	Nitric oxide inhibition assay	Anti-inflammatory activity	NO inhibition (IC_{50} of 270,38 ± 5.25 µg/mL)	(Derouich *et al*., 2020)
	Coriandrum sativum L.	Kasbour	Stems and leaves	Hydromethanolic extract	20 - 1000 µg/mL	Nitric oxide inhibition assay	Anti-inflammatory activity	NO inhibition (IC_{50} of 218,63 ± 6.41 µg/mL)	(Derouich *et al*., 2020)
	Coriandrum sativum L.	Kasbour	Seeds	Methanol extract	25-50 mg/kg	Carrageenan-Induced Paw edema in Rats	Antioxidant, Anti-Inflammatory and Antidiabetic Proprieties	87 % inhibition at 25 mg/kg after 6h	(Mechchate *et al*., 2021)
	Cuminum cyminum L.	Kemmûn	Seeds	Methanol extract	50 - 800 µg/mL	Inhibition of protein denaturation	Antioxidant and anti-inflammatory properties	57,66 % inhibition at 200 µg/mL (IC50 = 134.87 µg/mL)	(BOUHLALI *et al*., 2016)
	Petroselinum crispum (Mill.) Fuss	Maadnous	Stems and leaves	Hydromethanolic extract	20 - 1000 µg/mL	Nitric oxide inhibition assay	Anti-inflammatory activity	NO inhibition (IC_{50} of 142.45 ± 5.59 µg/mL)	(Derouich et al., 2020)
	Petroselinum sativum Hoffm.	Maadnous	Aerial parts	Hydro-ethanolic extract	500-1000 mg/kg	Carrageenan-Induced Paw edema in Rats	Estrogenic and anti-inflammatory activities	63,33 % inhibition at 500 mg/kg after 6h	(Slighoua *et al*., 2021)
	Petroselinum sativum Hoffm.	Maadnous	Aerial parts	Polyphenol fraction	500-1000 mg/kg	Carrageenan-Induced Paw edema in Rats	Estrogenic and anti-inflammatory activities	81,33 % inhibition at 220 mg/kg after 6h	(Slighoua *et al*., 2021)
	Aphloia theiformis (Vahl) Benn.	Mfandrabo	Leaves	Methanol extract	100-200 mg/kg	Carrageenan-Induced Paw edema in Rats	mmunomodulatory and Anti-inflammatory Activities	93 % inhibition at 200 mg/kg after 5h	(Hsoidrou *et al*., 2014)
Apocynaceae	*Caralluma europaea* (Guss.) N.E.Br.	Eddaghmouss	Aerial parts	Ethanol extract	100–200 mg/kg	Xylene Induced Mouse Ear Edema	Antioxidant Activity, Anti-Inflammatory and Analgesic Effects	62,04 % inhibition at 100 mg/kg	(Kebbou et al., 2019)
	Caralluma europaea (Guss.) N.E.Br.	Eddaghmouss	Aerial parts	Ethyl acetate extract	100–200 mg/kg	Xylene Induced Mouse Ear Edema	Antioxidant Activity, Anti-Inflammatory and Analgesic Effects	57,05 % inhibition at 100 mg/kg	(Kebbou *et al*., 2019)

	Caralluma europaea (Guss.) N.E.Br.	Eddaghmouss	Aerial parts	Hydroethanol	50–100 mg/kg	Carrageenan-Induced Paw edema in Rats	Anti-Inflammatory, Antifungal, and Antibacterial Activities	69,50 % inhibition at 100 mg/kg after 4h	(Amrati *et al.*, 2021)
	Caralluma europaea (Guss.) N.E.Br.	Eddaghmouss	Aerial parts	N-butanol	50–100 mg/kg	Carrageenan-Induced Paw edema in Rats	Anti-Inflammatory, Antifungal, and Antibacterial Activities	76,32 % inhibition at 100 mg/kg after 5h	(Amrati *et al.*, 2021)
	Caralluma europaea (Guss.) N.E.Br.	Eddaghmouss	Aerial parts	Polyphenol rich fractions	50–100 mg/kg	Carrageenan-Induced Paw edema in Rats	Anti-Inflammatory, Antifungal, and Antibacterial Activities	76,70 % inhibition at 100 mg/kg after 6h	(Amrati *et al.*, 2021)
Arecaceae	*Phoenix dactylifera* L.	Jihl	Fruit	Aqueous extract	2 mg/kg	Carrageenan-Induced Paw edema in Rats	Anti-inflammatory activity	68,2 % inhibition at 2 mg/kg	(Bouhlali *et al.*, 2018)
	Phoenix dactylifera L.	Boufgous	Seeds	Methanol extract	20–1000 µg/mL	Croton oil-induced ear edema in mice	Anti-inflammatory activity	58,37 % inhibition at 500 µg after 4h	(Bouhlali *et al.*, 2020)
	Phoenix dactylifera L.	Boufgous	Seeds	Methanol extract	20–1000 µg/mL	Carrageenan-Induced Paw edema in Rats	Anti-inflammatory activity	58,37 % inhibition at 30 mg/kg after 6h	(Bouhlali *et al.*, 2020)
	Phoenix dactylifera L.	Boufgous	Seeds	Methanol extract	20–1000 µg/mL	Inhibition of protein denaturation	Anti-inflammatory activity	Inhibition of albumin denaturation (IC_{50} = 241.65 ± 6.69 µg/mL)	(Bouhlali *et al.,* 2020)
	Phoenix dactylifera L.	Boufgous	Seeds	Methanol extract	20–1000 µg/mL	Nitric oxide inhibition assay	Anti-inflammatory activity	NO inhibition (IC_{50} of 114,45 ± 7.63 µg/mL)	(Bouhlali *et al.,* 2020)
	Phoenix dactylifera L.	Boustammi	Seeds	Methanol extract	20–1000 µg/mL	Croton oil-induced ear edema in mice	Anti-inflammatory activity	77,17 % inhibition at 500 µg after 4h	(Bouhlali *et al.,* 2020)
	Phoenix dactylifera L.	Boustammi	Seeds	Methanol extract	20–1000 µg/mL	Carrageenan-Induced Paw edema in Rats	Anti-inflammatory activity	58,37 % inhibition at 30 mg/kg after 6h	(Bouhlali *et al.*, 2020)
	Phoenix dactylifera L.	Boustammi	Seeds	Methanol extract	20–1000 µg/mL	Inhibition of protein denaturation	Anti-inflammatory activity	Inhibition of albumin denaturation (IC_{50} = 138.04 ± 7.83 µg/mL)	(Bouhlali *et al.*, 2020)
	Phoenix dactylifera L.	Boustammi	Seeds	Methanol extract	20–1000 µg/mL	Nitric oxide inhibition assay	Anti-inflammatory activity	NO inhibition (IC_{50} of 118,36 ± 5.92 µg/mL)	(Bouhlali *et al.*, 2020)
	Phoenix dactylifera L.	Jihl	Seeds	Methanol extract	20–1000 µg/mL	Croton oil-induced ear edema in mice	Anti-inflammatory activity	71,69 % inhibition at 500 µg after 4h	(Bouhlali *et al.*, 2020)
	Phoenix dactylifera L.	Jihl	Seeds	Methanol extract	20–1000 µg/mL	Carrageenan-Induced Paw edema in Rats	Anti-inflammatory activity	58,37 % inhibition at 30 mg/kg after 6h	(Bouhlali *et al.*, 2020)
	Phoenix dactylifera L.	Jihl	Seeds	Methanol extract	20–1000 µg/mL	Inhibition of protein denaturation	Anti-inflammatory activity	Inhibition of albumin denaturation (IC_{50} = 116.63 ± 6.75 µg/mL)	(Bouhlali *et al.*, 2020)

	Phoenix dactylifera L.	Jihl	Seeds	Methanol extract	20–1000 µg/mL	Nitric oxide inhibition assay	Anti-inflammatory activity	NO inhibition (IC_{50} of 108,57 ± 5.15 µg/mL)	(Bouhlali *et al*., 2020)
	Phoenix dactylifera L.	Majhoul	Seeds	Methanol extract	20–1000 µg/mL	Croton oil-induced ear edema in mice	Anti-inflammatory activity	50,64 % inhibition at 500 µg after 4h	(Bouhlali *et al*., 2020)
	Phoenix dactylifera L.	Majhoul	Seeds	Methanol extract	20–1000 µg/mL	Carrageenan-Induced Paw edema in Rats	Anti-inflammatory activity	58,37 % inhibition at 30 mg/kg after 6h	(Bouhlali *et al*., 2020)
	Phoenix dactylifera L.	Majhoul	Seeds	Methanol extract	20–1000 µg/mL	Inhibition of protein denaturation	Anti-inflammatory activity	Inhibition of albumin denaturation (IC_{50} = 209.38 ± 9.01 µg/mL)	(Bouhlali *et al*., 2020)
	Phoenix dactylifera L.	Majhoul	Seeds	Methanol extract	20–1000 µg/mL	Nitric oxide inhibition assay	Anti-inflammatory activity	NO inhibition (IC_{50} of 163,63 ± 6.39 µg/mL)	(Bouhlali *et al*., 2020)
Asparagaceae	*Dipcadi serotinum* (L.) Medik.	Bssal Eddib	Bulbs	Hydroethanolic extract	300 µg/cm2	Carrageenan-induced Ear edema in mice	Antioxidant, anti-inflammatory effect	22 % inhibition at 300 µg/cm2	(Moussaid *et al.,* 2011)
Brassicaceae	*Moricandia sinaica* (Boiss.) Boiss.	Krombe	Aerial parts	Hydromethanolic extract	250–500 mg/kg	Carrageenan-Induced Paw edema in Rats	Analgesic, Anti-Inflammatory and Antipyretic Activities	52,4 % inhibition at 500 mg/mL	(El-mekkawy *et al*., 2020)
Cactaceae	*Opuntia ficus-indica* (L.) Mill.	Lhindia	Flowers	Aqueous acetone extract	0,18–2.25 mg/mL	Nitric oxide inhibition assay	Antioxidant and anti-inflammatory activities	90% NO inhibition (IC_{50} of 0,19 mg/mL)	(Benayad *et al*., 2014)
Capparaceae	*Capparis spinosa* L.	Kabâr	Leaves	Ethanol extract	1.07 g/Kg	Paw oedema assay in mice	Anti-inflammatory activity	73,44 % inhibition at 1,07 g/kg	(El Azhary *et al*., 2017)
	Capparis spinosa L.	Kabâr	Leaves	Aqueous extract	100-500 µg/ml	Unknown	Anti-inflammatory activity	inhibition of another pro inflammatory cytokine, IL-17 at 500 µg/ml	(Moutia *et al*., 2016)
Cistaceae	*Cistus ladanifer* L.	Arguil, Bouchikh	Leaves	Aqueous Extract	150-200 mg/kg	Carrageenan-Induced Paw edema in Rats	Anti-Inflammatory and Analgesic Effects	93,77 % inhibition at 200 mg/kg after 3h	(El Hamsas El Youbi *et al.,* 2016)
	Cistus monspeliensis L.	Arguil, Bouchikh	Aerial parts	Aqueous extract	500 mg/kg	Carrageenan-Induced Paw edema in Rats	Anti-inflammatory and analgesic activities	85,78 % inhibition at 500 mg/kg after 6h	(Sayah *et al*., 2017)
	Cistus salviifolius L.	Arguil, Bouchikh	Aerial parts	Aqueous extract	500 mg/kg	Carrageenan-Induced Paw edema in Rats	Anti-inflammatory and analgesic activities	91,57 % inhibition at 500 mg/kg after 6h	(Sayah *et al*., 2017)
Colchicaceae	*Androcymbium gramineum* (Cav.) J.F.Macbr.	Ssgëm Lerneb	Bulbs	Hydroethanolic extract	300 µg/cm2	Carrageenan-induced Ear edema in mice	Antioxidant, anti-inflammatory effect	25 % inhibition at 300 µg/cm2	(Moussaid *et al*., 2011)
Compositae	*Anacyclus pyrethrum* (L)	Oud AL Attass	Roots	Hydroalcoholic extract	300 mg/kg	Carrageenan-Induced Paw edema in Rats	Analgesic, Anti-Inflammatory, and Wound Healing Properties	96 % inhibition at 300 mg/mL	(Jawhari *et al*., 2020)

	*Anacyclus pyrethrum (*L)	Oud AL Attass	Seeds	Hydroalcoholic extract	500 mg/kg	Carrageenan-Induced Paw edema in Rats	Analgesic, Anti-Inflammatory, and Wound Healing Properties	96% inhibition at 500 mg/mL	(Jawhari *et al*., 2020)
	Anacyclus pyrethrum (L)	Oud AL Attass	Capitula	Hydroalcoholic extract	500 mg/kg	Carrageenan-Induced Paw edema in Rats	Analgesic, Anti-Inflammatory, and Wound Healing Properties	98% inhibition at 500mg/mL	(Jawhari *et al*., 2020)
	Anacyclus pyrethrum (L)	Oud AL Attass	Roots	Aqueous extract	125-500 mg/kg	Xylene–induced Ear edema	Anti-inflammatory, Antinociceptive and Antioxidant Activities	62 % inhibition at 500 mg/kg	(Manouze *et al*., 2017)
	Anacyclus pyrethrum (L)	Oud AL Attass	Roots	Methanol extract	125-500 mg/kg	Xylene–induced Ear edema	Anti-inflammatory, Antinociceptive and Antioxidant Activities	65 % inhibition at 500 mg/mL	(Manouze *et al*., 2017)
	Dittrichia viscosa (L.) Greuter	Amakarman	Leaves	Aqueous extract	200 mg/kg	Carrageenan-Induced Paw edema in Rats	Anti-inflammatory and antioxidant activities	54 % inhibition at 200 mg/kg	(Lounis *et al*., 2018)
	Lactuca sativa L.	Mesiouka, harouka	leaves	Hydroalcoholic extract	200–400 mg/kg	Formaldehyde-induced pedal edema test in rats	Antioxidant and Anti-inflammatory Activities	50,1 % inhibition at 400 mg/mL	(Zekkori *et al*., 2018)
	Kleinia anteuphorbium (L.) Haw.	Cigar	Leaves	Aqueous extract	200 mg/kg	Carrageenan-Induced Paw edema in Rats	Anti-inflammatory and antioxidant activities	43% inhibition at 200 mg/kg	(Lounis *et al*., 2018)
Clusiaceae	*Allanblackia gabonensis* (Pellegr.) Bamps	Ntia	Stem bark	Methylene chloride fraction	37,5 - 300 mg/kg	Carrageenan-Induced Paw edema in Rats	Anti-inflammatory and anti-nociceptive activities	83,33 % inhibition by carrageenan at 150mg/mL	(Nguemfo *et al*., 2007)
	Allanblackia gabonensis (Pellegr.) Bamps	Ntia	Stem bark	Methylene chloride fraction	37,5 - 300 mg/kg	Carrageenan-Induced Paw edema in Rats	Anti-inflammatory and anti-nociceptive activities	42,10 % inhibition by histamine at 150 mg/ml	(Nguemfo *et al*., 2007)
	Allanblackia gabonensis (Pellegr.) Bamps	Ntia	Stem bark	Methylene chloride fraction	37,5 - 300 mg/kg	Carrageenan-Induced Paw edema in Rats	Anti-inflammatory and anti-nociceptive activities	64,20 % inhibition by arachidonic acid at 150 mg/ml	(Nguemfo *et al*., 2007)
	Allanblackia gabonensis (Pellegr.) Bamps	Ntia	Stem bark	Methylene chloride fraction	37,5 - 300 mg/kg	Carrageenan-Induced Paw edema in Rats	Anti-inflammatory and anti-nociceptive activities	40,29 % inhibition by dextran at 150 mg/ml	(Nguemfo *et al*., 2007)
	Garcinia mangostana L.	Tamoul	Leaves	Dichloromethane extract	31.25 - 1000 µg/ml	Inhibition of protein denaturation	Antioxidant, Anti-inflammatory and Cytotoxicological Properties	Inhibition of protein denaturation (IC_{50} = 152.79±3.34 µg/m)	(Chadon Alphonsine Assemian *et al*., 2019)

	Garcinia mangostana L.	Tamoul	Leaves	Ethanol extract	31.25 - 1000 µg/ml	Inhibition of protein denaturation	Antioxidant, Anti-inflammatory and Cytotoxicological Properties	Inhibition of protein denaturation (IC_{50} = 652.33 ± 12.23 µg/mL)	(Chadon Alphonsine Assemian *et al.,* 2019)
Coriariaceae	*Coriaria myrtifolia* L.	Arwaz or rewiza	Leaves	Ethyl acetate extract	0,005 - 0,013 mg/kg	The plantar edema model induced in rabbits by carrageenan.	Antioxidant and anti-inflammatory activities	68,2 % inhibition at 0,005 mg/kg dose after 3h	(Hafsé *et al*., 2017)
Cupressaceae	*Tetraclinis articulata* (Vahl) Mast.	Al'Araar or Azouka	Leaves	Essential oil	100–200 mg/kg	Carrageenan-Induced Paw edema in Rats	Antioxidant and anti-inflammatory activities	68,48 % inhibition at 200 mg/kg dose after 3h	(El Jemli *et al*., 2017)
	Tetraclinis articulata (Vahl) Mast.	Al'Araar or Azouka	Leaves	Essential oil	100–200 mg/kg	Trauma induced paw edema in rats	Antioxidant and anti-inflammatory activities	84,51 % inhibition at 200 mg/kg dose after 3h	(El Jemli *et al*., 2017)
Ericaceae	*Erica arborea* L.	Khlendj	Aerial parts	Ethanol extract	200–400 mg/kg	Carrageenan-Induced Paw edema in Rats	Antioxidant and anti-inflammatory activities	59 % inhibition at 400 mg/kg dose after 3h	(Amezouar *et al*., 2013)
Euphorbiaceae	*Euphorbia granulata* Forssk.	Lubaina	Whole plants	Methanol extract	20–200 mg/kg	Carrageenan-Induced Paw edema in Rats	Anti-inflammatory, antipyretic, analgesic activity	59,12 % inhibition at 200 mg/kg after 3h	(Ghauri *et al*., 2021)
Fabaceae	*Albizia anthelmintica* Brongn.	_	Leaves	Methanol extract	200–400 mg/kg	Carrageenan-Induced Paw edema in Rats	Anti-inflammatory, pain killing and antipyretic activities	34 % inhibition at 400mg/mL	(Sobeh, Rezq, *et al*., 2019)
	Albizia anthelmintica Brongn.	_	Leaves	Methanol extract	200–400 mg/kg	Cyclooxygenase assay	Anti-inflammatory, pain killing and antipyretic activities	COX-1 inhibition (IC_{50} of 4,11 µg/mL) COX-2 inhibition (IC_{50} of 0,054 µg/mL	(Sobeh, Rezq, *et al*., 2019)
	Albizia anthelmintica Brongn.	_	Leaves	Methanol extract	200–400 mg/kg	Lipoxygenase assay	Anti-inflammatory, pain killing and antipyretic activities	5-LOX inhibition (IC_{50} of ≥ 1,74 µg/mL)	(Sobeh, Rezq, *et al.*, 2019)
Geraniaceae	*Pelargonium graveolens* L'Hér.	El aatricha	Whole plants	Essential oil	250 mg/kg	Carrageenan-Induced Paw edema in Rats	Oxidative and sodium nitroprussid e stress and infammatio n	86,76 % inhibition at 250 mg/kg dose after 6h	(Marmouzi *et al*., 2019)
Lamiaceae	*Ajuga iva* (L.) Schreb.	Chendgo ura	Aerial parts	Essential Oil	0,5 –3 mg/ml	Inhibition of elastase activity	Anti-inflammatory activity	Elastase inhibition (IC_{50} of 192.21 ± 7.80 µg/mL)	(Bouyahya *et al*., 2021)
	Ajuga iva (L.) Schreb.	Chendgo ura	Aerial parts	Essential Oil	40–160 µg/ml	Inhibition of Tyrosinase activity	Anti-inflammatory activity	Tyrosinase inhibition (IC_{50} of 87.49 ± 0.98 µg/mL)	(Bouyahya *et al.,* 2021)
	Melissa officinalis L.	Trandjan e	Leaves	Essential Oil	200–400 mg/kg	Trauma induced paw edema in rats	Anti-inflammatory activity	94,44 % inhibition at 400 mg/kg after 6h	(Bounihi *et al*., 2013)
	Melissa officinalis L.	Trandjan e	Leaves	Essential Oil	200–400 mg/kg	carrageenan-induced paw edema test in rats	Anti-inflammatory activity	70,58 % inhibition at 400 mg/kg after 6h	(Bounihi *et al*., 2013)

	Mentha pulegium L.	Fliou	Aerial parts	Hydroethanolic extract	300 µg/cm2	Carrageenan-induced Ear edema in mice	Antioxidant, antiinflammatory effect	28 % inhibition at 300 µg/cm2	(Moussaid *et al*., 2011)
	Origanum compactum Benth.	Zaâtar	Leaves	Essential oil	4.21 mg/mL	Lipoxygenase assays	Antioxidant, antiinflammatory, and antibacterial effect	LOX inhibition (IC_{50} of 0.129 ± 0.004 mg/mL)	(El Kharraf *et al*., 2021)
	Origanum compactum Benth	Zaâtar	Leaves	Essential oil	4.21 mg/mL	Acetylcholinesterase assays	Antioxidant, antiinflammatory, and antibacterial effect	inhibition (IC_{50} of 0.13 ± 0.01 mg/mL)	(El Kharraf *et al*., 2021)
	Rosmarinus officinalis L.	Azir	Leaves	Essential oil	4.21 mg/mL	Lipoxygenase assays	Antioxidant, anti-inflammatory, and antibacterial effect	LOX inhibition (IC_{50} of 0.548 ± 0.005 mg/mL)	(El Kharraf *et al*., 2021)
	Rosmarinus officinalis L.	Azir	Leaves	Essential oil	4.21 mg/mL	Acetylcholinesterase assays	Antioxidant, anti-inflammatory, and antibacterial effect	inhibition (IC_{50} of 1.74 ± 0.17 mg/mL)	(El Kharraf *et al*., 2021)
	Thymus atlanticus (Ball)	Ziitra or Azukni	Leaves	Aqueous extract	50–150 mg/kg	Carrageenan-Induced Paw edema in Rats	Anti-inflammatory and anticoagulant effects	70 % inhibition at 100 mg/mL	(Khouya *et al*., 2020)
	Thymus atlanticus (Ball)	Ziitra	Aerial parts	Aqueous extract	900 µg/ear	Croton oil-induced ear edema in mice	Anti-inflammatory, anticoagulant and antioxidant effects	55,15 % inhibition at 900 µg/ear	(Khouya *et al*., 2015)
	Thymus atlanticus (Ball)	Ziitra	Aerial parts	Aqueous extract	50 mg/kg	Carrageenan-Induced Paw edema in Rats	Anti-inflammatory, anticoagulant and antioxidant effects	62,15 % inhibition at 50 mg/kg	(Khouya *et al*., 2015)
	Thymus atlanticus (Ball)	Ziitra	Aerial parts	Aqueous extract	200– 1500 µg/mL	Inhibition of albumin denaturation	Antioxidant, anti-inflammatory and anticoagulant activities	Inhibition of albumin denaturation (IC_{50} = 122.90 µg/mL)	(Hmidani *et al*., 2019)
	Thymus broussonetii Boiss.	Z'iitra	Leaves	Chloroform extract	300 µg cm 2	Croton oil-induced ear edema in mice	Anti-inflammatory activity	83,36 % inhibition at 1000 µg cm 2 dose after 6h	(Ismaili *et al*., 2002)
	Thymus maroccanus Ball	Z'iitra	Aerial parts	Ethanol extracts	300–600 mg/kg	Carrageenan-Induced Paw edema in Rats	Antioxidant Activity, Anti-Inflammatory Potential	55,36 % inhibition at 300 mg/kg dose after 6h	(Oubihi *et al*., 2020)
	Thymus maroccanus Ball	Z'iitra	Aerial parts	Methanol extract	300–600 mg/kg	Carrageenan-Induced Paw edema in Rats	Antioxidant Activity, Anti-Inflammatory Potential	57,51 % inhibition at 300 mg/kg dose after 6h	(Oubihi *et al.,* 2020)
	Thymus saturejoides Coss	Azukni	Leaves	Hexane extract	300 µg cm−2	Croton oil-induced ear edema in mice	Anti-inflammatory and in vitro	24 % inhibition at 300 µg cm−2 dose after 6h	(Ismaili *et al*., 2004)

							antioxidant activities		
	Thymus saturejoides Coss	Azukni	Leaves	Methanol extract	300 µg cm−2	Croton oil-induced ear edema in mice	Anti-inflammatory and in vitro antioxidant activities	29 % inhibition at 300 µg cm−2 dose after 6h	(Ismaili *et al*., 2004)
	Thymus saturejoides Coss	Azukni	Leaves	Chloroform extract	300 µg cm−2	Croton oil-induced ear edema in mice	Anti-inflammatory and in vitro antioxidant activities	65 % inhibition at 300 µg cm−2 dose after 6h	(Ismaili *et al*., 2004)
	Thymus saturejoides Coss.	Zaiitra	Aerial parts	Aqueous extract	900 µg/ear	Croton oil-induced ear edema in mice	Anti-inflammatory, anticoagulant and antioxidant effects	2,83 % inhibition at 900 µg/ear	(Khouya *et al*., 2015)
	Thymus saturejoides Coss	Zaiitra	Aerial parts	Aqueous extract	50 mg/kg	Carrageenan-Induced Paw edema in Rats	Anti-inflammatory, anticoagulant and antioxidant effects	8,93 % inhibition at 50 mg/kg	(Khouya *et al*., 2015)
	Thymus saturejoides Coss	Zaiitra	Aerial parts	Aqueous extract	200– 1500 µg/mL	Inhibition of albumin denaturation	Antioxidant, anti-inflammatory and anticoagulant activities	Inhibition of albumin denaturation (IC_{50} = 181.42 µg/mL)	(Hmidani *et al.*, 2019)
	Thymus vulgaris L.	Z'itra	Aerial parts	Essential Oil	100–400 mg/kg	Carrageenan-Induced Paw edema in Rats	Anti-inflammatory activity	58,4 % inhibition at 400 mg/mL	(Abdelli *et al.*, 2017)
	Thymus willdenowii Boiss.	Z'itra	Leaves	Chloroform extract	300 µg cm 2	Croton oil-induced ear edema in mice	Anti-inflammatory activity	92 % inhibition at 300 µg cm 2 dose after 6h	(Ismaili *et al*., 2001)
	Thymus zygis L.	Z'itra	Plant	Aqueous extract	900 µg/ear	Croton oil-induced ear edema in mice	Anti-inflammatory, anticoagulant and antioxidant effects	31,52 % inhibition at 900 µg/ear	(Khouya *et al*., 2015)
	Thymus zygis L.	Z'itra	Plant	Aqueous extract	50 mg/kg	Carrageenan-Induced Paw edema in Rats	Anti-inflammatory, anticoagulant and antioxidant effects	87,20 % inhibition at 50 mg/kg	(Khouya *et al*., 2015)
	Thymus zygis L.	Z'itra	Aerial parts	Aqueous extract	900 µg/ear	Croton oil-induced ear edema in mice	Antioxidant, anti-inflammatory and anticoagulant activities	39,83 % inhibition at 900 µg/ear after 3h	(Khouya *et al*., 2016)
	Thymus zygis L.	Z'itra	Aerial parts	Dichloromethane fraction	900 µg/ear	Croton oil-induced ear edema in mice	Antioxidant, anti-inflammatory and anticoagulant activities	28,32 % inhibition at 900 µg/ear after 3h	(Khouya *et al*., 2016)
	Thymus zygis L.	Z'itra	Aerial parts	Aqueous extract	50 mg/kg	Carrageenan-Induced Paw edema in Rats	Antioxidant, anti-inflammatory and anticoagulant activities	86,61 % inhibition at 50 mg/kg	(Khouya *et al.,* 2016)

	Thymus zygis L.	Z'itra	Aerial parts	Dichloromethane fraction	50 mg/kg	Carrageenan-Induced Paw edema in Rats	Antioxidant, anti-inflammatory and anticoagulant activities	12,66 % inhibition at 50 mg/kg	(Khouya *et al*., 2016)
	Thymus zygis L.	Z'itra	Aerial parts	Aqueous extract	200– 1500 µg/mL	Inhibition of albumin denaturation	Antioxidant, anti-inflammatory and anticoagulant activities	Inhibition of albumin denaturation (IC_{50} = 133.25 µg/mL)	(Hmidani *et al*., 2019)
Leguminosae	*Bauhinia reticulata* DC.	Nguiguis	Leaves	Methanol extract	40 µg/mL to 1000 µg/mL	Inhibition of heat induced protein denaturation	Antioxidant and the Anti-Inflammatory Effects	58,69 % Inhibition of albumin denaturation at 1000 µg/mL (IC_{50} = 121.43 ± 1.55 µg/mL)	(Boualam *et al*., 2021)
	Bauhinia thonningii Schum.	Nguiguis	Leaves	Methanol extract	40 - 1000 µg/mL	Inhibition of heat induced protein denaturation	Antioxidant and the Anti-Inflammatory Effects	67,39 % Inhibition of albumin denaturation at 1000 µg/mL (IC_{50} = 116.4 ± 0.73 µg/mL)	(Boualam *et al*., 2021)
Lythraceae	*Lawsonia inermis* L.	Lhana	Leaves	Methanol extract	50 - 800 µg/mL	Inhibition of protein denaturation	Antioxidant and anti-inflammatory properties	82,42 % inhibition at 200 µg/mL (IC_{50} = 103.21 µg/mL)	(BOUHLALI *et al*., 2016)
	Lawsonia inermis L.	Lhena	Leaves	Oil	0,1 mg/ml	Carrageenan induced pedal edema test in rabbits	Antioxidant, Anti-inflammatory and Photoprotective Effects	90,30 % inhibition at 0,5 mg/ml after 5h	(Zouhri *et al*., 2017)
	Punica granatum L.	Ounk Hmam	Fruit	Methanol extract	50-150 mg/kg	Albumin induced hind paw edema	Anti-inflammatory and antinociceptive effects	51 % inhibition at 150 mg/kg after 2h	(Ouachrif *et al*., 2012)
Myrtaceae	*Eugenia uniflora* L.	–	Leaves	Methanol extract	100 mg/kg	Carrageenan-induced hind paw edema	Antioxidant, anti-inflammatory activities	32 % inhibition at 100 mg/kg after 1h	(Sobeh, El-Raey, *et al*., 2019)
	Eugenia uniflora L.	–	Leaves	Methanol extract	100 mg/kg	Cyclooxygenase assay	Antioxidant, anti-inflammatory activities	COX-1 inhibition (IC_{50} of 5,63 µg/mL) COX-2 inhibition (IC_{50} of 0,18 µg/mL)	(Sobeh, El-Raey, *et al*., 2019)
	Eugenia uniflora L.	–	Leaves	Methanol extract	100 mg/kg	Lipoxygenase assay	Antioxidant, anti-inflammatory activities	5-LOX inhibition (IC_{50} of 2.14 µg/mL)	(Sobeh, El-Raey, *et al*., 2019)
	Syzygium aromaticum (L.) Merr. & L.M.Perry	Kranfal	Whole plants	Essential oil	250 mg/kg	Carrageenan-Induced Paw edema in Rats	Oxidative and sodium nitroprussid e stress and infammation	93,83 % inhibition at 250mg/kg after 6h	(Marmouzi *et al*., 2019)
Rhamnaceae	*Ziziphus lotus* (L.) Lam.	Sedra	Seeds	Oil	200-300 mg/kg	Carrageenan-Induced Paw edema in Rats	Anti-inflammatory activity	64,33 % inhibition at 200mg/mL	(El Hachimi *et al*., 2017)
Rosaceae	*Rosa* × *damascena* Herrm.	–	Flowers	Methanol extract	50- 800 µg/mL	Inhibition of protein denaturation	Antioxidant and anti-inflammatory properties	79,5 % inhibition at 200 µg/mL (IC_{50} = 129.04 µg/mL)	(BOUHLALI *et al*., 2016)
Sapotaceae	*Argania spinosa* (L.) Skeels	Argan	Seeds	Argan oil	300 -500 mg/kg	Carrageenan-Induced Paw edema in Rats	Anti-inflammatory activity	70,68 % inhibition at 500 mg/kg after 6h	(Kamal *et al*., 2019)

	Argania spinosa (L.) Skeels	Argan	Seeds	Argan oil	300 -500 mg/kg	Trauma induced paw edema in rats	Anti-inflammatory activity	49,63 % inhibition at 500 mg/kg after 6h	(Kamal *et al*., 2019)
Solanaceae	*Withania frutescens* (L.) Pauquy	Irram	Foliar parts	Ethanol extract	350 -450 mg/kg	Carrageenan-Induced Paw edema in Rats	Analgesic, anti-inflammatory, and healing activities	82,20 % inhibition at 450 mg/kg after 6h	(EL Moussaoui *et al*., 2020)
Thymelaeaceae	*Thymelaea hirsuta* (L.) Endl.	–	Aerial parts	Aqueous extract	500 mg/kg	Carrageenan-induced hind paw edema	anti-inflammatory and antiarthritic activities	68 % inhibition at 500 mg/ml after 5h	(Oudghiri and Azza, 2015)
	Thymelaea lythroides Barratte & Murb.	–	Aerial parts	Methanol extract	200 mg/kg	LPS induced microglial activation	Anti-inflammatory activity	Thymelaea lythroides reduces LPS-induced microglial activation	(Berkiks *et al*., 2018)
Zygophyllaceae	*Tetraena gaetula* (Emb. & Maire) Beier & Thulin	–	Aerial parts	Aqueous extract	5oo mg/kg	Carrageenan-Induced Paw edema in Rats	Anti-inflammatory activity	47 % inhibition at 500mg/mL	(Khabbal *et al*., 2006)

Conclusions

The present review reported the anti-inflammatory effects of Moroccan medicinal plants from their traditional use to the pharmacological studies, which linked the ethnopharmacological uses to the biological activities. It was noticed that many Moroccan herbal remedies could be used as anti-inflammatory remedies. The study found that 100 plant species belonging to 52 families are used to treat inflammation. The dominant family in this study concerning species number was Lamiaceae, and the most cited plant species are *Salvia officinalis* L, *Opuntia Ficus-Indica* L, *Lavandula stoechas* L, *Lawsonia Isermis* L, and *Rosmarinus officinalis* L. In terms of efficiency, the aqueous extract of *Cistus ladanifer*, the hydroalcoholic extract of *Anacyclus pyrethrum*, essential oil of *Melissa officinalis* and *Syzygium aromaticum* are the most effective anti-inflammatory agents *in vivo* models. Likewise, methanolic extracts of *Cuminum cyminum*, *Lawsonia inermis*, *Rosa damascena* and acetone extract of *Opuntia ficus-indica* are the most effective plant extracts for regulating inflammatory, and pro-inflammatory cells in the *in vitro* model. However, numerous plants used in Moroccan traditional medicinal have not been yet tested for their anti-inflammatory effects in laboratory. Therefore, further investigations are required regarding the *in vitro* and *in vivo* models and their bioactive compounds as well as their clinical investigations. In this way, it will also be essential to determine the toxicity of these plants in order to be able to apply them in clinical terms and contribute to develop now anti-inflammatory drugs.

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All authors read and approved the final manuscript.

Ethical approval (for researches involving animals or humans)

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Conflict of Interests

The authors declare that there are no conflicts of interest related to this article.

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