Medicinal plants used for gastrointestinal disorders in Morocco

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Review

Abstract

Background: The present study is devoted exclusively to ethnobotanical and pharmacological knowledge of plants used to treat gastrointestinal diseases in Morocco. Its main purpose is to collect data on the methods of preparation and administration of recipes, the pharmacological properties and the chemical constituents of each plant.

Method: The ethnobotanical and pharmacological information relating to these plants was obtained by a review of the literature available in electronic databases namely Google Scholar, PubMed, Scopus, Web of Science, Springer-Link and MEDLINE.

Results: In total, 216 plant species belonging to 65 families have been used in traditional Moroccan medicine to treat various digestive diseases. The species most used by local population were: *Trigonella foenum-graecum* L., *Pistacia lentiscus* L, *Allium cepa* L., *Allium sativum* L., *Foeniculum vulgare* Mill., *Artemisia herba-alba* Asso, *Ajuga iva* (L.) Schreb., *Ocimum basilicum* L., *Origanum compactum* Benth., *Rosmarinus officinalis* L., *Ceratonia siliqua* L. and *Punica granatum* (L.). The leaf was the most used part of the plant, and the decoction was the main method of preparation. Phytochemical analyzes revealed that these plants have many bioactive chemical constituents and very important pharmacological activities.

Conclusions: This study showed a great diversity of medicinal species used by the Moroccan population. However, it is necessary to systematically evaluate the listed plants to confirm their biological activities and recommend their best uses for treating gastrointestinal diseases.

Keywords: Medicinal plants, gastrointestinal disorders, ethnobotany, pharmacology, Morocco

Background

Diseases of the digestive tract are many and varied. A digestive disease is a pathology affecting part of the digestive system, whether it is the digestive tract (esophagus, small intestine, colon, rectum and anus) or the digestive glands (liver, bile ducts and pancreas). The pathologies of the digestive tract can emanate from several factors such as age, overweight, obesity, sedentary lifestyle, stress, poor food storage conditions, excessive alcohol consumption, lack of hygiene, consumption of drugs or other harmful substances, bad eating habits (Azizullah *et al.* 2011, Rahman *et al.* 2016, Tangjitman *et al.* 2015).

Digestive diseases are also due to pathogenic microorganisms for humans such as bacteria, viruses, helminths, fungi and protozoa (Dibner & Richards 2004, Dogan & Ugulu 2013, Rahman *et al.* 2016, Svihus 2014, Thakur *et al.* 2020). Other studies suggest that oxidative stress plays an important role in the pathophysiology of digestive diseases (Bajgai *et al.* 2022). Digestive disorders vary depending on the organ affected. Indeed, mortality due to these diseases has increased considerably in recent years (Tangjitman *et al.* 2015, Zhao *et al.* 2021). Among many gastrointestinal disorders, ulcerative colitis, Crohn's disease, functional dyspepsia, diverticular disease, irritable bowel syndrome and acid reflux are the most common serious illnesses (Bajgai *et al.* 2022). Diarrhea, a scourge that is still relevant today, kills 1.6 million children worldwide every year, the majority of them in developing countries. Although it is not a disease, but a symptom of other ailments. Its most common cause is the ingestion of contaminated water or food. (Recha & Manetu 2021, Troeger *et al.* 2018). The use of traditional medicine and plant extracts to treat gastrointestinal diseases is gaining popularity around the world, following historical, cultural and economic considerations. Indigenous peoples and traditional communities know how to exploit many plant species in many ways, transforming them into medicines. In developing countries, people residing in rural areas have practical knowledge of the various uses of the plants around them. This traditional knowledge, accumulated over centuries, is the collective property of these communities and is transmitted orally from generation to generation (Bozkurt 2021, Sargin *et al.* 2015, Woldemariam *et al.* 2021). Several studies have reported the use of medicinal plants for the treatment of digestive diseases in different regions of the world. On the other hand, several active compounds of these plants have been discovered based on ethnobotanical information. These plants are characterized by their fragrant smell or bitter taste. These qualities come from secondary metabolites like tannins, terpenoids and their derivatives and other chemical components (Ekpo *et al.* 2008, Pradhan *et al.* 2020, Wali *et al.* 2019). The effectiveness of herbal medicine is proven, and its undeniable health benefits have allowed natural medicine to enter our daily habits. The valorization of traditional medicine is thus of growing interest. This review article aims to provide an overview of ethnobotanical uses as well as recent studies concerning the pharmacological properties and chemical constituents of plants used in Morocco to treat different digestive system diseases.

Materials and Methods

We reviewed 82 research publications based on available ethnobotanical and pharmacological data on plants used in the treatment of gastrointestinal diseases in different regions of Morocco (Fez-Meknes region, High Atlas Central, Seksaoua Region, Talassemtane National Park and province of Tarfaya) published until October 2023 in various scientific journals using online databases namely Google Scholar, PubMed, Scopus, Web of Science, Springer-Link and MEDLINE. The search terms used were the following combination “Ethnobotanical study”, “Moroccan medicinal plants”, “gastrointestinal disorders in Morocco”, “diseases of the digestive system in Morocco”, “Etnopharmacology”, “Phytochemistry”. Each plant's family name, local name, plant part used, method of preparation, and diseases treated are compiled in Table 1. The number of references citing each plant species was used to determine the most used medicinal plants. The main chemical constituents and pharmacological activities of these plants are also summarized and presented in Table 2.

Results and Discussion

Ethnobotanical studies

We analyzed the literature and collected data on the explored regions. Five ethnobotanical surveys on plants used in the treatment of gastrointestinal diseases were reported in different areas of Morocco, namely Fez-Meknes region, High Atlas Central, Seksaoua Region, Talassemtane National Park and province of Tarfaya. In this review, 28 out of 216 medicinal plants used for the treatment of digestive disorders in Morocco were reported as the most used. Two species, *Trigonella foenum-graecum* L., and *Pistacia lentiscus* L were used in all study areas (5 areas), 10 species were used in four study areas and 16 species were used in three study areas. Figure 1 represents a comparison between the most used species in the five study areas.

An ethnobotanical study was carried out among 423 people including 108 traditional healers in the region of Fez-Meknes in order to highlight the traditional methods that the inhabitants of this region use to treat digestive problems. The results obtained made it possible to identify 50 medicinal species belonging to 25 families. The most used species are: *Foeniculum vulgare*, *Carum carvi*, *Glycyrrhiza glabra*, *Ammondaucus leucotrichus*, *Trigonella foenum-graecum and Coriandrum sativum*. Six categories of digestive disorders were treated by medicinal plants in the study area, namely digestion problems, intestinal comfort, acute ache, bloating, constipation and diarrhea (Es-Safi *et al.* 2020).

To gather information on plants used in the treatment of digestive diseases, a survey was conducted between 2015 and 2017 in the High Atlas Central of Morocco. The study made it possible to inventory 84 species of plants belonging to 37 families.

Lamiaceae and Compositae were the most reported plant families. The decoction was the most used mode of preparation. The results of the surveys revealed that the most used plants were *Carum carvi*, *Ammodaucus leucotrichus* and *Artemisia herba-alba* (Belhaj & Zidane 2021).

In Seksaoua Region (Western High Moroccan Atlas), an ethnobotanical study was carried out to describe the different uses of medicinal plants to treat gastrointestinal diseases. The results obtained revealed that the local population used 92 plants belonging to 44 botanical families and including 20 endemic species of Morocco such as *Pulicaria mauritanica*, *Thymelaea linifolia* and *Salvia taraxacifolia* (Hind *et al.* 2017).

A study by Redouan et al. in Talassemtane National Park (North of Morocco) reported that 96 plant species belonging to 33 botanical families were cited by the local population to treat 20 digestive symptoms and conditions. Teeth, gum symptom, diarrhea, abdominal pain epigastric and indigestion were the diseases most treated by medicinal plants. On the other hand, Leaves, fruits and seeds were the most used parts and the most common mode of administration was oral. The most used medicinal plants were *Foeniculum vulgare*, *Ammi Visnaga*, *Punica granatum* and *Trigonella foenum-graecum* (Redouan *et al.* 2022).

In the province of Tarfaya (South of Morocco), the local population used 73 medicinal species belonging to 36 families for the treatment of several digestive diseases, namely intestinal gas, diarrhea, indigestion, intestinal worms, stomach pain, constipation, intestinal diseases, bad breath, clean teeth, dyspepsia, gingivitis, poisoning, toothache, dysentery, heartburn and gastralgia. The most used plant species are: *Maerua crassifolia*, *Rhus tripartita*, *Artemisia herba-alba*, *Ammodaucus leucotrichus*, *Acacia nilotica* and *Adansonia digitata* (Idm'hand *et al.* 2020).

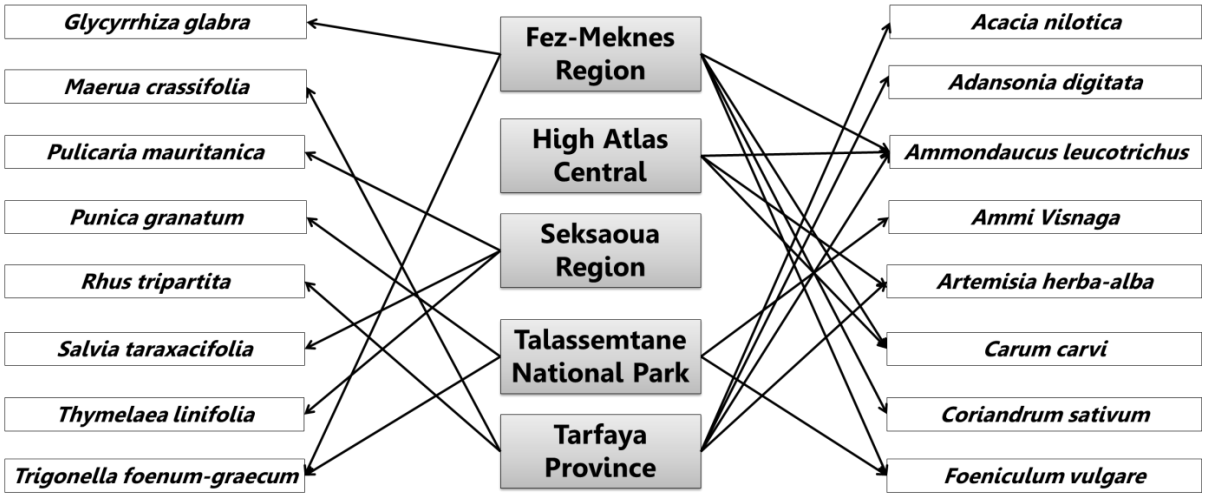

Figure 1. The most used medicinal plants in the five explored areas

Diversity of medicinal plants used to treat gastrointestinal disorders

This review revealed that Moroccans use a wide range of medicinal plants to treat different diseases that affect the digestive tract. The scientific name, the vernacular name, the part of the plant used, the methods of preparing medicinal recipes, and the therapeutic uses of each plant are compiled in Table 1.

Table 1. Medicinal plants used for the treatment of gastrointestinal disorders in Morocco

Family	Species	Local name	Plant part	Preparation mode	Traditional uses	References
Aizoaceae	*Aizoon canariense* L.	Lghassoul	Leafy stem	Decoction	Food poisoning	(Idm'hand *et al.* 2020)
Amaranthaceae	*Anabasis aretioides* Moq. & Coss. ex Bunge	Sellii	Leafy stem	Decoction	Food poisoning	(Idm'hand *et al.* 2020)
	Bassia tomentosa (Lowe) Maire & Weiller	Leġbiyra	Leaf	Powder	Food poisoning	(Idm'hand *et al.* 2020)
	Chenopodium acuminatum Willd.	Mkhinza	Whole plant	Decoction	Abdominal pain, cramps general	(Redouan *et al.* 2022)
	Chenopodium album L.	Amelgot	Seed	Decoction	Gastrointestinal disorders	(Hind *et al.* 2017)
	Dysphania ambrosioides (L.) Mosyakin & Clemants	Lmkhinza	Leaf, aerial part	Decoction, powder, juice, maceration	Intestinal gas, dysentery, diarrhea acute ache, digestion problems	(Belhaj & Zidane 2021, Es-Safi *et al.* 2020, Idm'hand *et al.* 2020)
	Salsola tetragona Delile.	Laarad	Leaf	Decoction	Stomach pain, heartburn	(Idm'hand *et al.* 2020)
	Spinacia oleracea L.	Sabanikh	Aerial part	Cooked	Gastric ulcer, promotes digestion.	(Belhaj & Zidane 2021)
Amaryllidaceae	*Allium cepa* L.	Lbsala	Bulb	Raw	Intestinal worms, acute ache, intestinal comfort, gastric ulcer, abdominal pain	(Belhaj & Zidane 2021, Es-Safi *et al.* 2020, Idm'hand *et al.* 2020, Redouan *et al.* 2022)
	Allium sativum L.	Thouma	Bulb	Raw, cooked	Intestinal worms, acute ache, digestion problems, diarrhea, hemorrhoids, constipation, abdominal pain, teeth	(Belhaj & Zidane 2021, Es-Safi *et al.* 2020, Idm'hand *et al.* 2020, Redouan *et al.* 2022)
Anacardiaceae	*Pistacia lentiscus* L	Drou – titek - tiwant	Leaf, fruit	Decoction, infusion, powder	Acute ache, digestion problems, gastric ulcer, teeth, gum symptom, complaint, constipation, abdominal pain	(Belhaj & Zidane 2021, Es-Safi *et al.* 2020, Hind *et al.* 2017, Redouan *et al.* 2022, Idm'hand, et *al.* 2020)
	Searsia albida (Schousb.) Moffett	Zewaya - neffis	Bark, leaf	Decoction, powder	Stomach pain, toothache	(Idm'hand *et al.* 2020)
	Searsia pentaphylla (Jacq.) F.A.Barkley	Tazart - Azaad	Fruit	Decoction	Diarrhea	(Belhaj & Zidane 2021)
	Searsia tripartita (Ucria) Moffett	Jdari	Leaf, bark	Decoction	Stomach pain, dyspepsia, heartburn, dysentery	(Idm'hand *et al.* 2020)
Apiaceae	*Ammi majus* L.	Tabllawt	Leaf, fruit	Decoction	Intestinal gas, dyspepsia, indigestion	(Belhaj & Zidane 2021, Redouan *et al.* 2022)

Ammi visnaga (L.) Lam	Bechnikha	Fruit	Decoction	Acute ache, digestion problems, flatulence, belching	(Es-Safi *et al.* 2020, Redouan *et al.* 2022)
Ammoides pusilla (Brot.) Breistr.	Nunkha	Aerial part	Decoction	Acute ache	(Es-Safi *et al.* 2020)
Ammodaucus leucotrichus Coss. Durieu	Kmoun reg	Seed	Decoction	Food poisoning, acute ache, digestion problems, bloating, intestinal gas, gastric ulcer, intestinal worms, intestinal gas	(Belhaj & Zidane 20212021, Es-Safi *et al.* 2020, Idm'hand *et al.* 2020)
Apium graveolens L.	Krafess	Aerial part	Juice	Acute ache, digestion problems	(Es-Safi *et al.* 2020)
Carum carvi L.	Lkrwiya	Seed	Powder, decoction	Intestinal worms, acute ache, digestion problems, bloating, intestinal gas, gastric ulcer	(Belhaj & Zidane 2021, Es-Safi *et al.* 2020, Idm'hand *et al.* 2020)
Coriandrum sativum L.	Kazbour	Leafy stem	Decoction	Intestinal diseases, acute ache, digestion problems, bloating	(Es-Safi *et al.* 2020, Idm'hand *et al.* 2020)
Cuminum cyminum L.	Lkmmoun	Seed	Powder	Dysentery, acute ache, digestion problems, bloating and Diarrhea	(Es-Safi *et al.* 2020, Idm'hand *et al.* 2020)
Daucus muricatus (L.) L.	Khizo berri	Root	Fresh	Abdominal pain	(Redouan *et al.* 2022)
Eryngium bourgatii Gouan	Alchuka zaraka	Leaf	Infusion	Constipation	(Redouan *et al.* 2022)
Eryngium glaciale Boiss.	Alchuka zaraka	Root	Decoction	Constipation	(Redouan *et al.* 2022)
Eryngium huteri Porta & Rigo	Alchuka zaraka	Root	Decoction	Constipation	(Redouan *et al.* 2022)
Foeniculum vulgare Mill.	Nafaa - besbass	Seed, fruit, root	Powder, decoction	Stomach pain, acute ache, digestion problems, intestinal comfort, bloating, intestinal gas, anorexia, intestinal diseases, flatulence, belching, irritable bowel syndrome, mouth, tongue, lip symptom, swallowing problem	(Belhaj & Zidane 2021, Es-Safi *et al.* 2020, Idm'hand *et al.* 2020, Redouan *et al.* 2022)
Kundmannia sicula (L.) DC.	Ziyata	Root	Decoction	Abdominal pain	(Redouan *et al.* 2022)
Petroselinum crispum (Mill.) Fuss	Maadnouss	Aerial part	Juice	Acute ache, constipation	(Es-Safi *et al.* 2020)

	Pimpinella anisum L.	Nafea	Seed	Powder, infusion	Acute ache, digestion problems, bloating, intestinal gas, gastric ulcer	(Belhaj & Zidane 2021, Es-Safi *et al.* 2020)
	Ridolfia segetum (L.) Moris	Tebche - slilo- slili	Seed, fruit, whole plant	Decoction, infusion	Gastric disorders, Dyspepsia, indigestion	(Belhaj & Zidane 2021, Redouan *et al.* 2022)
	Smyrnium olusatrum L.	Alhayar	Leaf	Powder	Abdominal pain	(Redouan *et al.* 2022)
	Stoibrax pomelianum (Maire) B.L.Burtt	Krafess berri	Fruit, flower, leaf	Powder, decoction	Abdominal pain	(Redouan *et al.* 2022)
Apocynaceae	*Caralluma europaea* (Guss.) N.E.Br.	Darmouss	Leaf	Decoction	Anorexia, indigestion.	(Belhaj & Zidane 2021)
	Nerium oleander L.	Ddefla	Leaf	Decoction	Teeth, gum symptom, complaint	(Redouan *et al.* 2022)
Araliaceae	*Hedera helix* L.	Lwwaya	Leaf	Infusion	Gastric ulcer	(Belhaj & Zidane 2021)
Aristolochiaceae	*Aristolochia fontanesii* Boiss. & Reut.	Tazert, berraztam	Roots	Decoction	Acute ache, digestion problems, constipation	(Es-Safi *et al.* 2020, Hind *et al.* 2017)
Arecaceae	*Chamaerops humilis* L.	Ddoum – Agaz	Fruit, leaf, flower	Raw, decoction	Gastric ulcer, digestive disorders	(Belhaj & Zidane 2021) (Hind, Anas et al. 2017, Redouan, Yebouk et al. 2022
	Phoenix dactylifera L.	Tmer	Fruit	Raw, powder	Diarrhea, constipation, stomach pain	(Idm'hand *et al.* 2020)
Asparagaceae	*Asparagus altissimus* Munby	Skkoum	Leaf	Decoction	Gastralgia	(Idm'hand *et al.* 2020)
Berberidaceae	*Berberis vulgaris* subsp. *australis* (Boiss.) Heywood	Argîs - izzirki	Leaf	Decoction	Gastric disorders	(Belhaj & Zidane 2021)
Boraginaceae	*Alkanna tinctoria* (L.) Tausch	Hourraisha elmalsa	Aerial part	Decoction	Abdominal pain	(Redouan *et al.* 2022)
	Heliotropium curassavicum L	Lehbalia	Leaf	Powder	Clean teeth, toothache	(Idm'hand *et al.* 2020)
Brassicaceae	*Brassica nigra* (L.) K.Koch	Bu-hammou	Aerial part	Infusion	Dastric ulcer, diarrhea	(Belhaj & Zidane 20212021)
	Brassica oleracea L.	Mkwwar	Leaf	Juice	Anorexia, gastric ulcer	(Belhaj & Zidane 2021)
	Raphanus raphanistrum subsp. *sativus* (L.) Domin	Lefjel	Seed	Raw	Gastric ulcer	(Belhaj & Zidane 2021)
Burseraceae	*Commiphora africana* (A.Rich.) Endl.	Oum nas	Gum	Powder	Toothache	(Idm'hand *et al.* 2020)
Cacataceae	*Opuntia ficus-indica* (L.) Mill.	Aknari	Flower, fruit	Raw, fresh	Intestinal diseases, stomach pain, Acute ache, digestion	(Es-Safi *et al.* 2020, Idm'hand *et al.* 2020, Redouan *et al.* 2022)

					problems, intestinal comfort, abdominal pain, diarrhea	
Cannabaceae	*Celtis australis* L.	Tagzaz	Fruit	Fresh	Diarrhea	(Redouan *et al.* 2022)
Capparaceae	*Capparis spinosa* L.	Lkbbar	Fruit, leaf	Decoction, powder	Dyspepsia	(Belhaj & Zidane 2021, Idm'hand *et al.* 2020)
	Maerua crassifolia Forssk.	Atil - Ssadra lkhadra	Leaf, bark	Decoction	Dyspepsia, indigestion, stomach pain, diarrhea, gastralgia, gingivitis	(Idm'hand *et al.* 2020)
Caryophyllaceae	*Gymnocarpos decandrus* Forssk.	Jefna	Leaf	Powder	Gastralgia	(Idm'hand *et al.* 2020)
Cistaceae	*Cistus albidus* L.	Shtappa	Leaf	Infusion	Dyspepsia, indigestion	(Redouan *et al.* 2022)
	Cistus creticus L.	Irgl	Leaf, seed	Decoction	Abdominal pain, gastric disorders	(Belhaj & Zidane 2021, Hind *et al.* 2017)
	Cistus populifolius L.	Irgl	Leaf	Decoction	Stomach pain	(Idm'hand *et al.* 2020)
Compositae	*Achillea millefolium* L.	Khala	Aerial part	Infusion	Gastric disorders, anorexia	(Belhaj & Zidane 2021)
	Anacyclus pyrethrum (L.) Lag.	Aerq chleuh - oud el atass	Aerial part, root	Decoction	Intestinal diseases, teeth	(Belhaj & Zidane 2021, Redouan *et al.* 2022)
	Artemisia absinthium L.	Chiba	Aerial part	Decoction, infusion	Digestion problems, intestinal comfort, worms	(Es-Safi *et al.* 2020, Redouan *et al.* 2022)
	Artemisia herba-alba Asso	Chih	Leaf, root	Decoction	Dysentery, heartburn, bad breath, intestinal worms, gastralgia, acute ache, digestion problems, intestinal comfort, intestinal diseases, gastrointestinal infection	(Belhaj & Zidane 2021, Es-Safi *et al.* 2020, Idm'hand *et al.* 2020, Redouan *et al.* 2022)
	Artemisia reptans C.Sm. ex Link	Chihia	Leafy stem	Powder	Gastralgia	(Idm'hand *et al.* 2020)
	Asteriscus graveolens (Forssk.) Less.	Tafsa	Leaf, stem	Powder, raw	Toothache, clean teeth	(Idm'hand *et al.* 2020)
	Brocchia cinerea (Delile) Vis.	Lgartofa - rabroba	Leaf	Decoction	Stomach pain	(Idm'hand *et al.* 2020)
	Carthamus tinctorius L.	Chouka el usfar	Flower	Decoction	Constipation	(Redouan *et al.* 2022)
	Centaurea acaulis L.	Taimart	Aerial part	Powder	Worms	(Redouan *et al.* 2022)
	Centaurea maroccana Ball	Tafgha	Root	Powder	Intestinal gas, gastric ulcer	(Belhaj & Zidane 2021)

	Centaurea pullata L.	Laltha	Root	Infusion	Abdominal pain	(Redouan *et al.* 2022)
	Chamaemelum nobile (L.) All.	Babounj	Fruit	Decoction	Acute ache, digestion problems, intestinal comfort, constipation	(Es-Safi *et al.* 2020)
	Cichorium intybus L.	Merrar	Leaf	Fresh	Abdominal pain	(Redouan *et al.* 2022)
	Cladanthus arabicus (L.) Cass.	Awerzit	Aerial part	Decoction	Abdominal pain	(Hind *et al.* 2017)
	Cynara cardunculus L.	Khorchof - taggua	Leaf	Decoction	Constipation	(Belhaj & Zidane 2021)
	Dittrichia viscosa (L.) Greuter	Tirrhilane	Aerial part	Decoction	Acute ache, digestion problems, abdominal pain	(Belhaj & Zidane 2021, Es-Safi *et al.* 2020, Redouan *et al.* 2022)
	Echinops glaberrimus DC.	Tasekra	Root	Decoction	Abdominal pain	(Redouan *et al.* 2022)
	Echinops spinosissimus Turra	Taskra	Rhizome	Decoction	Stomach disorders	(Hind *et al.* 2017)
	Glebionis coronaria (L.) Cass. ex Spach	Hmessou	Flower	Decoction	Intestinal gas	(Belhaj & Zidane 2021)
	Lactuca sativa L.	Khass	Leaf	Fresh	Abdominal pain	(Redouan *et al.* 2022)
	Launaea mucronata (Forssk.) Muschl.	Intrim	Aerial part	Decoction	Constipation, gastric ulcer	(Belhaj & Zidane 2021)
	Launaea nudicaulis (L.) Hook.f.	Talma	Aerial part	Powder	Abdominal pain	(Hind *et al.* 2017)
	Mantisalca salmantica (L.) Briq. & Cavill.	Thazmourth	Leaf	Infusion	Gastric disorders	(Belhaj & Zidane 2021)
	Matricaria chamomilla L.	Babounj, mansania	Leaf	Decoction, fresh	Indigestion, abdominal pain	(Idm'hand *et al.* 2020, Redouan *et al.* 2022)
	Picris asplenioides L.	Lhaydwan	Whole plant	Powder	Stomach pain, gastric ulcer	(Idm'hand *et al.* 2020)
	Pulicaria mauritanica Batt.	Bamghar	Aerial part	Decoction	Gastrointestinal desorders	(Hind *et al.* 2017)
	Saussurea costus Lipsch	Lkist lhandi	Root	Powder	Constipation	(Idm'hand *et al.* 2020)
	Scolymus hispanicus L.	Takot - Afezdad	Leaf	Cooked	Icterus, worms, other parasites	(Hind *et al.* 2017, Redouan *et al.* 2022)
	Scolymus maculatus L.	Ezzarnij	Leaf	Cooked	Irritable bowel syndrome	(Redouan *et al.* 2022)
Cucurbitaceae	*Citrullus colocynthis* (L.) Schrad.	Lhdej	Seed, fruit	Suppository, decoction	Dysentery, toothache	(Idm'hand *et al.* 2020)

	Cucurbita maxima L.	Lgraa	Seed	Powder	Intestinal worms	(Idm'hand *et al.* 2020)
Cupressaceae	*Juniperus communis* L.	Elaraar - amzi	Leaf	Infusion	Gastric disorders	(Belhaj & Zidane 2021)
	Tetraclinis articulata (Vahl) Mast.	Aaraar - azoka	Leaf, powder	Decoction, maceration	Stomach pain, gastric folds, diarrhea, abdominal pain and digestive disorders	(Hind *et al.* 2017, Idm'hand *et al.* 2020, Redouan *et al.* 2022)
Cynomoriaceae	*Cynomorium coccineum* L.	Tertout	Stem	Powder, decoction	Stomach pain, intestinal diseases, dysentery	(Idm'hand *et al.* 2020)
Ephedraceae	*Ephedra fragilis* Desf.	Amater	Aerial part	Decoction	Intestinal diseases	(Hind *et al.* 2017)
Ericaceae	*Arbutus unedo* L.	Assanu - boukhanno	Root, fruit	Decoction	Acute ache, digestion problems, diarrhea	(Belhaj & Zidane 2021, Es-Safi *et al.* 2020, Redouan *et al.* 2022)
Euphorbiaceae	*Croton tiglium* L.	Habbet melka	Seed	Decoction	Constipation	(Idm'hand *et al.* 2020)
	Euphorbia officinarum subsp. echinus (Hook. f. & Coss.) Vindt	Dghmouss	Stem	Powder, brut	Intestinal worms, dysentery, toothache	(Idm'hand *et al.* 2020)
	Mercurialis annua L.	Hourraiqa elmalsa	Whole plant	Infusion	Constipation	(Redouan *et al.* 2022)
	Ricinus communis L.	Kherwaa	Seed	Infusion	Constipation	(Redouan *et al.* 2022)
Fagaceae	*Quercus rotundifolia* Lam.	Abouhou - kerrouch - elJarb	Bark	Powder, decoction	Hemorrhoids, diarrhea	(Belhaj & Zidane 2021, Redouan *et al.* 2022)
	Quercus suber L.	Edlem - elballot	Bark	Powder	Gastrointestinal infection, abdominal pain	(Redouan *et al.* 2022)
Gentianaceae	*Centaurium erythraea* Rafn	Qussat el haiya	Aerial part	Infusion	Abdominal pain	(Redouan *et al.* 2022)
	Centaurium spicatum (L.) Fritsch	Gosset elhayya	Aerial part	Decoction	Gastric disorders	(Belhaj & Zidane 2021)
Iridaceae	*Crocus sativus* L.	Zaafaran	Stigmas	Infusion	Indigestion, dyspepsia, liver disease	(Belhaj & Zidane 2021, Redouan *et al.* 2022)
Juglandaceae	*Juglans regia* L.	Swak	Nuts, bark	Decoction	Bad breath, gingivitis, abdominal pain, teeth, gum symptom, complaint	(Idm'hand *et al.* 2020, Redouan *et al.* 2022)
Juncaceae	Juncus maritimus Lam.	Azmma	Seed	Powder, decoction	Stomach pain, constipation	(Hind *et al.* 2017)

Lamiaceae	*Ajuga chamaepitys* (L.) Schreb.	Sendgura	Whole plant	Decoction	Abdominal pain	(Redouan *et al.* 2022)
	Ajuga iva (L.) Schreb.	Chendgura	Leaf, aerial part, whole plant	Powder, decoction, maceration	Intestinal diseases, acute ache, digestion problems, diarrhea, dyspepsia	(Belhaj & Zidane 2021, Es-Safi *et al.* 2020, Idm'hand *et al.* 2020, Redouan *et al.* 2022)
	Ballota hirsuta Benth.	Merrouwt - warissma	Stem, aerial part	Decoction, infusion, vaporization	Gastric disorders, icterus	(Belhaj & Zidane 2021, Hind *et al.* 2017)
	Clinopodium nepeta subsp. *glandulosum* (Req.) Govaerts	Manta	Aerial part	Infusion	Intestinal diseases	(Belhaj & Zidane 2021)
	Lamium amplexicaule L.	Merrouwt tabldite	Leaf	Decoction	Diarrhea	(Belhaj & Zidane 2021)
	Lavandula angustifolia Mill.	Lokhzama	Aerial part, leaf, flowery summit	Decoction, infusion	Acute ache, digestion problems, intestinal comfort, abdominal pain, teeth, gum symptom, complaint	(Es-Safi *et al.* 2020, Redouan *et al.* 2022)
	Lavandula dentata L.	Lokhzama beldiya	Leafy stem, flowery summit	Decoction	Bad breath, liver disease, gastrointestinal infection	(Idm'hand *et al.* 2020, Redouan *et al.* 2022)
	Lavandula maroccana Murb.	Iguiz	Flower	Infusion	Indigestion	(Belhaj & Zidane 2021)
	Lavandula multifida L.	Lokhzama - igaz	Aerial part, leaf	Decoction, iinfusion	Acute ache, digestion problems, intestinal comfort, gastrointestinal disorders	(Es-Safi *et al.* 2020, Hind *et al.* 2017)
	Lavandula stoechas L.	Lokhzama, Alhalhal	Aerial part	Decoction	Acute ache, digestion problems, intestinal comfort, dyspepsia	(Es-Safi *et al.* 2020, Redouan *et al.* 2022)
	Marrubium vulgare L.	Meriwta - merrîw	Aerial part, leaf, stem	Decoction, infusion,	Acute ache, indigestion problems, intestinal gas, abdominal pain, cramps general, stomach function disorder, teeth, gum symptom, complaint	(Belhaj & Zidane 2021, Es-Safi *et al.* 2020, Redouan *et al.* 2022)
	Melissa officinalis L.	Naana atrunji	Whole plant	Infusion	Stomach function disorder, dyspepsia, indigestion, abdominal pain, cramps	(Redouan *et al.* 2022)

				general	
Mentha piperita L.	Naanaa beldi	Whole plant	Infusion	Stomach function disorder	(Redouan *et al.* 2022)
Mentha pulegium L.	Fliou	Aerial part, leaf, stem	Decoction, infusion	Acute ache, digestion problems, intestinal comfort, dyspepsia/indigestion, abdominal pain	(Es-Safi *et al.* 2020, Redouan *et al.* 2022)
Mentha rotundifolia (L.) Huds.	Mchichtro	Aerial part, leaf, stem	Decoction, infusion	Flatulence, gas, belching, abdominal pain	(Redouan *et al.* 2022)
Mentha spicata L.	Naanaa	Aerial part	Infusion	Worms, other parasites	(Redouan *et al.* 2022)
Mentha suaveolens Ehrh.	Timija - mchichtro	Leaf, aerial part	Decoction, infusion	Toothache, abdominal pain	(Idm'hand *et al.* 2020, Redouan *et al.* 2022)
Ocimum basilicum L.	Lahbaq	Leaf	Infusion, decoction, fresh	Constipation, intestinal comfort, diarrhea, mouth, tongue, lip symptom	(Belhaj & Zidane 2021, Es-Safi *et al.* 2020, Idm'hand *et al.* 2020, Redouan *et al.* 2022)
Origanum compactum Benth.	Zaatar - azokni	Leaf, aerial part	Decoction, infusion	Food poisoning, gastric ulcer, intestinal gas, acute ache, digestion problems, intestinal comfort, teeth, gum symptom, complaint, abdominal plaint, diarrhea	(Belhaj & Zidane 2021, Es-Safi *et al.* 2020, Idm'hand *et al.* 2020, Redouan *et al.* 2022)
Origanum elongatum (Bonnet) Emb. & Maire	Zaatar	Aerial part	Infusion	Dyspepsia, indigestion	(Redouan *et al.* 2022)
Origanum majorana ***L.***	Merdedouch	Aerial part	Decoction, infusion	Acute ache, digestion problems, intestinal comfort, intestinal gas, abdominal pain	(Es-Safi *et al.* 2020, Redouan *et al.* 2022)
Origanum vulgare L.	Assahtar	Aerial part	Decoction	Abdominal pain, dyspepsia, indigestion, flatulence, gas, belching	(Redouan *et al.* 2022)
Rosmarinus officinalis L.	Azir	Leaf, aerial part, stem	Decoction	Intestinal gas, constipation, gastralgias, acute ache, digestion problems, intestinal comfort, mouth, tongue, lip symptom, abdominal pain	(Belhaj & Zidane 2021, Es-Safi *et al.* 2020, Idm'hand *et al.* 2020, Redouan *et al.* 2022)
Salvia officinalis L.	Salmia	Leaf	Decoction, infusion, fresh	Acute ache, digestion problems, intestinal comfort, intestinal gas, teeth, gum	(Belhaj & Zidane 2021, Es-Safi *et al.* 2020, Redouan *et al.* 2022)

					symptom, complaint, flatulence, gas, belching	
	Teucrium polium L.	Jiida	Aerial part	Decoction	Diarrhea, indigestion, abdominal pain, liver disease	(Belhaj & Zidane 2021, Hind *et al.* 2017, Redouan *et al.* 2022)
	Thymbra capitata (L.) Cav.	Zaitra	Leaf, flowery summit	Decoction	Stomach function disorder	(Redouan *et al.* 2022)
	Thymus algeriensis Boiss. & Reut.	Zaitra	Leaf, flowery summit	Infusion	Stomach function disorder	(Redouan *et al.* 2022)
	Thymus broussonetii Boiss.	Zaitra, Tazoknit	Leaf	Decoction	Gastralgias	(Idm'hand *et al.* 2020)
	Thymus capitellatus Hoffmanns. & Link	Zaitra	Leaf, flowery summit	Decoction	Stomach function disorder	(Redouan *et al.* 2022)
	Thymus maroccanus Ball	Azokni	Leaf	Maceration	Gastric ulcer	(Belhaj & Zidane 2021)
	Thymus satureioides Coss. & Ball.	Azokni	Leaf	Decoction	Gastric ulcer, intestinal gas	(Belhaj & Zidane 2021)
	Thymus vulgaris L.	Zaitra	Aerial part	Decoction, infusion	Acute ache, digestion problems, intestinal comfort, gastric ulcer	(Belhaj & Zidane 2021, Es-Safi *et al.* 2020)
	Thymus willdenowii Boiss.	Zaitra	Leaf	Decoction	Teeth, gum symptom, complaint, mouth, tongue, lip disease, stomach function disorder, diarrhea, abdominal pain	(Redouan *et al.* 2022)
Lauraceae	*Laurus nobilis* L.	Ourak moussa - errand	Leaf	Infusion, decoction	Intestinal diseases, teeth, gum symptom, complaint, mouth, tongue, lip symptom, dyspepsia, indigestion	(Belhaj & Zidane 2021, Redouan *et al.* 2022)
Leguminosae	*Acacia nilotica* (L.) Delile	Sllaha	Fruit	Powder, decoction	Toothache, Stomach pain, bad breath, gingivitis	(Idm'hand *et al.* 2020)
	Acacia senegal (L.) Willd.	Aalelk	Gum	Decoction	Indigestion	(Idm'hand *et al.* 2020)
	Acacia tortilis (foressk) Hayne	Talh	Leaf	Decoction	Gastralgia, intestinal diseases, diarrhea	(Idm'hand *et al.* 2020)
	Anagyris foetida L	Foul Eddib - harrub lhanzir	Seed	Decoction	Constipation	(Redouan *et al.* 2022)

	Ceratonia siliqua L.	Kharroub	Fruit	Powder, decoction	Stomach pain, dysentery, gastric ulcer, intestinal diseases, food poisoning, acute ache, digestion problems, bloating and diarrhea	(Belhaj & Zidane 2021, Es-Safi *et al.* 2020, Idm'hand *et al.* 2020, Redouan *et al.* 2022)
	Cicer arietinum L.	Lhomms	Seed	Powder	Indigestion, gastric ulcer	(Belhaj & Zidane 2021)
	Glycyrrhiza glabra L.	Erk souss	Root	Decoction, infusion	Acute ache, intestinal confort, gastric ulcer, abdominal pain	(Belhaj & Zidane 2021, Es-Safi *et al.* 2020, Redouan *et al.* 2022)
	Lupinus angustifolius L.	Termas	Seed	Decoction	Worms, other parasites, abdominal pain, diarrhea	(Redouan *et al.* 2022)
	Ononis natrix L.	Afezdad	Leaf	Cooked	Icterus	(Hind *et al.* 2017)
	Scorpiurus muricatus L.	Eluguif	Leaf	Infusion	Diarrhea	(Redouan *et al.* 2022)
	Senna alexandrina Mill.	Sana - Falajit	Leaf	Decoction	Constipation, acute ache, digestion problems	(Es-Safi *et al.* 2020, Idm'hand *et al.* 2020)
	Trigonella foenum-graecum L.	Lhelba – tifidas	Seed	Powder, decoction, maceration, infusion	Stomach pain, acute ache, digestion problems, intestinal comfort, bloating, diarrhea, anorexia, abdominal pain	(Belhaj & Zidane 2021, Es-Safi *et al.* 2020, Hind *et al.* 2017, Idm'hand *et al.* 2020, Redouan *et al.* 2022)
	Vicia faba L.	Foul	Seed	Cooked	Abdominal paint	(Redouan *et al.* 2022)
	Vicia sativa L.	Kurfalla	Seed	Cooked	Abdominal paint	(Redouan *et al.* 2022)
Linaceae	*Linum usitatissimum* L.	Zeriat el Ketan	Seed	Powder	Acute ache, digestion problems, intestinal comfort, against bloating and diarrhea	(Es-Safi *et al.* 2020)
Lythraceae	*Lawsonia inermis* L.	Lhenna	Leaf	Decoction	Food poisoning	(Idm'hand *et al.* 2020)
	Punica granatum L.	Rman	Bark	Powder, decoction	Stomach pain, acute ache, digestion problems, against diarrhea, mouth, tongue, lip symptom, abdominal paint	(Belhaj & Zidane 2021, Es-Safi *et al.* 2020, Idm'hand *et al.* 2020, Redouan *et al.* 2022)
Malvaceae	*Adansonia digitata* L.	Tajmakht - taghiya	Leaf, fruit	Powder, infusion	Gastralgia, intestinal diseases, diarrhea, heartburn	(Idm'hand *et al.* 2020)
	Althaea officinalis L.	Khatmiya	Root	Decoction, infusion	Ulcère, intestinaux diarrhée	(Belhaj & Zidane 2021)

	Hibiscus sabdariffa L.	Bissam - lkrkadi	Chalices of flowers	Infusion	Dyspepsia, intestinal worms	(Idm'hand *et al.* 2020)
	Malva parviflora L.	Amzgra	Aerial part	Cooked	Constipation	(Belhaj & Zidane 2021)
	Malva sylvestris L.	Lkhobbiza	Leaf	Cooked	Diarrhea	(Idm'hand *et al.* 2020)
Molluginaceae	*Corrigiola litoralis* L.	Serghina	Root	Decoction	Acute ache, digestion problems	(Es-Safi *et al.* 2020)
Moraceae	*Ficus carica* L.	Chriha	Fruit	Decoction	Constipation	(Idm'hand *et al.* 2020)
Musaceae	*Musa paradisiaca* L.	Lbanan	Bark	Poultice	Clean teeth	(Idm'hand *et al.* 2020)
Myrtaceae	*Eucalyptus globulus* Labill	Lkalitos	Leaf	Powder	Stomach pain	(Idm'hand *et al.* 2020)
	Myrtus communis L.	Rihane	Leaf	Decoction	Food poisoning, acute ache, digestion problems, intestinal comfort, diarrhea, abdominal pain	(Es-Safi *et al.* 2020, Idm'hand *et al.* 2020, Redouan *et al.* 2022)
	Syzygium aromaticum (L.) Merr. & L.M. Perry	Qranfel	Clove, seed	Powder, decoction	Toothache, indigestion, bad breath, teeth, gum symptom, complaint, mouth, tongue, lip symptom, abdominal pain	(Idm'hand *et al.* 2020, Redouan *et al.* 2022)
Oleaceae	*Fraxinus angustifolia* Vahl	Dardar	Seed	Powder	Liver disease	(Redouan *et al.* 2022)
	Olea europaea L.	Zitoun	Fruit, leaf	Raw, oil, decoction	Constipation, acute ache, digestion problems, intestinal comfort, gastrointestinal infection	(Es-Safi *et al.* 2020, Idm'hand *et al.* 2020, Redouan *et al.* 2022)
	Phillyrea latifolia L.	Metwal	Bark	Decoction	Abdominal pain	(Redouan *et al.* 2022)
Papaveraceae	*Fumaria officinalis* L.	Lwarda dlard	Root	Decoction	Gastric disorders,	(Es-Safi *et al.* 2020)
	Papaver rhoeas L.	Belaaman	Seed	Powder	Acute ache, gastric disorders	(Belhaj & Zidane 2021, Es-Safi *et al.* 2020)
Pinaceae	*Cedrus libani* A.Rich.	Kdran	Stem	Resin	Toothache	(Idm'hand *et al.* 2020)
Piperaceae	*Piper cubeba* (L.) F.	Alkabbaba	Seed	Powder	Acute ache, digestion problems	(Es-Safi *et al.* 2020)
Plantaginaceae	*Globularia alypum* L.	Taslgha	Flower	Infusion	Gastric ulcer	(Belhaj & Zidane 2021)
	Plantago albicans L.	Illoman	Aerial part	Powder	Abdominal pain	(Hind *et al.* 2017)
Plumbaginaceae	*Limonium sinuatum* (L.) Mill.	Lgarsa	Leaf	Decoction	Indigestion	(Idm'hand *et al.* 2020)
Poaceae	*Avena sterilis* L.	Askoune	Fruit	Raw	Gastric disorders	(Belhaj & Zidane 2021)
	Cynodon dactylon (L.) Pers.	Njem	Rhizome	Decoction	Diarrhea	(Idm'hand *et al.* 2020)

	Hordeum vulgare L.	Zraa	Seed	Powder, poultice, decoction	Diarrhea, stomach pain, dyspepsia	(Idm'hand *et al.* 2020)
	Panicum miliaceum L.	Tafsout	Seed	Decoction	Indigestion	(Belhaj & Zidane 2021)
	Panicum turgidum Forssk.	Oum rokba	Leaf	Decoction	Diarrhea	(Idm'hand *et al.* 2020)
	Zea mays L.	Zghb lkbal	Stigma	Decoction	Stomach pain, diarrhea	(Idm'hand *et al.* 2020)
Polygonaceae	*Emex spinosa* (L.) Campd.	Houmaida	Seed	Infusion, decoction	Diarrhea, abdominal pain, rectal, anal pain	(Redouan *et al.* 2022)
	Rumex acetosa L.	Houmaida	Seed	Infusion, decoction	Flatulence, gas, belching, diarrhea, abdominal pain	(Redouan *et al.* 2022)
	Rumex bucephalophorus L.	Houmaida	Seed	Decoction	Diarrhea, abdominal pain	(Redouan *et al.* 2022)
	Rumex pulcher L.	Houmaida	Seed	Decoction, infusion	Diarrhea, abdominal pain, dyspepsia, indigestion	(Redouan *et al.* 2022)
Pteridaceae	*Adiantum capillus-veneris* L.	Chaar lghol, kuzbur lbir	Aerial part	Decoction	Abdominal pain	(Redouan *et al.* 2022)
Ranunculaceae	*Clematis flammula* L.	Annar albarda	Leaf	Decoction	Abdominal pain	(Redouan *et al.* 2022)
	Delphinium pentagynum Lam.	Habbet ras	Leaf	Decoction	Diarrhea	(Belhaj & Zidane 2021)
	Nigella sativa L.	Sanouj	Seed	Raw	Acute ache, digestion problems, intestinal comfort, bloating, diarrhea	(Belhaj & Zidane 2021, Es-Safi *et al.* 2020)
	Ranunculus bullatus L.	Mrniss - wdan lhalouf	Leaf	Infusion	Gastric disorders	(Belhaj & Zidane 2021)
Resedaceae	*Reseda alba* L.	Tabaddit	Leaf	Infusion	Diarrhea	(Belhaj & Zidane 2021)
Rhamnaceae	*Ziziphus lotus* (L.) Lam.	Ssder - Nbeg	Fruit, leaf	Powder, decoction	Stomach pain, acute ache, digestion problems, intestinal comfort, bloating, anorexia, diarrhea, gastric ulcer	(Belhaj & Zidane 2021, Es-Safi *et al.* 2020, Idm'hand *et al.* 2020)
Rosaceae	*Crataegus monogyna* Jacq.	Admam	Flower	Infusion	Diarrhea	(Redouan *et al.* 2022)
	Cydonia oblonga Mill.	Sferjel	Leaf, fruit	Friction, cooked	Hemorrhoids, teeth, gum symptom, abdominal pain, diarrhea	(Belhaj & Zidane 2021, Redouan *et al.* 2022)
	Prunus armeniaca L.	Lmchmach	Fruit	Powder	Diarrhea, gastric ulcer	(Belhaj & Zidane 2021)
	Prunus domestica L.	Lbrkouk	Leaf	Decoction	Constipation	(Belhaj & Zidane 2021)

	Prunus dulcis (Mill.) D.A.Webb	Lawz	Fruit	Fresh	Diarrhea	(Redouan *et al.* 2022)
	Rosa canina L.	Lward	Flower	Decoction	Constipation, diarrhea	(Belhaj & Zidane 2021, Idm'hand *et al.* 2020)
	Rosa centifolia L.	Lward	Flower	Decoction	Gastric disorders	(Belhaj & Zidane 2021)
	Rosa × damascena Herrm.	Lward	Fruit	Raw	Intestinal comfort	(Es-Safi *et al.* 2020)
	Sanguisorba minor Scop.	Faggouss laklab	Aerial part	Infusion	Intestinal gas, gastric disorders	(Belhaj & Zidane 2021)
Rutaceae	*Citrus limon* (L.) Osbeck	Laymon el beldi	fruit	Juice	Abdominal pain	(Redouan *et al.* 2022)
	Ruta graveolens L.	Lfijel	Root	Decoction	Indigestion	(Belhaj & Zidane 2021)
Schisandraceae	*Illicium verum* Hook.f.	Lbadiane	Seed	Decoction	Acute ache, digestion problems	(Es-Safi *et al.* 2020)
Scrophulariaceae	*Scrophularia canina* L.	Wijjan	Aerial part	Decoction	Constipation	(Hind *et al.* 2017)
Solanaceae	*Lycium intricatum* Boiss.	Lghardag	Leaf	Decoction	Stomach pain, intestinal diseases	(Idm'hand *et al.* 2020)
	Solanum americanum Mill.	Adil nouchn	Leaf	Decoction	Gastric ulcer	(Belhaj & Zidane 2021)
Tamaricaceae	*Tamarix gallica* s.l.	Tarfa	Leaf	Decoction	Stomach pain, food poisoning	(Idm'hand *et al.* 2020)
Thymelaeaceae	*Daphne gnidium* L.	Lezzaz - metnan	Leaf	Decoction	Teeth, gum Symptom, complaint	(Redouan *et al.* 2022)
	Thymelaea antiatlantica Maire	Anawt	Latex	Uncooked	Constipation	(Hind *et al.* 2017)
Urticaceae	*Parietaria mauritanica* Durieu	Herrast lehjar	Leaf	Poultice	Hemorrhoids, gastric ulcer	(Belhaj & Zidane 2021)
Verbenaceae	*Aloysia citriodora* Palau	Lwiza	Leaf	Decoction, infusion	Intestinal comfort, intestinal diseases, dyspepsia	(Belhaj & Zidane 2021, Es-Safi *et al.* 2020, Redouan *et al.* 2022)
Vitaceae	*Vitis vinifera* L.	Laanab - addelya	Leaf	Poultice, decoction	Hemorrhoids, abdominal pain	(Belhaj & Zidane 2021, Redouan *et al.* 2022)
Zingiberaceae	*Alpinia officinarum* Hance	Khoulandjan	Root	Powder	Gastric disorders, anorexia	(Belhaj & Zidane 2021)
	Elettaria cardamomum (L.) Maton	Qaaqolla	Seed	Decoction	Acute ache, digestion problems	(Es-Safi *et al.* 2020)
	Zingiber officinale Roscoe	Skinjbir	Rhizome	Powder, infusion	Dysentery, dyspepsia, indigestion, abdominal pain	(Idm'hand *et al.* 2020, Redouan *et al.* 2022)

Zygophyllaceae	*Tetraena gaetula* (Emb. & Maire) Beier & Thulin	Laagaya	Stem	Powder	Intestinal diseases, gastralgia	(Idm'hand *et al.* 2020)

Distribution of medicinal plants

A total of 216 plant species belonging to 65 families were reported as being used in the treatment of gastrointestinal diseases in Morocco. Among plant families, Lamiaceae had the highest number of species followed by Compositae, Apiaceae, Leguminosae, Amaranthaceae and Rosaceae (Figure 2).

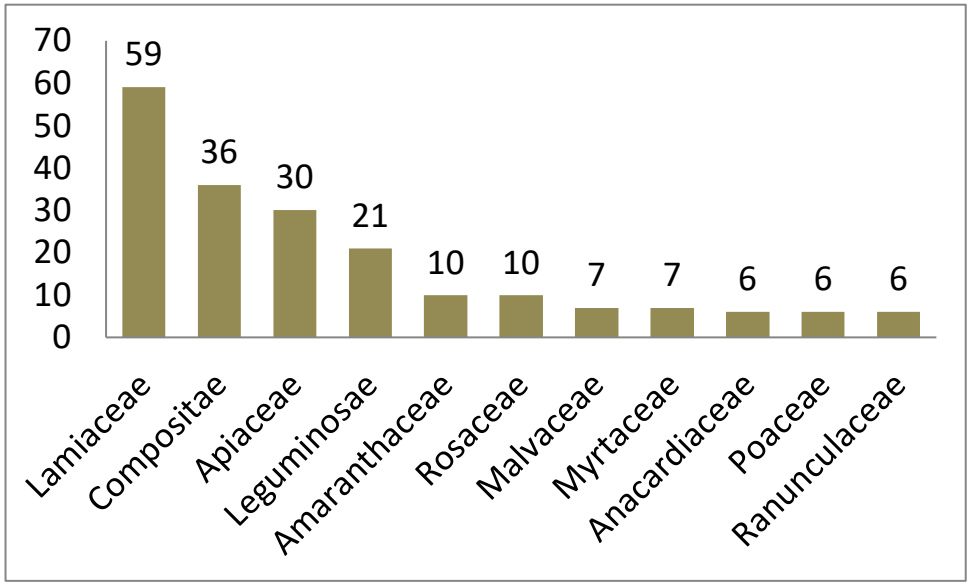

Figure 2. Ethnomedicinal plant species distribution among botanical families

Plant part used and modes of preparation

Our review of the literature showed that indigenous peoples used 17 parts of plants namely aerial part, bark, bulb, flower calyxes, clove, flower, fruit, gum, latex, leaf, nut, rhizome, root, seed , stem, stigma and whole plant. They are used to treat gastrointestinal diseases, but with a certain preference for the leaves (figure 3). Several operating methods are used by the population to create medicinal formulations (cooked, decoction, fresh, infusion, juice, maceration, poultice, powder, raw and suppository). However, extractions by decoction, powder or infusion remain the most common processes (figure 4).

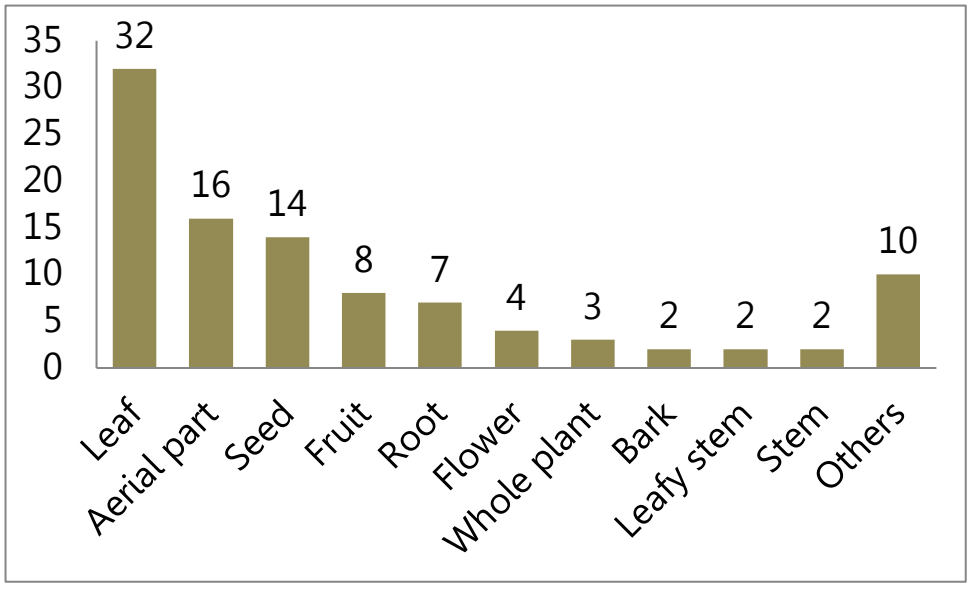

Figure 3. Plant parts used in herbal preparations (%)

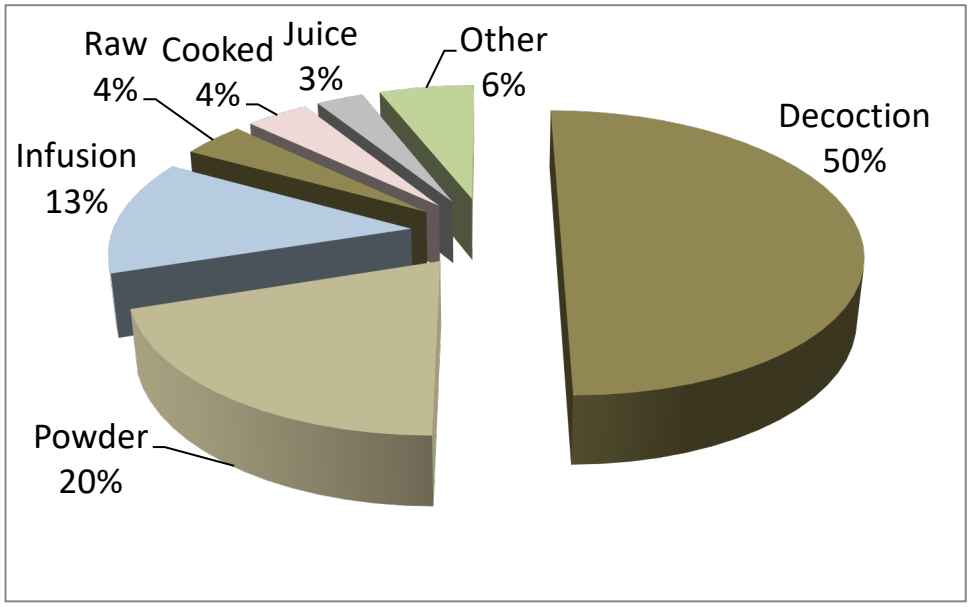

Figure 4. Modes of preparation (%)

Pharmacological and phytochemical studies

The results of the pharmacological studies and phytochemical analysis are presented in Table 2. It appears from the analysis of this table that several large groups of chemical compounds are characterized in these plants. These are mainly flavonoids, alkaloids, essential oils, tannins, steroids and terpenes. These chemical substances give plants pharmacological properties making it possible to treat conditions recognized as being at the origin of these diseases which affect the digestive tract. The chemical constituents and pharmacological properties of the most used species are discussed below.

Trigonella foenum-graecum L. (Family Leguminosae), commonly known as Fenugreek, is widely grown medicinal plant throughout the world. The seeds and oils of this plant have gained attention for their potential applications in the treatment and prevention of a wide range of diseases. Phytochemical investigations on Fenugreek have revealed the presence of various phytochemicals including galactomannan, diosgenin, 4-hydroxyisoleucene, 3-hydroxy-4, 5-dimethyl-2(5H) furanone, tryptophan, lysine, alkaloids, flavonoids, free amino acids, saponins, glycosides, vitamins, minerals, mucilage, proteids and volatile oils.Various biological activities of *Trigonella foenum-graecum* have been extensively studied like antidiabetic, immunomodulatory, antioxidant, chemopreventive, antimicrobial, anticancer, gastroprotective, anti-inflammatory, antipyretic, analgesic, neuropharmacological, anthelmintic, anti-plasmodial, hypocholesterolemic and urotoxicity activities (Arunabha 2019, Yadav *et al.* 2019).

The antiulcer activity of the methanol extract of Fenugreek leaves was tested against stress-induced ulcers in rats. The antiulcer effect of the plant has been compared with omeprazole. The leaf extract caused a significant reduction in ulcer score showing protection against ulcer. The gastroprotective effect of the plant was confirmed by histopathological studies, which showed the prevention of mucosal lesions and submucosal edema in the stomach in comparison with untreated and omeprazole-treated rats. Histopathological studies showed that treatment of rats with this extract caused prevention of mucosal lesions and submucosal edema in the stomach, confirming the gastroprotective effect of the plant (Anand SC *et al.* 2012).

The gastroprotective activity of aqueous and ethanolic extracts of seeds of *Trigonella foenum-graecum* on gastric ulcer induced by ethanol was studied in experimental rats. The extracts showed a very significant prevention ($P<0.001$) of gastric ulcer affirming that the plant has gastroprotective properties (Afroz *et al.* 2017).

The antidiarrheal effect of the aqueous extract of the whole plant of Fenugreek was studied using the castor induced diarrheal model. The aqueous extract significantly decreased the average weight of feces compared to the control indicating that the plant has anti-diarrheal activity as claimed in these traditional uses (Boyina *et al.* 2014).

A study by Kheirandish et al. showed the protective effect of *Trigonella foenum graecum* on experimental intestinal ischemia/reperfusion injury in rats. Fenugreek seed extract protected the intestinal mucosa from experimentally induced damage in rats (Kheirandish *et al.* 2011).

Pistacia lentiscus L., commonly known as lentisk or mastic tree, is a shrub or small tree in the Anacardiaceae plant family native to the Mediterranean basin. It has been reported that lentisk is a valuable medicinal plant with potential to cure many human diseases. There are many chemical constituents in *Pistacia lentiscus*, including banillic acid, gallic acid trans-cinnamomic acid, isomasticadienonic acid, masticadienolic acid, moronic acid, oleanolic acid, oleanolic aldehyde, p-hydroxy-benzoic acid, p-hydroxy-phenylacetic acid, tirucallol and tyrosol. Many scientists have shown various biological and pharmacological effects of this plant, especially antibacterial, anti-inflammatory, antioxidant, anti-ulcer, anti-diabetic, cardioprotective and anti-cancer properties (Pachi *et al.* 2020, Soulaidopoulos *et al.* 2022).

The antimicrobial and antioxidant activities of lentisk leaf extracts were tested against eight bacteria, five molds and yeasts. The study revealed strong antifungal activity and considerable antibacterial activity. *In vit*ro, extracts of phenolic compounds also showed high reducing activity and scavenging activity for superoxide anion (Nabila *et al.* 2008).
The antibacterial and antifungal activities of *Pistacia lentiscus* fruit oil has been tested against many bacteria and yeasts using the disk diffusion method. The results showed positive activities of the fruit oil against all species tested with maximum antibacterial effect against *Staphylococcus aureus* and *Pseudomonas aeruginosa* and maximum antifungal effect against *Candida parapsilosis* (Dhieb *et al.* 2021).

The effects of *Pistacia lentiscus* resin have been tested on intestinal damage and inflammation in trinitrobenzene sulfonic acid-induced colitis. Daily oral administration of 100 mg of powder caused a decrease in all inflammatory cytokines ($P \leq .05$), thus suggesting that this plant could have a role in the treatment of Crohn's disease (Gioxari *et al.* 2011).

The anti-inflammatory effect of oil extracted from the ripe fruit of *Pistacia lentiscus* was evaluated on colitis induced in rats by instillation of 2,4,6-trinitrobenzenesulfonic acid. The oil showed a protective effect on intestinal inflammation in rats with disappearance of erosion and decreased of cryptitis (Naouar *et al.* 2016).

The anti-ulcerogenic activity of the fatty oil of mastic tree was tested on gastric ulcers induced by ethanol in Wistar rats. Oral administration of the fatty oil significantly reduced ulcerated and hemorrhagic areas, thus confirming the prophylactic and therapeutic effects of this plant against gastric ulcers (Boutemine *et al.* 2018).

Conclusions

This review is the first work that explicitly highlights the knowledge of plants used in the treatment of digestive problems in Morocco. Detailed information on the 216 inventoried plant species has been carefully recorded and analyzed to accurately preserve knowledge about the various therapeutic uses of these plants. The large number of medicinal species used to treat gastrointestinal disorders shows the importance of herbal medicine for the Moroccan population, especially the older generations who have retained a wide know-how. Nevertheless, a large number of the plants listed have not yet been the subject of scientific studies in the laboratory to experimentally evaluate their biological potential against diseases of the digestive system. On the other hand, certain plants are used without taking into account problems of toxicity and/or interactions. Therefore, it is urgent to carry out other pharmacological and toxicological studies on the compounds present in the plants that we have cited in order to determine their place in the treatment of gastrointestinal diseases.

Declarations

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Table 2. Pharmacological activities and chemical constituents of the most used medicinal species

Species	Pharmacological activities	Known chemical constituents	References
Ajuga iva (L.) Schreb.	Antidiabetic, antioxidant, antimicrobial, anti-hypercholesterolemia, hypolipidemic , insecticide and litholitic effects	20-hydroxyecdysone, cyasterone, ajugasterone, apigenin dihexoside, apigenin, carvacrol, ecdysterone and palmitic acid	(Bouyahya *et al.* 2020a, El-Hilaly *et al.* 2006)
Allium cepa L.	Antimicrobial, antioxi-dant, analgesic, anti-inflammatory, anti-diabetic, hypolipidemic, anti-hypertensive, and immunopro-tective effects	Flavonoids such as quercetin and kaempferol, alk(en)yl cysteine sulfoxides including S-methyl cysteine sulfoxide and S-propyl cysteine sulfoxide, cycloalliin, thiosulfinates, and sulfides are main compounds existing in the plant.	(Galavi *et al.* 2021, Teshika *et al.* 2019)
Allium sativum L.	Antioxidant, anti-inflammatory, antibacterial, antifungal, immunomodulatory, cardiovascular protective, anticancer, hepatoprotective, digestive system protective, anti-diabetic, anti-obesity, neuroprotective, and renal protective properties	Sulfur-containing phytoconstituents such as alliin, allicin, ajoenes, vinyldithiins, and flavonoids such as quercetin	(El-Saber Batiha *et al.* 2020, Shang *et al.* 2019)
Ammodaucus leucotrichus Coss. Durieu	Antioxidant, antibacterial, antifungal, antidiabetic, anti-inflammatory, anticholinesterase and cytotoxicity activities	Monoterpenes and their derivatives, sesquiterpenes and their derivatives, tannins, anthracenes compounds, sterols, triterpenes, reducing compounds, alkaloids, phenol acids, saponins, flavonoids and coumarins	(Idm'hand *et al.* 2020, Manssouri *et al.* 2020)
Arbutus unedo L.	Antibiotic, antifungal, antiparasitic, antiaggregant, antidiabetic, antihypertensive, anti-inflammatory, antitumoral, antioxidant, and spasmolytic properties	Flavonoids, tannins, phenolic acids, organic acids, α-tocopherol, carotenoids, anthocyanins, triterpenoids, fatty acids, sterols, vitamin c, fibers, calcium (Ca), potassium (K), magnesium (Mg), phosphorus (P), and other bioactive compounds	(El Haouari *et al.* 2021, Morgado *et al.* 2018)
Artemisia herba-alba Asso	Antibacterial, antispasmodic, anti-diabetic, antioxidant, leishmanicidal, and antifungal properties	Chrysanthenone, camphor, α-thujone, β-thujone, 1,8-cineol, tricyclene, Sabinene and α-terpinene	(Asdadi *et al.* 2020, Idm'hand *et al.* 2020)
Carum carvi L.	Anti-diabetic, antioxidant, hepatoprotective, antiulcerogenic, antimicrobial, insecticidal, diuretic, analgesic, renoprotective, molluscicidal, endocrine, anti-cholinesterases, Immunomodulatory properties	Carvacrol, Carvone,α-pinene, limonene, γ-terpinene, linalool, carvenone, and p-cymene	(Akram *et al.* 2019, Goyal *et al.* 2018)
Ceratonia siliqua L.	Antioxidant, antidiarrheal, antibacterial, antifungal, anti-inflammatory, antidiabetic activities and also hepatoprotective and antiproliferative effects	Phenolic compounds, flavonoids, tannins, anthocyanins, alkaloids, glycosides, proteins and minerals	(Brassesco *et al.* 2021, Lakkab *et al.* 2018)

Chamaerops humilis L.	Anti-inflammatory, antioxidant, anabolic, antiseptic, urinary, antimitotic, hypoglycemic, antilithic and diuretic activities	Flavonoids, phenols, saponins, sterols, gallic tannins and terpenoids	(Cadi *et al.* 2021, Lachkar *et al.* 2022)
Dittrichia viscosa (L.) Greuter	Antioxidant, antimicrobial, cytotoxic, nematicidal and insecticidal, anti-glycation and anti-diabetic activities	1,8-cineole, caryophyllene oxide, α-terpenyl acetate, α-muurolol, hydrosol p-menth-1-en-9-ol, linalool, cis-sabinene hydrate and α-muurolol	(Mrid *et al.* 2022, Vuko *et al.* 2021)
Dysphania ambrosioides (L.) Mosyakin & Clemants	Antitumor, antiprotozoal, allelopathic, antiviral, immunoregulatory, anti-inflammatory, and antioxidant activities	Ascaridole, p-cymene, α-terpinene, terpinolene, carvacrol, and trans-isoascaridole	(Hewis *et al.* 2020, Singh & Pandey 2021)
Foeniculum vulgare Mill.	Antimicrobial, antifungal, antidiabetic, antioxidant, anticancer, anti-inflammatory, anticarcinogenic, bronchodilatory, gastrointestinal, estrogenic, hepatoprotective, hypolipidemic, antispasmodic, antinociceptive, antihirsutism, antithrombotic and antidepressant effects	Saponins, flavonoids, cardiac glycosides, sterols, triterpenes, coumarins, volatile oils, protein, fat, minerals, fibre, carbohydrates, calcium, potassium, sodium, iron, phosphorus, thiamine, riboflavin and niacin	(Al-Snafi 2018a, Mehra *et al.* 2021)
Glycyrrhiza glabra L.	Antidepressant, antimicrobial, anticancer, antioxidant, protective, antiulcer, antidiabetic, hypolipidemic, anti-inflammatory, antiviral, and antidiabetic activities	Alkaloids, glycosides, carbohydrates, starches, phenolic compounds, flavonoids, proteins, pectin, mucilage, saponins, lipids, tannins, sterols and steroids	(Al-Snafi 2018, Pastorino *et al.* 2018)
Marrubium vulgare L.	Anti-inflammatory, antiedematogenic, analgesic, antioxidant, antimicrobial, antidiabetic, cardiovascular hypolipidemic and antispasmodic effects	Alkaloids, sterols, steroids, terpenoids, saponins, flavonoid, catecholic tannins, anthocyans, phenolic compounds and many other bioactive ingredients	(Aćimović *et al.* 2020, Al-Snafi *et al.* 2021)
Myrtus communis L.	Anti-inflammatory, antimicrobial, antioxidant, hypoglycaemic, anticancer, analgesic, antidiarrheal properties	Myricetin, coumarins, myrtucommulone A and B, Myrtenol, myrtenol acetate, limonene, pinene, p-cymene, geraniol, phenylpropanoid, methyl eugenol phospholipids, phenolic compounds and essential oil	(Aleem & Anis 2021, Jabri *et al.* 2018)
Ocimum basilicum L.	Anti-cancer, radioprotective, anti-microbial, anti-inflammatory, immunomodulatory, anti-stress, anti-diabetic, anti-pyretic, anti-arthritic, anti-oxidant effects	Linalool, geraniol, methyl eugenol, methyl chavicol, p-allylanisole, 1,8–cineole, trans–α–bergamotene, and neryl acetate	(Dhama *et al.* 2021, Shahrajabian *et al.* 2020)

Olea europaea L.	Cholesterol-lowering, hypoglycemic, cytotoxic, antibacterial, neuroprotective, antioxidant, anti-inflammatory and hypotensive activities	Phenolic compounds (oleuropein, hydroxytyrosol, verbascoside, apigenin-7-glucoside and luteolin-7-glucoside), flavonoids, secoiridoids, triterpenes, biophenols, benzoic acid derivatives, xylitol, sterols, isochromans and sugars	(Alesci *et al.* 2022, Idm'hand *et al.* 2020)
Opuntia ficus-indica (L.) Mill.	Antioxidant, wound healing, skin protective, hepatoprotective, anticancer, antidiabetic, antihypercholesterolemic, and anti-obesity activities	Ascorbic acids, vitamins, carotenoids, fibers, amino acids, flavonoids, betaxanthin, betacyanin and alkanoids	(Abbas *et al.* 2022, Tilahun & Welegerima 2018)
Origanum compactum Benth.	Antibacterial, antioxidant, antiparasitic, antifungal, and anticancer effects	γ-Terpinene, o-Cymene, carvacrol , β-caryophyllene, β-linalool, 2-Carene , β-Bisabolene, myrcene, 3-Thujene, caryophylene oxide, 4-terpineol and α-Pinene	(Bouyahya *et al.* 2020, Zeroual *et al.* 2020)
Pistacia lentiscus L	Antibacterial, anti-inflammatory, antioxidant, anti-ulcer, anti-diabetic, cardioprotective and anti-cancer properties	Banillic acid, gallic acid trans-cinnamomic acid, isomasticadienonic acid, masticadienolic acid, moronic acid, oleanolic acid, oleanolic aldehyde, p-hydroxy-benzoic acid, p-hydroxy-phenylacetic acid, tirucallol and tyrosol	(Pachi *et al.* 2020, Soulaidopoulos *et al.* 2022)
Punica granatum L.	Anti-oxidative, anti-hypertensive, cardioprotective and antidiabetic properties	Alkaloids, anthocyanidins, tannins, flavonoids, phenolics, proanthocyanidins, sterols, terpenes, terpenoids, xanthonoids, fatty acids, organic acids, lignans, saccharides, and vitamin C	(Maphetu *et al.* 2022, Ranjha *et al.* 2021)
Rosmarinus officinalis L.	Antibacterial, antidiabetic, anti-inflammatory, antitumor, antioxidant, anti-inflammatory, anti-skin-cancer, antinociceptive, antifungal and UV-protective effects	Camphor, 1,8-cineole, α-pinene, borneol, camphene, β-pinene limonene, arnosol carnosic, rosmarinic, ursolic, oleanolic and micromeric acid	(Andrade *et al.* 2018, Demacedo *et al.* 2020)
Salvia officinalis L.	Anti-oxidant, antidiabetic, anti-inflammatory, anti-microbial, anticancer and hypolipidemic properties	Caffeic, vanillic, ferulic, rosmarinic acids, luteolin, apigenin, quercetin, α- and β-thujone, 1,8-cineole, camphor, carnosic acid, carnosol, rosmadial, manool, oleanolic and ursolic acids	(Pizani *et al.* 2022, Sharma *et al.* 2019)
Tetraclinis articulata (Vahl) Mast.	Antioxidant, antibacterial, antifungal, anticorrosion, cytotoxic, insecticidal, leishmanicidal, larvicidal, anti-inflammatory, antidiarrheal, vasorelaxant, and protective activities	α-pinene, cis-Verbenone, L-pinocarveol, bicyclo[4.1.0]hept-2-ene,α-campholenal and D-limonene	(Saber *et al.* 2021, Saber *et al.* 2022)

Teucrium polium L.	Antioxidant, antibacterial, antinociceptive, antispasmodic, antidiabetic, diuretic, hypo-lipidemic, antifungal and cytotoxic properties	Tannin, terpenoid, saponin, flavonoid, sterol, β-caryophyllene, diterpenoids, caryophyllene oxide, asparagine, ditryne and resinous sub-stances	(Khazaei *et al.* 2018, Rahmouni *et al.* 2021)
Trigonella foenum-graecum L.	Antidiabetic, immunomodulatory, antioxidant, chemopreventive, antimicrobial, anticancer, gastroprotective, anti-inflammatory, antipyretic, analgesic, neuropharmacological, anthelmintic, anti-plasmodial, hypocholesterolemic and urotoxicity activities	Galactomannan, diosgenin, 4-hydroxyisoleucene, 3-hydroxy-4, 5-dimethyl-2(5H) furanone, tryptophan, lysine, alkaloids, flavonoids, free amino acids, saponins, glycosides, vitamins, minerals, mucilage, proteids and volatile oils	(Arunabha 2019, Yadav *et al.* 2019)

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