Mexico's sage richness, traditional uses and chemical composition: a review

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ABSTRACT

Objective: To report the genus richness, the traditional uses and the main chemical constituents of *Salvia* species distributed in Mexico.

Design/Methodology/Approach: A bibliographic review was made in several databases such as Scopus, Web of Science, ScienceDirect and Google Scholar to know the diversity of the genus, compile the traditional uses and the main chemical constituents of *Salvia*. Books and theses available in the repositories of the National Autonomous University of Mexico (UNAM in Spanish) were also reviewed.

Results: In Mexico there are 318 species distributed in three subgenera with an endemism of about 84%; 63 native species of *Salvia* have traditional uses, mainly medicinal and only 17 species are edible, ornamental and ceremonial. Sages are used to treat 141 ailments, the most reported being stomach pain, diarrhea, insomnia, fever, susto, bile, cough and dysentery. Terpenes are the most diverse and abundant constituents in *Salvia* species, followed by phenolic acids and flavonoids.

Study Limitations/Implications: This review provided insight into the great diversity of Mexican salvias and their medicinal importance in treating various ailments. However, few species have been studied phytochemically and pharmacologically.

Findings/Conclusions: In the future, with prior implementation of their cultivation, Mexican sages could be a promising resource as a herbal remedy and/or as a source of bioactive compounds to provide medical care in the treatment of diseases, mainly of the digestive system.

Keywords: Biodiversity, ethnobotany, phytochemistry, flavonoids, alternative medicine, traditional medicine, terpenoids.

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INTRODUCTION

The species of the genus *Salvia* are known in Mexico as chias, myrtles or salvias (sages) and belong to the family Lamiaceae, which in Mexico and the world is one of the families with the largest number of species. The name *Salvia* comes from the Latin word *salvus*, meaning to save or intact, referring to the healing properties attributed to numerous species (Martínez-Gordillo *et al.*, 2017). The genus is well represented with

more than 1000 species around the world, with Mexico and South America recognised as sites of diversification as they contain a high number of species. In Mexico, the genus *Salvia* has a 318 species richness, and is distributed in all states of the country (Martínez-Gordillo *et al.*, 2017; Martínez-Gordillo *et al.*, 2023). The genus includes herbs and shrubs, often aromatic, with simple, opposite leaves and a 4-sided stems. The flowers are grouped in spikes, bilabiate, zygomorphic, coloured in white, yellow, purple, red, violet or blue. The diagnostic characteristic of the genus is the presence of two stamens with elongated connective, which function as a staminal lever that moves when pollinators visit and allows pollen to adhere to the pollinator's body (Martínez-Gordillo *et al.*, 2023). The wide variety of uses of *Salvia* dates back to ancient times. In Europe, medicinal use has been recorded since the first medical school was founded in Salerno, Italy (Inić & Gašparac, 2023). There is a proverb alluding to its medicinal importance "Why should a man die whilst sage grows in his garden?". Salvias are also appreciated for their great beauty, which is why they are commonly found in gardens as ornamental plants and are also used as a condiment in the cuisine of Eurasian countries (Ortiz-Mendoza *et al.*, 2022). There are species of *Salvia* that are used in traditional and alternative medicine in various regions of the world. Among the most common uses that have been attributed to it are useful to prevent infections, relieve pain, cure digestive problems and serve as painkillers. Dried extracts of the root of *Salvia miltiorrhiza* Bunge, also known commercially as Danshen or Tanshen in China, is one of the most popular natural products in Asia and has been used extensively as a treatment for heart and kidney diseases. In China, 700 companies produce the preparation (Hernández-Agero *et al.*, 2002). For Mexico, there are reports of the use of sages since the 16th century, as food, medicine and for ceremonial use (Miranda & Valdés, 1991; Sahagun, 1975). Such is the case of *S. hispanica* L., which in Mesoamerica was a species known as chia, a nahuatl word meaning "oily", due to the large number of oils found in the seed. The Mayans used it as a medicine and the Aztecs used it as an important food source (Cahill, 1996). A common practice in pre-columbian Mexico was to make flour from the seeds, known as "chianpinolli", which was incorporated into tortillas, tamales and a drink called "chianatole". For the Aztecs, the relationship they had with this species was very important, because they used it in rituals, to worship the goddess Chicomecóatl, who was the goddess of subsistence, especially of maize and also of fertility. Another example is the pastora or ska pastora, *Salvia divinorum* Epling *et* Játiva, which is used in Mexico by the mazatec people to treat culture-bound syndrome or for divinatory medicine, and at the same time its hallucinogenic power has been proven (Cahill, 1996; Díaz, 2014). The different uses of *Salvia* species are justified by the great diversity of chemical compounds they produce (Hernández-Agero *et al.*, 2002; Ortiz-Mendoza *et al.*, 2022). The aim of the present work is to report the genus richness, traditional uses and main chemical constituents of native *Salvia* species in Mexico.

MATERIALS AND METHODS

The information presented is the result of an extensive literature review that included a systematic search in databases such as Scopus®, Web of Science®, ScienceDirect®, and Google Scholar®. For this search, the keyword "*Salvia*" was used in combination with

"Mexico" and without year restrictions. Results related to species that were not native or endemic to Mexico were excluded. Additionally, for traditional uses of *Salvia*, printed materials available in both Spanish and English were reviewed from the library of the Institute of Biology at the National Autonomous University of Mexico (UNAM). The computer search was conducted using the terms "*Salvia*" in conjunction with specific epithets and the words diversity, ethnobotany, phytochemistry, Mexico, and secondary metabolites. The information was organized and compiled into tables for analysis. To represent the chemical molecules in this manuscript, ChemDraw Professional 17.0.0.206 software was used.

RESULTS AND DISCUSSION

Diversity and endemism of the genus in Mexico

In Mexico, the genus *Salvia* presents a richness of 318 species, distributed in the subgenera *Calosphace*, *Heterosphace* and *Audibertia* (Rose *et al*., 2021) with an endemism of 84% (Figure 1), being Mexico the main center of diversity of *Calosphace* with 301 species and 249 endemics. The subgenus *Audibertia* occurs mainly in Baja California, with 14 of the 19 species of this taxon, while *Heterosphace* is the least diverse with only three species (*Salvia henryi* A. Gray, *S. roemeriana* Scheele, and *S. summa* A. Nelson), which are found in the north of the country (Walker & Eiisens, 2001).

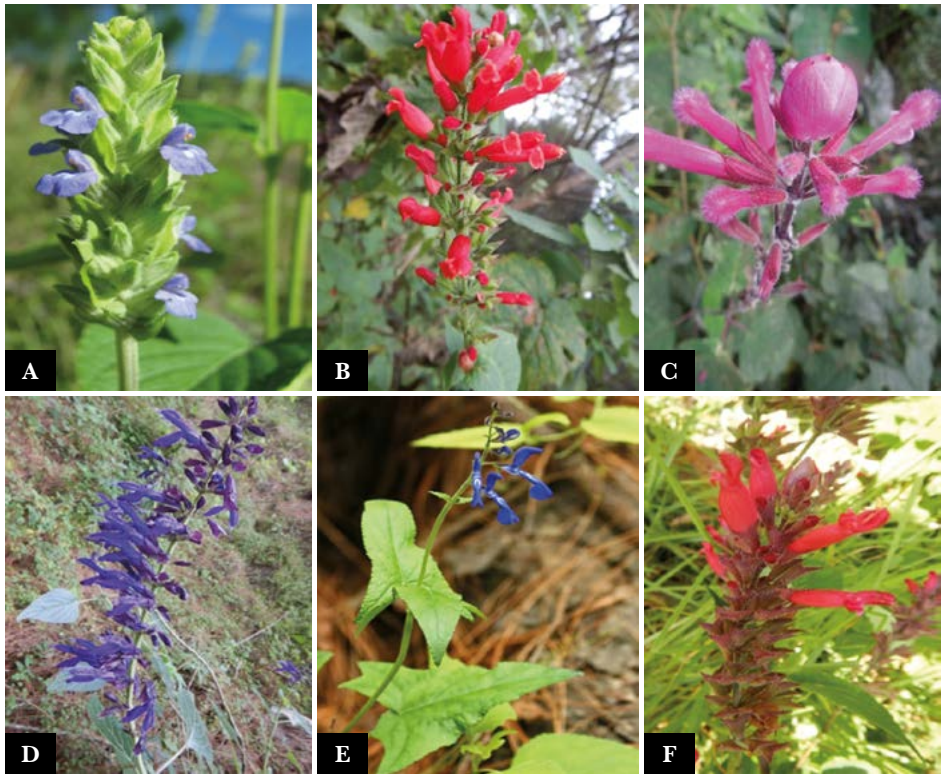

Figure 1. Salvias from Mexico: A) *Salvia hispanica*, B) *S. holwayi*, C) *S. involucrata*, D) *S. mexicana*, E) *S. vitifolia* and F) *S. wagneriana*.

Distribution of the genus *Salvia* in Mexico

The genus is distributed in all the federal states of the country, the states with the greatest presence of *Salvia* are Oaxaca, Guerrero, Puebla, Jalisco and Michoacán, and they are found in mountainous regions, especially in Sierra Madre Occidental (at west), Sierra Madre del Sur (at south) and Eje Neovolcánico Transversal (Trans-Mexican Volcanic Belt), where the vegetation types that harbor most species are temperate forests, particularly coniferous and oak forests, although they can also be found in tropical forests and arid zones, the latter being preferred by the subgenus *Audibertia* (Martínez-Gordillo *et al*., 2017).

Uses of *Salvia* in Mexico

In Mexico, *Salvia* has a long history of interaction with humans. Many of the ancestral uses are still preserved; but others are falling into disuse and are under-represented today. An example of this is *S. hispanica*, which was a very important crop in ancient Mexico (Cahill, 1996) and is now a minor crop in localities such as Atzitzihuacan and Tochimilco in Puebla, although it is also cultivated in Jalisco, Michoacán, Puebla, Querétaro and Zacatecas, with yields up to 0.740 tons/hectare (Gobierno de la Ciudad de México, 2022). Something similar occurs with *S. apiana* Jeps. and *S. columbariae* Benth., whose seed is reported as edible among the Kumiai, but this use seems to be disappearing, as in interviews with several members of this culture, carried out in May 2023, all of them stated that they no longer eat them. The case of *S. divinorum* is the opposite of the previous one, after its use by the Mazatecs for divinatory medicine became known and it was proven that it has hallucinogenic effects, it is now used for 'recreational' purposes and is available in many parts of the world, being acquired via the internet. In Mexico, 63 native species are recorded as having traditional uses, mainly medicinal, and only 17 species are edible or ornamental. Six species are reported as edible by consumption of the seeds (*S. apiana*, *S. carduacea* Benth. *S. columbariae*, *S. hispanica* and *S. mexicana* L.) or the flowers (*S. apiana* and *S. fulgens* Cav.) (Alonso-Castro *et al*., 2015; Bello-González *et al*., 2015; Cornejo-Tenorio & Ibarra-Manríquez, 2008). Nine species are reported as ornamentals (*S. clinopodioides* Kunth *S. coccinea* Buc'hoz ex Etl., *S. elegans* Vahl *S. hispanica*, *S. leucantha* Cav. *S. mexicana*, *S. microphylla* Kunth, *S. polystachya* Cav. and *S. purpurea* Cav.) (Cornejo-Tenorio & Ibarra-Manríquez, 2008; Estrada *et al*., 2007; Standley, 1920; Villavicencio & Pérez Escandón, 1995). The latter also include *S. splendens* Sellow ex J.A. Schultes, which is introduced (Martínez *et al*., 1995). Ceremonial species are *S. gesneriiflora* Lindl. *et* Paxton, *S. mocinoi* Benth., *S. purpurea* and *S. thyrsiflora* Benth. (Bello-González & Salgado-Garciglia, 2007; Naranjo, 2012). Two species have domestic use: *S. cinnabarina* M. Martens & Galeotti, for brooms and face dye, as make-up and *S. mexicana* whose leaves are used as a scouring pad (Bello-González & Salgado-Garciglia, 2007; Naranjo, 2012). Considering its use in traditional medicine, *Salvia* is used to treat 141 ailments, grouped into 15 apparatuses and systems of the human body (Ortiz-Mendoza *et al*., 2022). The most reported ailments are stomach pain, diarrhea, insomnia, fever, fright, bile, cough and dysentery. The most commonly reported diseases are digestive system, female reproductive system and culture-bound syndrome, which are also the

categories with the highest number of species (Table 1). The most commonly used species are *Salvia microphylla*, *S. coccinea* and *S. lavanduloides* Kunth, and they are also the ones with the highest number of use categories (Ortiz-Mendoza *et al.*, 2022).

Table 1. Ailments grouped by human body apparatus and systems.

Apparatus and systems	Ailments	*Salvia* species	References
Digestive system	Digestive affections, bile, gallstones, stomach colic, baby colic, constipation, anger, diarrhea, dysentery, red dysentery, stomach pain, gas, gastritis, hemorrhoids, liver, indigestion, stomach and bowel cleansing, upset stomach, purging, torcijón (acute abdominal pain), vomiting.	*S. adenophora, S. amarissima, S. axillaris, S. ballotiflora, S. breviflora, S. carduacea, S. chamaedryoides, S. cinnabarina, S. coccinea, S. elegans, S. gesneriiflora, S. herbacea, S. hispanica, S. karwinskii, S. lavanduloides, S. leucantha, S. melissodora, S. mexicana, S. micrantha, S. microphylla, S. polystachia, S. protracta, S. purpurea, S. reflexa, S. reptans, S. semiatrata, S. shannonii, S. serotina, S. tiliifolia, S. thymoides, S. xalapensis*	Argueta, 1994; Bello-González & Salgado-Garciglia, 2007; Calzada & Bautista, 2020; Domínguez-Vázquez & Castro-Ramírez, 2002; González *et al.*, 2004; Lozano, 1996; Maldonado Almanza, 1997; Martínez *et al.*, 1995; Mercado, 2013; Ortiz-Mendoza *et al.*, 2022
Female reproductive system	Abortifacient, contraceptive, cramps, menstrual disorder, dysmenorrhoea, recent childbirth pain, pregnancy care, gynecological diseases, infertility, vaginal bleeding, childbirth inflammation, lactogen, cleansing women from childbirth, irregular menstruation, to conceive family, to facilitate childbirth, difficult childbirth, postpartum care, menstrual problems, recaída de señora (set of pains and discomforts that women usually suffer after childbirth)	*S. ballotiflora, S. cacaliifolia, S. cinnabarina, S. coccinea, S. fruticulosa, S. gesneriiflora, S. hispanica, S. holwayi, S. involucrata, S. karwinskii, S. laevis, S. lavanduloides, S. leucantha, S. melissodora, S. mexicana, S. microphylla, S. polystachia, S. purpurea, S. prunelloides, S. reptans*	Alonso-Castro *et al.*, 2015; Argueta, 1994; Bello-González & Salgado-Garciglia, 2007; Campos-Xolalpa *et al.*, 2021; Cruz-Pérez *et al.*, 2021; Domínguez-Vázquez & Castro-Ramírez, 2002; Espinosa, 1985; González *et al.*, 2004; Lozano, 1996; Navarro & Avendaño, 2002; Ortiz-Mendoza *et al.*, 2022
Culture-Bound Syndrome	Aire, aire en oídos, aljorra, calentar coyunturas, dolor de aire, empacho, espanto, vergüenza, fiebre, herido por rayo, llanto, mal aire, mal aire de muerto, mal de ojo, panzón de borrego, pérdida del alma o espíritu, purificar o limpiar ambiente, susto, susto de niños	*S. amarissima, S. apiana, S. chamaedryoides, S. cinnabarina, S. coccinea, S. fruticulosa, S. gesneriiflora, S. involucrata, S. lasiantha, S. lavanduloides, S. leptostachys, S. leucantha, S. melissodora, S. microphylla, S. patens, S. purpurea*	Argueta, 1994; Cruz-Pérez *et al.*, 2021; Domínguez-Vázquez & Castro-Ramírez, 2002; Solano-Picazo & Blancas, 2018
Respiratory system	Respiratory conditions, asthma, bronchitis, constipated catarrh, nasal congestion, sore throat, flu, colds, coughs, whooping cough (pertussis)	*S. apiana, S. elegans, S. lavanduloides, S. leucantha, S. mellifera, S. mexicana, S. microphylla*	Argueta, 1994; Martínez-Moreno *et al.*, 2016; Ortiz-Mendoza *et al.*, 2022; White-Olascoaga *et al.*, 2013
Skin and adnexa	Hair (hair loss, care, alopecia), erysipelas, scald, buried thorns, wounds, infected wounds, skin inflammation, "quemado" (dermatitis), hives	*S. adenophora, S. amarissima, S. iodantha, S. lavanduloides, S. mexicana, S. microphylla, S. misella, S. patens, S. polystachia, S. protracta, S. sessei, S. tiliifolia*	Aburto, 2013; Cruz-Pérez *et al.*, 2021; Esquivel-García *et al.*, 2018; Heras & Ariza, 2007; Lozano, 1996; Molina-Mendoza *et al.*, 2012
Musculoskeletal system	Arthritis, dislocation, muscle pain, oedema, rheumatic fever, bone strengthening, bumps, bruises, sprains, rheumatism	*S. apiana, S. coccinea, S. elegans, S. hispanica, S. keerlii, S. mellifera, S. misella, S. purpurea, S. reflexa, S. reptans, S. serotina*	Argueta, 1994; González *et al.*, 2004; Martínez *et al.*, 1995; Ortiz-Mendoza *et al.*, 2022

Table 1. Continues...

Apparatus and systems	Ailments	*Salvia* species	References
Signs and symptoms	Pain, headache, waist pain, chills, fever, lack of appetite, swelling, children's infections, swollen feet, primary stabbing headache	*S. cinnabarina, S. coccinea, S. elegans, S. holwayi, S. lavanduloides, S. leucantha, S. melissodora, S. mexicana, S. microphylla, S. misella, S. purpurea, S. reptans*	Argueta, 1994; Cuevas-Morales *et al.*, 2022; Domínguez-Vázquez & Castro-Ramírez, 2002; González *et al.*, 2004; Ortiz-Mendoza *et al.*, 2022
Sense organs	Eyes health (Conjunctivitis, eye pain, conjunctival irrigation, ocular discomfort, eye conditions, foreign object in the eyes, cleansing chincuapos, for the eyes), Ear health (earache, hearing impairment)	*S. coccinea, S. elegans, S. hispanica, S. mexicana, S. microphylla*	Argueta, 1994; Domínguez-Barradas *et al.*, 2015; Martínez *et al.*, 1995; Ortiz-Mendoza *et al.*, 2022; Soto, 1987; Zamora-Martinez *et al.*, 1992
Other	Cancer, caustic, tonic, weakness, viper bite, paralysis, parasites	*S. gesneriiflora, S. herbacea, S. lavanduloides, S. leucantha, S. microphylla, S. misella, S. purpurea, S. shannonii, S. tiliifolia*	Argueta, 1994; Calzada & Bautista, 2020; González *et al.*, 2004; Ortiz-Mendoza *et al.*, 2022
Therapeutic practices	Postpartum bath, bathing a newborn, steam therapy, wound cleansing, limpias or barridas (the therapist literally sweeps the body of the patient), massage	*S. elegans, S. involucrata, S. iodantha, S. leucantha, S. microphylla, S. patens, S. protracta, S. rubiginosa*	Aburto, 2013; Argueta, 1994; Breedlove & Laughlin, 1993; Lozano, 1996; Ortiz-Mendoza *et al.*, 2022
Circulatory system	Anaemia, heart, hemorrhage, nose bleed, blood pressure	*S. coccinea, S. hispanica, S. lavanduloides, S. microphylla, S. polystachia, S. regla*	Argueta, 1994; Ortiz-Mendoza *et al.*, 2022
Nervous system	Epilepsy, insomnia, children's insomnia, nervousness, calming children	*S. elegans, S. fulgens, S. leucantha, S. melissodora, S. microphylla*	Argueta, 1994; Ortiz-Mendoza *et al.*, 2022
Infectious diseases	Abscesos, fogazos, malaria, paperas, sarampión Abscesses, cold sore, malaria, mumps, measles	*S. coccinea, S. elegans, S. fulgens, S. reflexa, S. tiliifolia*	González *et al.*, 2004; Ortiz-Mendoza *et al.*, 2022
Urinary system	Urinary tract stones, kidney problems, kidney	*S. laevis, S. lavanduloides, S. leucantha, S. melissodora, S. mexicana, S. microphylla*	Cruz-Pérez *et al.*, 2021; Lozano, 1996
Metabolic diseases	Diabetes	*S. amarissima, S. fruticulosa, S. lavanduloides, S. leucantha, S. mexicana, S. oaxacana, S. tiliifolia*	Argueta, 1994; Ortiz-Mendoza *et al.*, 2022

Chemical constituents of the genus *Salvia*

Sages synthesize a large number of secondary metabolites, so called because they originate from chemical compounds formed from primary metabolism. The main groups are terpenoids and phenolic compounds, which have been isolated and identified from around 90 salvias distributed in Mexico (Ortiz-Mendoza *et al.*, 2022).

Terpenes constitute a very broad group of metabolites isolated in *Salvia* species, classified according to the number of carbons in their chemical structure, with compounds with 10, 15, 20, 25, 30 and 40 carbon atoms, many of which are the main constituents of essential oils, some examples are α-pinene, β-pinene, camphene, camphor, borneol, menthol, phellandrene, limonene, thymol, carvacrol, p-cymene, myrcene, linalool, farnesol and geraniol, among others (Figure 2) (Imanshahidi & Hosseinzadeh, 2006; Ortiz-Mendoza *et*

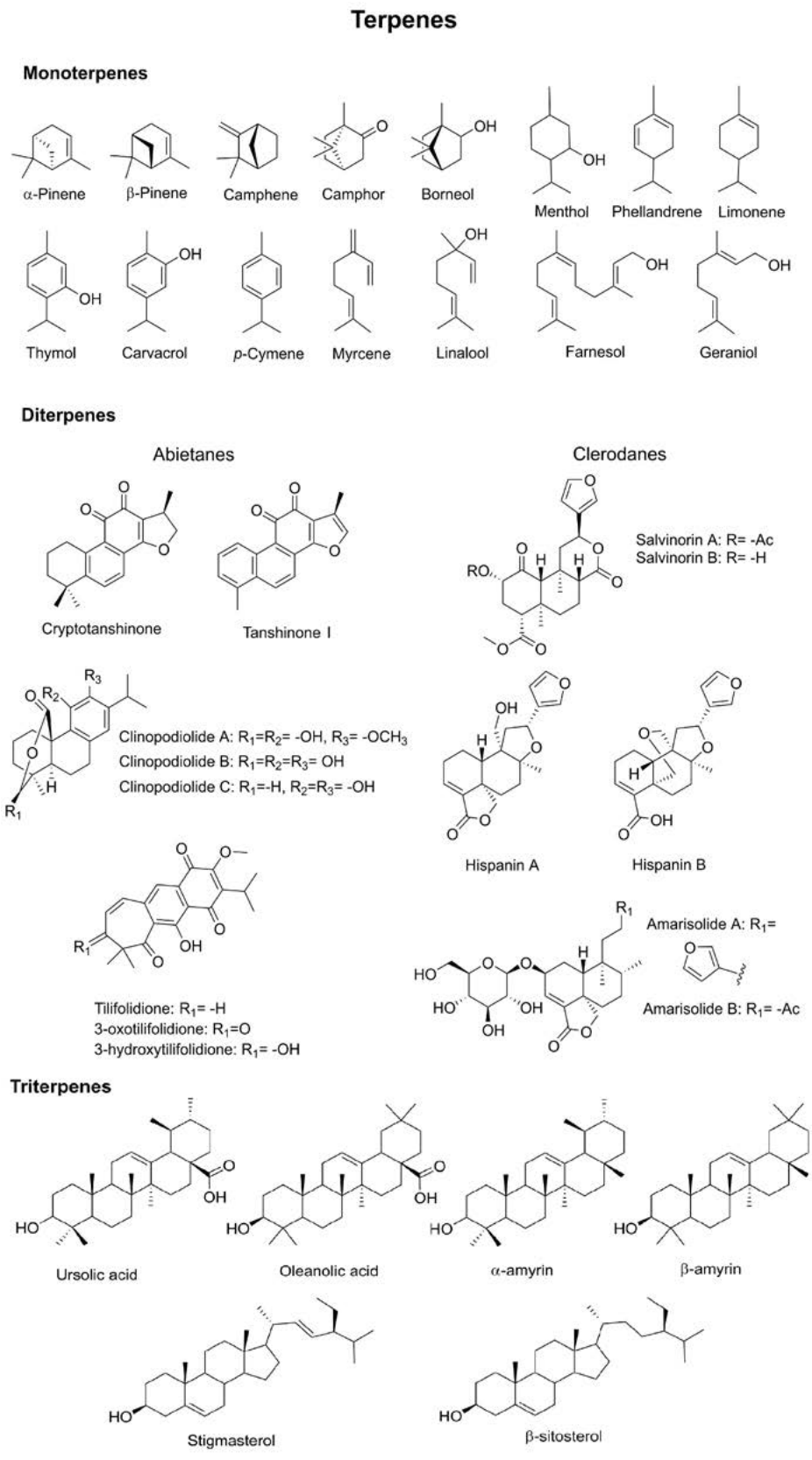

Figure 2. Structures of terpenes isolated from *Salvia* species.

al., 2022; Wu *et al.*, 2012). The major terpenoids in *Salvia* are compounds with 20 and 30 carbons, better known as diterpenes and triterpenes, respectively. Diterpenes stand out in sages, mainly abietanes (*i.e.* tanshinones, clinopodiolides, tilifolidiones) and clerodanes (*i.e.* salvinorins, hispanines, amarisolides, among others) with the highest number of structures (Figure 2) (Adams *et al.*, 2005; Bigham *et al.*, 2003; Bustos-Brito *et al.*, 2019; Esquivel & Sánchez, 2005; Fan *et al.*, 2019; Salinas-Arellano *et al.*, 2020). The psychoactive compound, Salvinorin A, a clerodane isolated from *S. divinorum*, is considered to be a naturally occurring hallucinogen, and unlike other psychoactives such as alkaloids (morphine), it lacks nitrogen. The mechanism of action of Salvinorin A is via the opioid receptors, which also exerts an analgesic effect, as does morphine; however, what has attracted the attention of the pharmaceutical industry is that it is a powerful antidepressant. It is banned for both consumption and research purposes in some countries, such as Germany, Japan, Poland, Russia and Belgium. In Norway, Finland, Estonia and Iceland, the plant is legal to use for medicinal purposes and can only be obtained by prescription (Cahill, 1996; Ortiz-Mendoza *et al.*, 2022). Within the triterpenes, it is common for sages to synthesise ursolic acid, oleanolic acid, α-amyrin, β-amyrin, stigmasterol and β-sitosterol (Figure 2). Ursolic acid and oleanolic acid are generally isolated from *Salvia* species with high yields (Ortiz-Mendoza *et al.*, 2022; Wu *et al.*, 2012). These compounds have such varied biological activities, even a single compound has several health benefits, as in the case of ursolic acid, which has been attributed anti-inflammatory, analgesic, gastroprotective, antimicrobial, antiviral, antitumour and hepatoprotective properties (Hussain *et al.*, 2017).

Other important compounds in salvias are characterized by having one or more hydroxyl (-OH) groups attached to an aromatic ring, commonly called phenols (Figure 3). One of the main characteristics of these compounds is that they are powerful antioxidants, and in general protect the body from damage caused by oxidizing agents, such as ultraviolet rays, environmental pollution and toxic substances present in some foods. Within this large group of compounds are phenolic acids, the most common of which in *Salvia* are caffeic acid, ferulic acid and rosmarinic acid. Flavonoids are widely distributed in sages, the main ones being apigenin, luteolin, quercetin, kaempferol and rutin. These compounds are characterized by their antioxidant, antitumour, anti-inflammatory, antimicrobial, chemopreventive and neuroprotective properties. Quercetin promotes health by lowering blood pressure and cholesterol, as well as reducing inflammation, by preventing the development of chronic diseases such as diabetes, hypertension and cancer, among others. The fatty acids, especially omega-3 fatty acids, present in chia seeds, as well as the flavonoids kaempferol, quercetin and rutin have been found to have an effect on patients with type 2 diabetes (these patients are characterized by insulin resistance and high blood glucose levels), whose blood glucose levels are kept under control with a chia diet. In addition to reducing the risk of cardiovascular and brain diseases (Hernández-Pérez *et al.*, 2020; Ortiz-Mendoza *et al.*, 2022; Ullah *et al.*, 2016) (Figure 3).

Cultivation, potential and perspectives

Salvia is the most diverse genus in Mexico, and is an integral part of Mexican biodiversity and culture. Its cultivation, whether for ornamental, medicinal or economic use, reflects

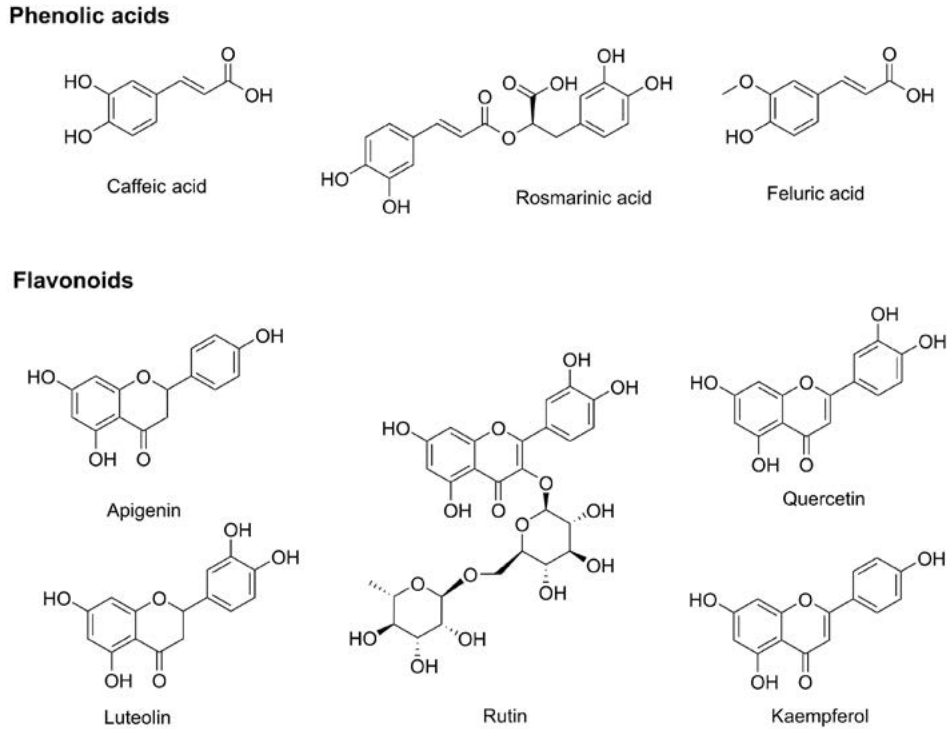

Figure 3. Structures of phenols isolated from *Salvia* species. This figure was created using Chem Draw Professional 17.0.0.206.

the richness and diversity of the phylogenetic resources of this genus. It is essential that its cultivation and conservation be promoted sustainably. Conservation strategies should be established, according to localities with ideal characteristics for its growth. There are *Salvia* species considered rare and at risk of germplasm loss due to habitat loss (Flores-Tolentino *et al*., 2020). Native species, in particular, play an important role in ecosystems and traditional culture. It is essential to highlight the salvias that have traditionally been cultivated in Mexico, either for their medicinal properties, ornamental value or cultural importance; however, despite their high use value, few species are cultivated. Chia stands out with a planted area in Mexico of 6,238 hectares, with a production of 4,771 tonnes and a production value of around 273 million pesos (Gobierno de la Ciudad de México, 2022). Other species that are cultivated, although exact figures are not available, are *Salvia divinorum*, *Salvia coccinea* and *Salvia leucantha* Cav. The cultivation of sages not only safeguards an essential part of Mexico's biological and cultural heritage, but also represents an invaluable economic opportunity for local communities (Ramírez *et al.*, 2016). Encouraging plant-based agriculture not only helps to preserve the genetic diversity of the species, but can also generate sustainable income and promote environmentally friendly farming practices. As the world moves towards an environmentally conscious approach and seeks sustainable resources, salvias offer a unique combination of cultural, medicinal, economic and ecological benefits. It is imperative that society recognises and capitalizes on these advantages by encouraging research, education and investment in salvias cultivation and conservation.

CONCLUSION

Medicinal plants have played an important role in the history and culture of the people of Mexico, and the use and application of remedies is knowledge that has been passed down orally from generation to generation. The genus *Salvia* is not only the most diverse in Mexico but has also been a key element in traditional Mexican medicine, particularly those species used to relieve physical ailments as well as those that address spiritual or emotional issues. Out of the 318 species distributed in Mexico, it is known that 20% have some use, totaling approximately 63 species, many of which are used in traditional medicine, primarily to alleviate digestive problems.

Moreover, Mexican *Salvia* species have significant potential as ornamental plants, making it crucial to investigate this aspect. This is particularly important to avoid the fate of other native Mexican species, such as *Dahlia* spp., *Euphorbia pulcherrima* Willd. ex Klotzch, and *Tagetes* spp., which have become prominent in the global ornamental plant trade —a sector in which Mexico currently has very low participation.

It is essential to emphasize the medicinal importance of *Salvia* and its active constituents to promote pharmacological research and the implementation of its cultivation for future use as phytopharmaceuticals. Additionally, exploring novel studies of the *Salvia* genus can uncover potential applications in cosmetics and personal care products due to its antioxidant and anti-inflammatory properties. Investigating its role in the food industry could also be promising, given its potential benefits for digestive and metabolic health. Metabolomics could further reveal new profiles of bioactive compounds, leading to the development of innovative products across various fields.

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