Review

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Ethnobotanical Medica, Pharmacology and Phytochemistry of the Species *Salvia* del Valle de México: A Review

Rocio Ortega[1], Fernando Calzada[2], Ángeles Fortis-Barrera[1], Jesus Solares-Pascasio[1], Francisco Javier Alarcón-Aguilar[1*]

[1]Laboratorio de Farmacología, Departamento de Ciencias de la Salud, División de Ciencias Biológicas y de la Salud, Universidad Autónoma Metropolitana, Iztapalapa, CDMX 02200, México.
[2]Unidad de Investigación Médica en Farmacología, UMAE Hospital de Especialidades, 2° Piso CORSE, Centro Médico Nacional Siglo XXI, CDMX, México.

***Corresponding author:** Francisco Javier Alarcón-Aguilar, email: aaaf@xanum.uam.mx

Received May 22nd, 2024; Accepted August 4th, 2024.

DOI: http://dx.doi.org/10.29356/jmcs.v68i4.2288

Abstract. The *Salvia* genus is one of the most extensive in the Lamiaceae family. The *Salvia* genus comprises approximately 900 species worldwide, 33 of which exist in the Valle de México, the most populated region of Mexico. The taxonomic identification of these species often represents a problem because they present a great variety of synonyms or variations in their nomenclature, like *S. polystachya* with 12 synonymies. The traditional medicinal uses of *Salvia* species in Mexico are varied and include treatment for around 97 diseases. At least 20 species of the *Salvia* genus have well-documented medicinal ethnobotanical information with various uses, including gastrointestinal disorders, gynecological problems, promoting childbirth, antipyretic, disinfecting wounds, diabetes, and respiratory issues. The phytochemistry of the *Salvia* species from the Valle of Mexico is also vast and diverse; at least 315 chemical compounds have been identified, mainly terpenoids, that have received significant attention due to their multifaceted biological activities. Among the activities mentioned are anticancer, anti-hyperglycemic, anti-fungal, anti-inflammatory, or anti-microbial. Some of the compounds present more than one biological activity. Given their extensive structural diversity, terpenoids represent a great source of compounds for developing new therapeutic agents. However, additional clinical and experimental studies are still needed to elucidate the mechanisms of action, optimal doses, and potential toxicity of the isolated compounds.
Keywords: *Salvia spp.*; lamiaceae; medicinal plants; terpenoid compounds; phytochemistry; pharmacology.

Resumen. El género *Salvia* es uno de los más extensos en la familia Lamiaceae. El género *Salvia* comprende aproximadamente 900 especies alrededor del mundo, de las cuales 33 se encuentran en el Valle de México, la región más poblada de México. La identificación taxonómica de estas especies representa frecuentemente un problema al presentar una gran cantidad de sinonimias o variaciones en su nomenclatura, como *S. polystachya* que tiene 12 sinonimias. Los usos en medicina tradicional de Salvias en México son variados, incluyendo tratamiento para alrededor de 97 enfermedades. Por lo menos 20 especies del género *Salvia* tienen información bien documentada de sus usos médicos y etnobotánicos, con una amplia variedad de usos que incluye desórdenes gastrointestinales, problemas ginecológicos, promotores de parto, antipirético, para desinfectar heridas, diabetes o problemas respiratorios. La fitoquímica de las especies de *Salvia* del Valle de México es también amplia y diversa. Por lo menos 315 compuestos químicos han sido identificados y aislados, principalmente terpenoides, que han recibido gran atención debido a sus actividades biológicas multifacéticas, como anticancerígenas, antihiperglucémicas, antifúngica, antiinflamatorias o antimicrobianas. Algunos de los compuestos presentan más de una actividad biológica. Dada su extensa diversidad estructural, los terpenoides representan una amplia fuente de compuestos para el desarrollo de nuevos agentes terapéuticos. Sin embargo, estudios clínicos y experimentales

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

adicionales son necesarios para elucidar el mecanismo de acción, dosis óptimas y toxicidad potencial de los compuestos aislados.
Palabras clave: *Salvia spp.*; lamiaceae; plantas medicinales; compuestos terpenoides; fitoquímica; farmacología.

Introduction

The Lamiaceae (Labiatae) family comprises approximately 236 genera and 7,173 species [1,2]. The genus *Salvia* is one of the most extensive groups in this family, representing around 900 species worldwide [3,4]. The term *Salvia* comes from the Latin "*salvare*," meaning "to heal or be safe and unharmed," referring to the healing properties of these species [2,5-9], which are recognized in worldwide traditional medicine. In the Americas, around 500 species are registered in Mexico, Central America, and South America, representing the second most diverse territory, with approximately 312 species, of which 75 to 88% are endemic [5,10-12]. In Mexico, the most significant number of *Salvia* species is concentrated in the western and southeastern, along the Occidental Sierra Madre, the Trans-Mexican Volcanic Belt, and the Sierra Madre del Sur.

Salvia species are typically shrubs or climbing shrubs from 30 to 150 cm tall that can be annual or perennial [12]. Their stems are angular, characteristic of the Lamiaceae family, with leaves that are usually velvety or hairy, and they can often be rugose, entire, toothed, lobed, or pinnate. The flower stalks produce small bracts different from the basal leaves. Inflorescences are borne in clusters or panicles that produce brightly colored flowers, depending on the species [7,9,12]. The calyx is tubular or bell-shaped without a bearded throat, divided into two lips (that is why the name of labiates): the upper whole or tridentate and the lower cleft. The corolla is usually bilabiate. The stamens are two short structures with bicellular anthers. Many species have trichomes (hairs) on the surface of the leaves, stems, and flowers [7,9,12].

Several *Salvia* species have great economic importance due to their edible, aromatic, and medicinal properties. Many of these species contain high amounts of essential oils, phenolic compounds, antioxidants, and other valuable chemical constituents [5]. The main compounds described in the *Salvia* species are terpenoids and flavonoids. Aerial parts, especially flowers and leaves, contain flavonoids, triterpenoids, and monoterpenes, while the roots contain primarily diterpenoids [7,9,10]. *Salvia* species have been used since ancient times for different ailments, ranging from aches to epilepsy, and the primary uses are for treating colds, bronchitis, tuberculosis, hemorrhages, and menstrual disorders, among others [7,9]. The Mexican *Salvia* species are highly valued for their medicinal, nutritional, and ritualistic uses and are often used as part of vernacular medicine or in mystical/religious rituals. Prominent examples are *Salvia divinorum* (“planta de la pastora”), which is a hallucinogen plant used in rituals by the Mazatecas, an endemic population in the northeastern of Oaxaca [13], and *Salvia hispanica* (chia), which is widely used as a food source since pre-Hispanic times [14].

Ramamoorthy (2001) botanically identified 33 *Salvia* species in the Valle de México [9] (Table 1). The Valle de México has an altitude of 2,240 meters (7,350 ft), covering around 7,866 km^2, and includes 16 town halls in Mexico City, 59 municipalities of the State of Mexico, and one municipality in the State of Hidalgo [15]. Geographically, it is located between the Anahuac Lake and Volcano Region of the physiographic province of the Neo-volcanic Axis and is surrounded by the mountains of Monte Alto, Monte Bajo, and Las Cruces, as well as the Sierra Nevada and Chichinauhtzin mountain range (Fig. 1). This surface presents intermountain, valleys, plateaus, and ravines, as well as semi-deep land, in which are located the lakes of Texcoco, Xochimilco, and Chalco. There are also isolated topographic prominences, such as the "Cerro de la Estrella," the "Cerro del Peñón," and the "Cerro de Chapultepec." The Valle de México also represents the most populated region of Mexico, with more than 20 million inhabitants, who often agree with these species despite their lack of knowledge about their medical uses and properties. In this region, 33 species of *Salvia* had been recorded [9]. Although several researchers worldwide have contributed ethnobotanical, phytochemical, and pharmacological information for some of these species [5,16-19], it is still necessary to continue working on the supplementation and organization of this information. In certain instances, these species exhibit a broad range of botanical synonyms or variations in their nomenclature, which can result in some confusion, like *S. polystachya*, that have 12 botanical synonymies and 11 common names. Therefore, their taxonomic identification often represents a problem. This review aims to organize and synthesize the ethnobotanical, pharmacological, and phytochemical knowledge of the 33 *Salvia* species described by Ramamoorthy in the Valle de México [9]. These species have been extensively

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

documented by diverse research groups in Mexico and other regions, including Europe and Asia [20-25]. Our primary objective is to critically analyze and compare these data, advancing their study at the ethnopharmacological, phytochemical, and therapeutic levels. By doing so, we seek to validate the traditional uses attributed to these remarkable plant species.

Table 1. Scientific name of the 33 *Salvia* species described by Ramamoorthy in the Valle de México [9].

1.	*S. axillaris Moc & Sessé ex Benth.*	2.	*S. carnea* Kunth.	3.	*S. chamaedryoides* Cav.
4.	*S. circinata* Cav.	5.	*S. concolor* Lamb. ex Benth	6.	*S. elegans* Vahl.
7.	*S. filifolia* Ramamoorthy	8.	*S. fulgens* Cav.	9.	*S. gesneriiflora* Lindl & Paxton
10.	*S. helianthemifolia* Benth.	11.	*S. hirsuta* Jacq.	12.	*S. hispanica* L.
13.	*S. keerlii* Benth.	14.	*S. laevis Benth.*	15.	*S. lavanduloides* Kunth.
16.	*S. leucantha* Cav.	17.	*S. melissodora* Lag. Me Vaugh.	18.	*S. mexicana* L.
19.	*S. microphylla* H.B.&H.	20.	*S. misella* Kunth.	21.	*S. mocinoi Benth.*
22.	*S. moniliformis* Fern.	23.	*S. oreopola* Fern.	24.	*S. patens* Cav.
25.	*S. polystachya* Cav.	26.	*S. prunelloides* Kunth.	27.	*S. pulchea* DC.
28.	*S. reflexa* Hornem.	29.	*S. reptans* Jacq.	30.	*S. stachyoides* Kunth.
31.	*S. tiliifolia* Vahl.	32.	*S. tubifera* Cav.	33.	*S. verbenacea* L.

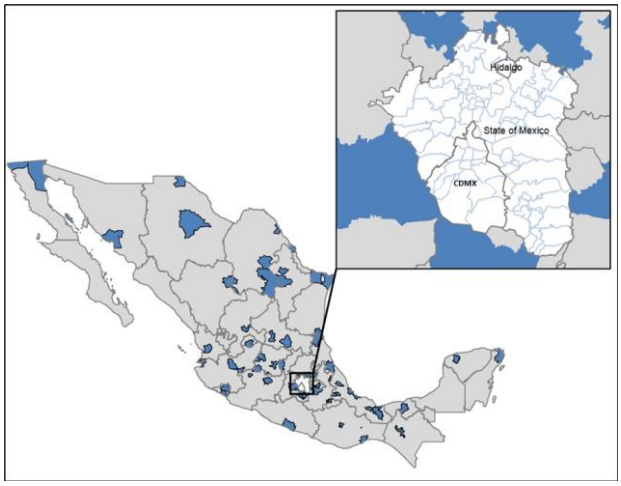


Fig. 1. The delimitation of Mexican metropolitan areas (Valle de México). Modified from OECD, 2015

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Methodology

Information from the 33 species of *Salvias* recorded by Ramamoorthy in the Valle de México [9] was obtained from diverse databases, such as Web of Science, Google Scholar, Google Books, Scopus, ScienceDirect, SpringerLink, Wiley Online, PubMed, textbooks, taxonomic reviews, university theses, and SciFinder. With the obtained data, such as botanical characteristics, botanical synonymy, empirical uses, and biological activities, a meta-analysis was performed, and the compounds isolated were documented.

Results and discussion

Botanical synonymy, popular names, and distribution

Plant nomenclature is ruled by the International Code of Botanical Nomenclature, which aims to provide a correct and accepted name for a taxon based on publication priority. The application of the norms of the code and the taxonomic studies that imply some change in the circumscription of the taxon result in changes in nomenclature and botanic synonymy, such that in the study of medicinal plants, the synonymies can be a problem by creating confusion in any investigation [26,27]. Therefore, the first step was identifying which species had synonyms or some variation (Table 2), highlighting that many of the *Salvia* species studied (84 %) presented some of these conditions. The plant with a significant number of synonyms was *S. polystachya*, with 12 synonymies, seven variations, and three subspecies, followed by *S. carnea*, with 13 synonymies and two variations: *S. fulgens*, with 11 synonymies and three variations, and *S. mexicana* with nine synonymies and three variations. This situation illustrates how easy it is to make mistakes when working with species *Salvia*, so taxonomic identification is a priority before any study. Another frequent problem for species identification focuses on popular or common names with ethnobotanical relevance. However, In Mexico, the popular names vary depending on the region where they are found. Of the included species in the present study, 57.6% had more than one popular name, where "mirto," "chia," and "salvia" are the most used. *S. microphylla* is recognized with 18 popular names, followed by *S. lavanduloides* with 15 names. The consulted bibliography recorded a single popular name for five species; no popular name for nine species was documented. The importance of the correct name of the plant species consists in being able to avoid confusion or even a duplicate work for incorrect use of the names; in the case of *S. circinata* (*S. amarissima*), it is possible to observe publications with both names; it is essential to corroborate the correct and accepted scientific name of the plant. [28,29].

The geographical distribution of these 33 species is not exclusive to the Valle de México. Most of them are distributed in several states of Mexican territory (Table 2). The data indicate that in the state of Michoacan, there are around 27 species, followed by the State of Mexico with 18, and the State of Hidalgo with 17. The best-distributed species in Mexico are *S. polystachya* and *S. hispanica* (Table 2). These data are essential if we consider that the same common name can be used to name different species of the same or other genera, or a single species can receive several names, which vary from one region to another, and because some species share the same distribution in the Valle de México, including Ciudad de México, Estado de México, and Hidalgo. We agree with [2] that research focused on medicinal plants requires essential botanical assistance, especially in taxonomy and nomenclature.

The distribution of the plants in the different regions also affects the kind and concentration of secondary metabolites in the plant. In *S. hispanica*, the weather, altitude, humidity, and nutrients of the region of Veracruz, which is in the East of Mexico, with significant humidity, being a jungle area, are not the same conditions that the State of Durango, in the north of the country, with a desert climate. The different territorial, geographic, and climatic conditions provoke changes in the metabolites, and it may affect all the *Salvia* species that have a wide distribution in the country, even in the same species with different geographical distribution. These changes are a significant area of study to determine the impact of the different conditions in synthesizing metabolites of pharmacological interest [28,30].

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Table 2. Scientific name, botanical synonymy, popular names, and distribution of *Salvia* species from the Valle de México.

Scientific name	Botanical synonymy / Varieties	Common name	Distribution in other states of Mexico
***S. axillaris* Moc & Sessé ex Benth.**	= *S. cuneifolia* Benth. = *S. axillaris* var. *axillaris*.	Hisopo de Puebla Vegeta	Durango Guanajuato Hidalgo Jalisco Michoacán Oaxaca Puebla San Luis Potosí Tlaxcala Veracruz
***S. carnea* Kunth.**	= S. *membranacea* Benth. = S. *pseudogracilis* Epling. = S. *myriantha* Epling. = S. *natalis* Epling = *S. carnea* var. *carnea*. = *S. debilis* Epling. = *S. gracilis* Benth. = *S. iodochroa* Briq. = *S. irazuensis* Fernald. = *S. killipiana* Epling. = *S. martensii* Galeotti. = *S. membranacea* var. *villosula* Benth. = *S. purpurascens* M. Martens & Galeotti. = *S. sidifolia* M. Martens & Galeotti. = *S. simulans* Fernald.	Chía	Chiapas Guerrero Hidalgo Michoacán Oaxaca Nayarit Veracruz
***S. chamaedryoides* Cav.**	= *S. menthifolia* Ten. = *S. chamaedrifolia* Andrews. = *S. chamaedryoides* var. *isochroma* Fernald. = *S. chamaedrys* Willd.	Mirto	Hidalgo Morelos Nuevo León Puebla San Luis Potosí Zacatecas
***S. circinata* Cav.**	= *S. amarissima Ort.* = *S. amara* Jacq. = *S. hirsuta Sessé* & Moc. non Jacq.	Bretónica Chupona Diabetina Hierba de cáncer Hierba de tapón Prodigiosa *Ñadri* (otomí)	Estado de México Guerrero Michoacán Oaxaca San Luis Potosí Veracruz
***S. concolor* Lamb. ex Benth**	= *S. cyanea* Benth. = *S. cyaniflora* A. Dietr. = *S. cyanifera* Otto ex Benth.	Hierba	Colima Estado de México Guerrero Jalisco Michoacán Morelos Puebla

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Scientific name	Botanical synonymy / Varieties	Common name	Distribution in other states of Mexico
***S. elegans* Vahl.**	= *S. camertonii* Regel. = *S. incarnata* Cav. = *S. longiflora Sessé* & Moc. = *S. microcalyx* Scheele. = *S. punicea* M. Martens & Galeotti. = *S. rutilans* Carrière. = *S. elegans* var. *sonorensis* Fernald. = *S. microculis* Poir.	Flor del cerro Hierba del burro Limoncillo Mirto Mirto de campo Mirto de flor roja Mirto inglés Mirto mocho Salvia Toronjil de monte *Jetcho deni* (otomí)	Chihuahua Durango Estado de México Hidalgo Michoacán Oaxaca Puebla Sonora Veracruz
***S. filifolia* Ramamoorthy**	NS	NS	Guanajuato Michoacán Estado de México
***S. fulgens* Cav.**	= *S. cardinalis* Kunth. = *S. boucheana* Kunth. = *S. cardinalis* Kunth. = *S. incana* M. Martens & Galeotti. = *S. grandiflora* Sessé & Moc. = *S. orizabensis* Fernald. = *S. pendula* Sessé & Moc. = *S. schaffneri* Fernald. = *S. fulgens* var. *boucheana* (Kunth) Benth. = *S. fulgens* f. *boucheana* (Kunth) Voss. = *Piaradena fulgens* (Cav.) Raf.	Mirto Mirto macho Mirto macho del popo *Pinyesi* (mazahua)	Estado de México Michoacán Puebla Tlaxcala
***S. gesneriiflora* Lindl & Paxton**	= *S. barbata* Sessé & Moc. = *S. fulgens* f. *gesneriiflora* (Lindl. & Paxton) Voss.	Aparicua Flor de colibrí Flor de chuparrosa Flor de *Tzintzungaraman* (purépecha)	Estado de México Jalisco Michoacán Puebla
***S. helianthemifolia* Benth.**	NS	Mirto corriente	Guanajuato Guerrero Hidalgo Jalisco Michoacán Morelos Querétaro San Luis Potosí Veracruz

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Scientific name	Botanical synonymy / Varieties	Common name	Distribution in other states of Mexico
***S. hirsuta* Jacq.**	= S. *cryptanthos* Schult. = S. *phlomoides* Cav. = S. *sideritidis* Vahl. = *S. bracteata* Poir. = *S. ciliaris* Sessé & Moc. = *S. ciliata* Poir. = *S. nepetifolia* Desf.	NS	Durango Estado de México Guanajuato Hidalgo Oaxaca Querétaro San Luis Potosí Texcoco Tlaxcala Zacatecas
***S. hispanica* L.**	= *S. hispanica* var. chionocalyx Fernald. = *S. hispanica* var. intonsa Fernald. = *S. neohispanica* Briq. = *S. prysmatica* Cav. = *S. schiedeana* Stapf. = *S. tetragona* Moench. = *Kiosmina hispanica* (L.) Raf. = *S. chia* Colla. = *S. chia* Sessé & Moc.	Chía Chía blanco *Tzozolxochitl*	Coahuila Chihuahua Durango Guanajuato Guerrero Jalisco Michoacán Morelos Oaxaca Puebla San Luis Potosí Sonora Veracruz
***S. keerlii* Benth.**	NS	NS	Durango Guanajuato Hidalgo Michoacán Nuevo León Oaxaca Querétaro San Luis Potosí Tamaulipas Zacatecas
S. laevis Benth.	= *S. laevis* Benth. = *S. comosa* Peyr. = *S. comosa* var. *hypoglauca* Fernald. = *S. hypoglauca* Briq. = *S. pseudocomosa* Epling.	Salvia real Palmita	Durango Estado de México Guanajuato Hidalgo Jalisco Michoacán Oaxaca Puebla Querétaro San Luis Potosí Veracruz

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Scientific name	Botanical synonymy / Varieties	Common name	Distribution in other states of Mexico
***S. lavanduloides* Kunth.**	= *S. agnes* Epling. = *S. humboldtiana* Schult. = *S. lavanduloides* Kunth var. *latifolia* Benth. = *S. fratrum* Standl. = *S. lavanduloides* var. *hispida* Benth. = *S. purpurina* La Llave.	Altamisa Alucena Azulilla Cantuesco Cenicilla Chabacal Ordoncillo Lucema Lúcuma Mazorquita Poleo Salvia morada *Yaxal nich vomol* (tzotzil) *Recámpona* (mazahua) *Cuetehton* (náhuatl)	Chiapas Estado de México Guerrero Hidalgo Michoacán Morelos Oaxaca Puebla Veracruz
***S. leucantha* Cav.**	= *S. bicolor* Sessé & Moc. = *S. discolor* Kunth. = S. *leucantha* f. *iobaphes* Fernald.	Algodoncillo Cordoncillo Cordón de Jesús Cordón de San Francisco Lana Rabo de gato Salvia cruz Salvia real Moco de pavo *Moradoxóchitl* (náhuatl) *Tochomixochitl*	Estado de México Hidalgo Michoacán Morelos Oaxaca Puebla San Luís Potosí Tabasco Zacatecas
***S. melissodora* Lag. Me Vaugh.**	= *S. scorodoniaefolia* Poir. = *S. scorodoniae* Desf. ex Poir. = *S. scorodoniaefolia* var. crenaea Fernald. = *S. scorodonia* Benth. = *S. dugesii* Fernald.	Orégano *Tkulh origan* (tepeh) *Tikolh origam*	Chihuahua Durango Guerrero Hidalgo Michoacán Oaxaca Zacatecas
***S. mexicana* L.**	= *S. mexicana* L. var. *mexicana* = *S. mexicana* var. *minor* Benth. = *S. mexicana* f. *minor* Sessé & Moc. = *S. mexicana* var. *major* Benth. = *Hemistegia mexicana* (L.) Raf. = *Jungia altissima* Moench. = *S. amethystina* Salisb. = *S. lupulina* Fernald. = *S. nitidifolia* Ortega. = *S. papilionacea* Cav. = *Sclarea mexicana* (L.) Mill. = *Sclarea mexicana* (L.) Dill.	Chía Marrubio Tacote Tapachichi *Azul-sipari* (purépecha) *Charahuesca* (purépecha) *Ichukuta* (purépecha) *Tapachichi*	Chiapas Chihuahua Jalisco Michoacán Morelos Oaxaca Sinaloa Tlaxcala Veracruz Zacatecas

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Scientific name	Botanical synonymy / Varieties	Common name	Distribution in other states of Mexico
***S. microphylla* H.B. & H.**	= *S. microphylla* Kunth. var. microphylla. = *S. microphylla* var. neurepia. = *S. grahamii* Benth. = *S. lemmonii* A. Gray. = *S. microphylla* Sessé & Moc. = *S. microphylla* var. canescens A. Gray. = *S. microphylla* var. wislizeni A. Gray. = *S. obtusa* M. Martens & Galeotti. = *S. odoratissima* Sessé & Moc. = *S. lesemia coccinea* Raf.	Diente de acamaya Hierba de mirto Mastranzo Mirto Mirto blanco Mirto de castilla Mirto chico Mirto de huerto Mirto violeta Toronjil Verbena Mistro Mistru *Mishto* (tzotzil) *Tzil bomol* (tzotzil) *Ix tasalak* (tepehua) *Mustia* (purepecha) *Kaisto nchia* (popoloca)	Chiapas Durango Estado de México Guanajuato Hidalgo Jalisco Michoacán Nuevo León Puebla Tamaulipas Veracruz
***S. misella* Kunth.**	= *S. riparia* Kunth. = *S. lateriflora* Fernald. = *S. obscura* Benth. = *S. viscosa* Sessé & Moc. = *S. privoides Benth*. = *S. occidentalis* var. *obscura* (Benth.) M. Gómez	Chía Hierba del cáncer Hierba de golpe Quelite lengua de toro Venenosa	Baja California Guerrero Michoacán Tamaulipas Veracruz
S. mocinoi Benth.	= *S. lophantha* Benth. = *S. rubiginosa* Benth. = *S.* rubiginosa var. hebephylla Fernald. = *S. saltuensis* Fernald = *S. zacuapanensis* Brandegee. = *S. lophanthoides* Fernald.	NS	Guerrero Jalisco Michoacán Puebla
***S. moniliformis* Fern.**	NS	NS	Estado de México Morelos
***S. oreopola* Fern.**	NS	NS	Estado de México Morelos Oaxaca
***S. patens* Cav.**	= *S. decipiens* M. Martens & Galeotti. = *S. grandiflora* Née ex Cav. = *S. macrantha* Schltdl. = *S. spectabilis* Kunth. = *S.* staminea M. Martens & Galeotti.	Flor de gallito Quiquiriquí Mirto Mirto azul	Estado de México Hidalgo Michoacán San Luis Potosí

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Scientific name	Botanical synonymy / Varieties	Common name	Distribution in other states of Mexico
***S. polystachya* Cav.**	= *S. polystachya* Ort. = *S. brevicalyx* Benth. = *S. caesia* Willd. = *S. cataria* Briq. = *S. compacta* Kuntze. = *S. compacta* var. *irazuensis* Kuntze. = *S. compacta* var. *latifolia* Kuntze. = *S. compacta* var. *oerstediana* Kuntze. = *S. durandiana* Briq. ex T. Durand & Pittier. = *S. eremetica* Cerv. ex Lag. = *S. flexuosa* C. Prezl ex Benth. = *S. lilacina* Fernald. = *S. lineatifolia* Lag. = *S. menthiformis* Fernald. = *S. polystachya* var. albicans Fernald. = *S. polystachya* subsp. *caesia* (Humb. & Bonpl.) Briq. = *S. polystachya* subsp. *compacta* (Kuntze) Alziar. = *S. polystachya* subsp. *durandiana* Briq. = *S. polystachya* var. philippensis Fernald. = *S. polystachya* var. potosiana Briq. = *S.* polystachya var. seorsa Fernald. = *S. reducta* Epling.	Alchichía Azulema Chía de campo Hierba chica Lucemilla Mirto Poleo azul Romerillo Santomexochitl Ulcema *Xilpapah*	Chiapas Colima Estado de México Guanajuato Guerrero Hidalgo Jalisco Michoacán Morelos Nayarit Oaxaca Puebla Querétaro San Luis Potosí Tamaulipas Tlaxcala Veracruz
***S. prunelloides* Kunth.**	= *S. prunelloides* f. *minor* Loes. = *S. rhombifolia* Sessé & Moc. = *S. trichandra* Briq.	Hierba de gallo Oreja de venado Salvia azul *Suimalh nanakl* (tepech)	Chiapas Durango Michoacán Nuevo León San Luis Potosí Zacatecas
***S. pulchea* DC.**	= *S. ancistrocarpha* Fernald. = *S. doliostachys* Lag. ex Benth.	NS	Estado de México Michoacán
***S. reflexa* Hornem.**	= *S. aspidophylla* Schult. = *S. trichostemoides* Pursh.	Almaraduz grande Chía Mimititán	Estado de México Michoacán Nuevo León Zacatecas
***S. reptans* Jacq.**	= *S. angustifolia* Cav. = *S. angustifolia* var. *glabra* Briq. = *S. angustifolia* var. *glabra* A. Gray. = *S. heterotricha* Fernald. = *S. leptophylla* Benth. = *S. linearis* Sessé & Moc. = *S. linifolia* M. Martens & Galeotti. = *S. virgata* Ortega. = *S. unicostata* Fernald.	Hierba de golondrina Hierba de pozuña Romerillo	Chiapas Estado de México Hidalgo Jalisco Michoacán Puebla Zacatecas

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Scientific name	Botanical synonymy / Varieties	Common name	Distribution in other states of Mexico
***S. stachyoides* Kunth.**	= *S. elongata* Kunth. = *S. stricta* Sessé & Moc. = *S. simplex* Spreng. = *S. betónica* Schult.	Salvia Negra	Michoacán Morelos Veracruz
***S. tiliifolia* Vahl.**	= *S. fimbriata* Kunth. = *S. myriantha* Epling. = *S. obvallata* Epling. = *S. psilophylla* Epling. = *S. tiliifolia* Lag. = *S. tiliifolia* var. *albiflora* (M. Martens & Galeotti) L.O. Williams. = *S. tiliifolia* var. *alvajaca* (Oerst.) L. O. Williams. = *S. tiliifolia* var. cinerascens Fernald. = *S. tiliifolia* var. rhyacophila Fernald. = S. tiliaefolia Vahl.	Chia chimarrona Chupona Hierba de gallo Limpia tuna Tronadora	Chiapas Hidalgo Michoacán Nuevo León Sonora Tamaulipas Veracruz Zacatecas
***S. tubifera* Cav.**	= *S. excelsa* Benth. = *S. monochila* Donn. Sm. = *S. venosa* Fernald. = *S. longiflora* Willd.	NS	Hidalgo Guerrero Veracruz
***S. verbenacea* L.**	= S. *vervenaca* L.	NS	NS

NS = Not specified

Botanical characteristics

The different species of the *Salvia* genus have similar morphological characteristics [31]. Table 3 enlists some botanical characteristics reported by Ramamoorthy in 2001 [9], complemented by Lara-Cabrera [32]. Most of these species (75.5 %) are "perennial herbaceous" of 0.15 m (*S. helianthemifolia* Benth.) to 4 m (*S. fulgens* Cav.) and can be found at different altitudes ranging from 650 to 2400 meters. In the different species, the leaves vary in size from 5-8 mm to 50-140 mm long and have various shapes, from elliptical to ovate. The flowering time in plants is of great importance; it involves essential changes in metabolism and the translocation of nutrients, ensuring the production of seeds and, therefore, the survival of the species [33,34]. In the salvias studied, it was possible to document data on flowering times for 14 species, less than half (42.2 %) of the studied plants, and no pattern was observed in these data, so it is possible to find different species of *Salvia* in bloom throughout the year. The colours of the bilabiate calyx and the corolla are also diverse (red, pink, blue, lilac, and white), although the blue corolla is predominant (69.7 %). However, in at least nine species (27.3 %), the colour of the corolla can be variable. Habitat and altitude, among other abiotic and biotic environmental factors, can modify their physical or chemical characteristics, impacting the secondary metabolism's evolution and phenotypic plasticity [35].

Considering the similarity observed in the distinct S*alvia* species, it is essential and necessary to take special care in the taxonomic identification to avoid correlation errors and extrapolation [26], which could put in risk the reproducibility and continuation of pharmacological and chemical studies with these species [2,30]. The chemical composition varies between species, seasons, and habitats, as well as the stage of development or the plant organ (ontogeny of leaves, flowers, and fruits), factors that lead to significant qualitative differentiations where the composition can undergo significant changes. Some components can vary from traces (10 %) in the initial stages up to 50-70 % in the full bloom stage [36], which should be considered in phytochemical studies.

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Table 3. Botanical characteristics of *Salvia* species from Valle de México. [10]

Plant name	Habitat	Leaves	Flowers	Flowering	Altitude range (meters)	Vegetation
S. axillaris	Perennial-herbaceous Ascending: NS	Sessile obovate to oblanceolate Rounded apex 7 - 12 x 30 - 45 mm	Bilabiate calyx Corolla: Light lilac / white	NS	2400-2800	Grasslands Bushes Quercus forest Juniperus forest
S. carnea	Perennial-herbaceous Ascending: 0.5-1.5 m	Ovate Acuminate apex 30 - 90 x 20 - 60 mm	Bilabiate calyx Corolla: Pink / White	Sep - May	2800-3500	Mountain mesophyll forest Quercus forest Pinus forest Pinus-Quercus Forest Abies forest
S. chamaedryoides	Herbaceous-perennial / subshrub Ascending: 20-80 cm	Ovate to deltoid-elliptic Rounded apex 6 - 20 x 3 - 10 mm	Bilabiate calyx Corolla: Blue	NS	2300-2800	Grassland Bushes Quercus forest Juniperus forest
S. circinata	Perennial-herbaceous Ascending: 30 cm-1.5 m	Ovate Acumite apex 30 - 100 x 12 - 45 mm	Bilabiate calyx Corolla: Blue-purple/white	Aug - Nov	1650-2800	Grassland Bushes Disturbed Areas
S. concolor	Perennial-herbaceous Ascending: 50 cm-2 m	Ovate to ovate-deltoid Acuminate apex 50 - 120 x 30 - 120 mm	Bilabiate calyx Corolla: Dark blue.	Sep	2650-3300	Coniferous forest Mesophilic forest
S. elegans	Perennial-herbaceous / Bushy Ascending: 80 cm-2m	Ovate Acute apex 8 - 6 x 6 - 35 mm	Bilabiate calyx Corolla: Red	NS	2550-3100	Mountain mesophyll forest Abies forest Pinus forest Quercus forest
S. filifolia	Perennial-herbaceous Ascending: ± 35 cm	Sessile Lineal sometimes Oblanceolate / narrowly-oblanceolate Acute apex 10 - 60 x 2 - 3 mm	Bilabiate calyx Corolla: Blue	Jul - Nov	2390-2800	Encino deteriorated forest Pinus forest Quercus forest

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Plant name	Habitat	Leaves	Flowers	Flowering	Altitude range (meters)	Vegetation
S. fulgens	Arbustive Ascending: 1-4 m	Ovate Acute apex 30 - 140 x 15 - 70 mm	Bilabiate calyx Corolla: Deep red/white	NS	2650-3400	Mountain mesophyll forest Juniperus forest Mixed forest Pinus-Encino Forest
S. gesneriiflora	Climbing shrub Ascending: 80 cm-2.5 m	Ovate RouNSed apex 30 - 110 x 30 - 80 mm	Bilabiate calyx Corolla: Red	Oct - May	1950-3200	Mesophyll forest Quercus forest Mixed forest Coniferous forest Pinus forest Pinus-Quercus Forest Shores of agricultural crops
S. helianthemifolia	Perennial-herbaceous Ascending: 15-70 cm	Elliptic-orbicular Rounded apex 10 - 50 x 4 - 20 mm	Bilabiate calyx Corolla: Blue	Aug - Apr	2000-3200	Mountain mesophyll forest Quercus forest Pinus forest Pinus-Quercus Forest Coniferous forest Secondary scrub
S. hirsuta	Perennial-herbaceous Ascending: 20-60 cm	Oblong-elliptic Obtuse apex 20 - 35 x 10 - 14 mm	Bilabiate calyx Corolla: Blue	Jun - Oct	2250 – 2600	Grasslands Scrubs Disturbed areas
S. hispanica	Perenne Ascending: 1 m	Ovate-lanceolate Acuminate apex 30 - 60 x 10 - 20 mm	Bilabiate calyx Corolla: Purple/blue	Sep - Nov	2050-2500	Quercus forest Tropical deciduous forest Mixed forest
S. keerlii	Bushy Ascending: 1-3.5 m	Ovate Acute-obtuse apex 20 - 40 x 7 - 30 mm	Bilabiate calyx Corolla: Blue to purple/white	Jul - Dec	2170-3100	Quercus forest Juniperus forest Pinus-Quercus Forest Juniperus-quercus forest Submontane xerophytic scrubland

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Plant name	Habitat	Leaves	Flowers	Flowering	Altitude range (meters)	Vegetation
S. laevis	Perennial-herbaceous Ascending: 30-70 cm	Lanceolate-oblong-lanceolate Acute apex 25 - 80 x 3 - 12 mm	Bilabiate calyx Corolla: Blue	Jun - Nov	1520 -3200	Quercus forest Xerophytic scrubland Abies forest Pinus forest Pinus-Quercus Forest Mesophyll forest Grasslands Scrubs
S. lavanduloides	Perennial-herbaceous Ascending: 50 cm-1 m	Elliptic Acute apex 30 - 90 x 6 - 15 mm	Bilabiate calyx Corolla: Blue	Oct - May	1650 -3300	Mountain mesophyll forest Quercus forest Pinus-Quercus Forest Mixed forest Secondary vegetation
S. leucantha	Ascending: 45 cm-1 m	Lanceolate Acute apex 40 - 120 x 4 - 18 mm	Bilabiate calyx Corolla: White and covered with purple hair	Sep - Dec	1000-2800	Pinus forest Encino forest Xerophytic scrublands
S. melissodora	Perennial-herbaceous Arbustive Ascending: 50 cm-2 m	Oval Ovate-oblong / ovate-deltoid Acute apex 10 - 50 x 70 - 30 mm	Bilabiate calyx Corolla: Blue-purple/white	Jul - Mar	1550 - 2600	Xerophytic scrubland Slopes Hill
S. mexicana	Perennial-herbaceous Arbustive Ascending: 50 cm-3 m	Ovate Acuminate apex 60 - 180 x 25 - 120 mm	Bilabiate calyx Corolla: Blue	NS	2250 - 3000	Quercus forest Pinus forest Disturbed areas
S. microphylla	Arbustive Ascending: 40 cm-1.5 m	Elliptic oval or deltoid Acute to rounded apex 10 - 70 x 4 - 30 mm	Bilabiate calyx Corolla: Red	NS	NS	Juniperus forest Encino forest Mixed forest Evergreen forest Pinus forest Pinus-Encino Forest Xerophytic scrubland Grassland

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Plant name	Habitat	Leaves	Flowers	Flowering	Altitude range (meters)	Vegetation
S. misella	Perennial-herbaceous Ascending: 50 cm-1.5 m	Opposite sessile/elliptic Acuminate apex 20 - 50 x 10 - 20 mm	Bilabiate calyx Corolla: Blue	NS	650-2250	Mountain mesophyll forest Disturbed vegetation of tropical deciduous forest The transition zone between the mountain mesophyll and encino forest
S. mocinoi	Perennial-herbaceous Arbustive Ascending: 50 cm-2 m	Ovate Acute / acuminate apex 15 - 55 x 6 - 28mm	Bilabiate calyx Corolla: Blue	NS	2400-2650	Mountain mesophyll forest Pinus forest Oak forest
S. moniliformis	Perennial-herbaceous Ascending: 40 cm-1 m	Elliptic Acute apex 20 a 35 x 8 – 10 mm	Bilabiate calyx Corolla: Blue	NS	2300-2800	Mountain mesophyll forest Coniferous forest Pinus forest Oyamel forest
S. oreopola	Herbaceous Ascending: ± 40 cm	Deltoid-ovate Acute apex 14 - 40 x 10 - 35 mm	Bilabiate calyx Corolla: Blue	NS	2600	Pinus forest
S. patens	Perennial-herbaceous Ascending: 30 cm-1 m	Ovate to ovate-deltoid Acute apex 50 - 140 x 40 - 120 mm	Bilabiate calyx Corolla: Blue	NS	2500-2800	Quercus forest
S. polystachya	Perennial-herbaceous Arbustive Ascending: 50 cm-3.5 m	Ovate - elliptic Acuminate apex 30 - 140 x 20 - 70 mm	Bilabiate calyx Corolla: Blue-violet/white	Jun.-Nov.	2250-2900	Encino forest Pinus forest Grassland Secondary scrub Disturbed areas
S. prunelloides	Perennial-herbaceous Ascending: 15-40 cm	Rhomboid Ovate-rhomboid / oblong Acute to rounded apex 7 - 60 x 7 - 27 mm	Bilabiate calyx Corolla: Blue	NS	2400-3600	Coniferous forest

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Plant name	Habitat	Leaves	Flowers	Flowering	Altitude range (meters)	Vegetation
S. pulchea	Perennial-herbaceous Arbustive Ascending: 1-2 m	Ovate Acute-acuminate apex 25 - 140 x 25 - 60 mm	Bilabiate calyx Corolla: Red	NS	2350-2400	Grassland Xerophytic scrubland
S. reflexa	Perennial-herbaceous Ascending: 20 cm-1 m	Oblong-elliptic / linear Acute apex 15 - 60 x 4 - 10 mm	Bilabiate calyx Corolla: White	NS	2250-2600	Scrub Disturbed areas
S. reptans	Perennial-herbaceous Ascending: 30 cm-1 m	Linear or linear-oblong Acute-rounded apex 5 - 8 x 1 - 5 mm	Bilabiate calyx Corolla: Purple/blue	NS	2300-2700	Pinus forest Encino forest Grassland Scrub Disturbed areas
S. stachyoides	Perennial-herbaceous AsceNSing: 50 cm-1 m	Elliptic Acute apex 25 - 70 x 7 - 32 mm	Bilabiate calyx Corolla: Blue	NS	2800-3100	Pinus forest Grassland
S. tiliifolia	Perennial-herbaceous Ascending: 20 cm-1.5 m	Ovate-orbicular Acute apex 10 - 50 x 10 - 50 mm	Bilabiate calyx Corolla: Blue	NS	2300-2600	Ruderal weed
S. tubifera	Perennial-herbaceous Ascending: ± 2 m	Ovate-orbicular Acuminate apex 50 - 160 x 40 - 110 mm	Bilabiate calyx Corolla: Scarlet red	NS	2300	Xerophytic scrubland
S. verbenacea	Herbaceous Ascending: ± 20 cm	Ovate-oblong Rounded apex 50 - 90 x 20 - 56 mm	Bilabiate calyx Corolla: Blue	NS	2300	NS

NS: Not specified

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Traditional uses and pharmacology

Regarding Traditional Medicine, Mexico is recognized as the second most important country in the world that uses that kind of therapy, with a tremendous ancestral tradition and richness in the use of medicinal plants to treat different diseases and for ritual, only right after China [37]. The different ethnic groups living in Mexico maintain deep and ancestral knowledge of medicinal plants as traditional practices and beliefs about diseases and cures [37]. This cultural legacy dates back to published works written in the 16th century and still survives in modern Mexico [38]. The use and knowledge of medicinal plants by the Mexican population is a common practice for three main reasons: 1) the need to treat diseases, 2) an extensive flora, and 3) the existence of many indigenous groups that preserve their traditions [39]. Unsurprisingly, the population turns to various species of *Salvia* to treat diverse ailments, given the botanical abundance and diversity these plants represent in Mexico.

Table 4 provides a detailed account of the ethnobotanical uses we have documented for the 33 *Salvia* species included in this study. Based on our data, we can infer that leaves are the most frequently employed part of various *Salvia* species. This preference arises due to the ease of leaf collection and the minimal impact on plant viability. In some cases, the complete plant, or other parts of the plant (roots and steam) used are specifically described. Comparing the metabolites expressed in different plant parts is essential to comprehensively understand metabolite synthesis. Investigating whether specific compounds are localized to certain plant regions or distributed uniformly across the entire plant represents a critical avenue for further research.

Of the 33 species registered in the Valle de México, 20 are used for everyday purposes, mainly *S. verbenacea*, *S. polystachya*, *S. lavanduloides*, and *S. elegans* (Fig. 2). These species' most frequently reported uses were gastrointestinal diseases, such as stomach pain and diarrhea. Notably, diarrhea remains a significant health problem in Mexico, ranking as the second most common ailment across all age groups [40]. Additionally, these *Salvia* species find application in promoting childbirth, managing gynecological issues (such as menstrual colic), and serving as antipyretic agents. Furthermore, they are utilized for wound treatment, diabetes management, and respiratory conditions (Table 4).

Pharmacological studies play an essential role in unraveling the therapeutic potential of medicinal plants. In the case of *Salvia* species, approximately 13 out of the 33 species (representing 39 %) have undergone pharmacological scrutiny involving investigations into extracts, fractions, and isolated compounds. A total of 28 distinct pharmacological effects have been documented, with notable prominence given to antioxidant, anti-bacterial, and anti-hyperglycemic properties. Among the studied species (Fig. 2), *S. verbenacea* stands out with 11 reported pharmacological activities, followed by *S. polystachya* (9 activities) and *S. circinata* (5 activities). The predominant mode of preparation for these species involves herbal infusions or tisanes, in which the bioactive compounds are extracted using water and heat [41].

Table 4 provides a comprehensive overview of pharmacological studies across diverse *Salvia* species. Notably, cytotoxic and anticancer activities emerge as promising avenues, offering new prospects for cancer treatment. Some species exhibit anti-bacterial, anti-fungal, and anti-parasitic effects. Other species are also used for treating fever, rheum, and edema, while their anti-inflammatory, antinociceptive, and antipyretic actions are similar to non-steroidal anti-inflammatory drugs (AINEs). The actions at the level of the nervous system, derived by their traditional uses of cultural connotation ("susto," "mal de ojo," "aire"), were recorded as anti-depressants, anxiolytics, and neuroprotective in different experimental conditions.

Interestingly, our pharmacological investigations align with the effects observed in traditional medicine. Specifically, many studies have focused on medicinal plant species' gastrointestinal and gynecological effects. However, it is crucial to emphasize that the number of research validating these plants' traditional uses is limited. For example, while 120 traditional uses have been documented for 20 species, only 42 specific studies have been conducted on 12 *Salvia* species (Fig. 3). Even more pertinent is that only a handful of these studies have developed into identifying the pure compounds responsible for those effects. Some species have yet to be studied; for example, based on this work, species such as *S. filifolia* and *S. laevis* lack pharmacological studies that support the attributed medicinal uses; furthermore, no specific compounds have been identified in these species.

Our comprehensive review underscores the imperative to validate the diverse traditional uses attributed to *Salvia* species. Certain species, such as *S. polystachya and S. circinata*, have been associated with hypoglycemic effects through the inhibition of α-glucosidases and sodium-dependent glucose cotransporter-1 (SGLT-1) [28,42]. Furthermore, *Salvia* species find application in hypertension management, with emerging evidence at the vascular level. However, studies supporting these effects in other *Salvia* species remain scarce and underscore the need for multidisciplinary research, including bioassay-guided studies, to validate all traditional uses.

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Table 4. Medicinal uses and pharmacological effects of identified *Salvia* species from the Valle de México.

Plant name	Traditional use	Part used										Pharmacological effect	Extract			Ref.
		Cp	Ap	L	B	S	F	R	Sd	Fr	NS		Ext	Frt	IC	
S. axillaris	Expectorant										X					[70]
S. chamaedryoides	"Espanto"				X							Anti-bacterial	X	X	X	[71–72]
	Abortive										X	Hypoglycemic	X	X	X	
	"Aire"				X											
S. circinata	"Espanto"			X								Anti-conceptive	X	X	X	[16,29, 71-75]
	"Aire"			X								Anti-hyperglycemic	X		X	
	Analgesic										X	Anti-inflammatory	X		X	
	Anti-diabetic			X								Anti-MDR			X	
	Diarrhea			X	X							Cytotoxic			X	
	Helminthiases										X					
	Lack of appetite			X												
	Menstrual colic			X												
	Rheumatism	X														
	Stomachache										X					
	Ulcers										X					
	Vomit			X												

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Plant name	Traditional use	Part used										Pharmacological effect	Extract			Ref.
		Cp	Ap	L	B	S	F	R	Sd	Fr	NS		Ext	Frt	IC	
S. elegans	"Espanto"	X			X							Anti-hypertensive	X	X		[8,39, 71,72, 76-82]
	"Mal de ojo"										X	Anti-depressant	X			
	"Aire"	X										Anxiolytic	X			
	"Aire" (in babies)			X		X	X									
	Anxiety										X					
	Cooling	X														
	Cough										X					
	Fever								X							
	Injured feet										X					
	Insomnia	X		X												
	Knocking / edema			X	X	X		X								
	Measles			X		X		X								
	Pain in the knees										X					
	Postpartum			X		X		X			X					
	Relapse of Ladies						X									
	Sick shower			X		X	X									
	Skin rashes										X					

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Plant name	Traditional use	Part used										Pharmacological effect	Extract			Ref.
		Cp	Ap	L	B	S	F	R	Sd	Fr	NS		Ext	Frt	IC	
S. elegans	Stimulate saliva										X					[8,39, 71,72, 76-82]
	Stomachache			X		X		X								
	Vomit										X					
S. filifolia	Deposition										X					[83]
S. fulgens	"Fuegos" induced by fever									X						[39,72]
	Sleeping draught				X	X										
	Sleeping draught (infants)			X		X	X									
S. gesneriiflora	Diarrhea			X								Antioxidant	X			[40,76, 84,85]
	Stomachache			X								Spasmolytic	X			
												Anti-inflammatory	X			
S. hispanica	Bile										X	Antioxidant	X			[4,39, 84]
	Cathartic										X					
	Cough										X					
	Diarrhea	X						X								
	Expulsion of larvae / foreign bodies from the eyes								X							
	Eye burns										X					
	Labor pain										X					

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Plant name	Traditional use	Part used										Pharmacological effect	Extract			Ref.
		Cp	Ap	L	B	S	F	R	Sd	Fr	NS		Ext	Frt	IC	
S. hispanica	Laxative										X					[4,39, 84]
	Muscle pain			X												
	Nutritional supplement								X							
	Spit blood										X					
S. laevis	Kidney diseases			X												[72,76, 86]
	Promote conception				X											
S. lavanduloides	"Torzón"										X					[39,72, 79,81, 87]
	"Aire"					X										
	Alopecia			X	X											
	Anti-dysentery			X	X											
	Antipyretic			X	X											
	Bronchitis			X	X		X									
	Coldness (children)										X					
	Controlling vaginal bleeding										X					
	Cough			X	X		X									
	Diarrhea										X					
	Fever										X					

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Plant name	Traditional use	Part used										Pharmacological effect	Extract			Ref.
		Cp	Ap	L	B	S	F	R	Sd	Fr	NS		Ext	Frt	IC	
S. lavanduloides	Gallbladder condition			X		X	X									[39,72, 79,81, 87]
	Gynecological diseases										X					
	Hemostatic			X	X											
	Oxytocic			X	X											
	Paralysis										X					
	Stomachache										X					
	Toothache										X					
	Vomit										X					
	Wash wounds										X					
	Whooping cough			X	X											
S. leucantha	"Espanto"						X					Anti-bacterial			X	[4,39, 71,72, 76,87-89]
	Abortive	X		X								Cytotoxic			X	
	"Aire"	X			X											
	Bile (courage)	X														
	Chest/lung pain	X		X												
	Cough			X												
	Kidney Diseases				X						X					

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Plant name	Traditional use	Part used										Pharmacological effect	Extract			Ref.
		Cp	Ap	L	B	S	F	R	Sd	Fr	NS		Ext	Frt	IC	
S. leucantha	Liver disease				X						X					[4,39, 71,72, 76,87-89]
	Matrix fall						X									
	Menstrual colic			X												
	Postpartum				X											
	Relapse of ladies				X											
	Stomachache	X		X												
	Stops menstruation			X												
S. melissodora	Diarrhea										X					[79,90]
	Pain										X					
S. mexicana	Bile			X								Anti-inflammatory	X			[72,79, 91,92].
	Diarrhea			X								Antioxidant	X			
	Menstrual colic			X												
	Promote conception	X														
	Stomachache										X					
S. microphylla	“Empacho”	X			X						X	Anti-microbial			X	[39-40,72, 76,83, 84,89, 93,94]
	“Espanto”	X		X	X						X					
	“Mal de ojo”						X									

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Plant name	Traditional use	Part used										Pharmacological effect	Extract			Ref.
		Cp	Ap	L	B	S	F	R	Sd	Fr	NS		Ext	Frt	IC	
S. microphylla	"Aire"															[39-40,72,76,83,84,89,93,94]
	Anti-dysentery			X	X											
	Bile										X					
	Bone strengthening															
	Diarrhea			X							X					
	Earache			X												
	Gynecological diseases	X														
	Headache			X												
	Insomnia				X											
	Leg scald				X											
	Menstrual colic			X							X					
	Nerves						X									
	Postpartum baths			X	X											
	Promote conception				X						X					
	Stomachache			X	X											
	Waist pain				X											

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Plant name	Traditional use	Part used										Pharmacological effect	Extract			Ref.
		Cp	Ap	L	B	S	F	R	Sd	Fr	NS		Ext	Frt	IC	
S. misella	Bruising			X		X						Antioxidant	X			[39,95, 96]
	Erysipelas			X			X									
	Skin rashes					X										
	Warts			X		X										
	Wash wounds			X		X										
S. patens	Children's restroom (3 months)										X					[77]
	Infected wounds										X					
	Joint heating										X					
S. polystachya	Anti-abortion				X							Anti-protozoal	X			[39-40,72, 76,83, 84,89, 93,94]
	Anti-diuretic										X	Anti-amoebic			X	
	Anti-dysentery								X			Anti-giardial			X	
	Anti-gastric										X	Anti-hyperglycemic	X	X	X	
	Anti-hemorrhagic										X	Antioxidant	X			
	Anti-malarial										X	Acts over dermal fibroblast expression			X	
	Antipyretic										X	Protective (Cerebral ischemia)	X			
	Scabies										X	α-Glucosidase Inhibitor			X	

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Plant name	Traditional use	Part used										Pharmacological effect	Extract			Ref.
		Cp	Ap	L	B	S	F	R	Sd	Fr	NS		Ext	Frt	IC	
S. polystachya	Diarrhea				X							SGLT1 Inhibitor			X	[39-40,72,76,83,84,89,93,94]
	Diuretic				X											
	Emollient										X					
	Flu										X					
	Gastritis				X											
	Hair growth				X											
	Headache				X											
	Menstrual colic				X											
	Nosebleed			X	X											
	Parasites				X											
	Promote conception	X														
	Purgative				X						X					
	Stomachache										X					
	Wounds disinfect	X														
	Wound healing	X														
S. reflexa	Stomach affections	X														[72]

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Plant name	Traditional use	Part used										Pharmacological effect	Extract			Ref.
		Cp	Ap	L	B	S	F	R	Sd	Fr	NS		Ext	Frt	IC	
S. reptans	Diarrhea	X			X	X						Anti-bacterial	X	X	X	[72,94]
	Fever	X														
	Stomachache	X			X	X										
	Swelling	X				X										
	Twists	X														
	Wound healing	X														
S. tiliifolia	Abscesses										X	Neuroprotective			X	[39,91, 92,95, 96,101]
	Mumps										X					
	Snake bite										X					
	Vomit										X					
S. verbenacea	Abscesses	X		X								Anti-bacterial				[20]
	“Aire”	X										Anticancer				
	Anti-hypertensive						X					Anti-fungal				
	Antipyretic			X								Anti-hemolytic				
	Anti-rheumatic			X								Anti-hyperglycemic				
	Antiseptic			X								Anti-hypertensive				
	Anti-spasmodic	X		X								Anti-leishmanial				

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Plant name	Traditional use	Part used										Pharmacological effect	Extract			Ref.
		Cp	Ap	L	B	S	F	R	Sd	Fr	NS		Ext	Frt	IC	
	Anti-sweat		X	X								Antioxidant				
	Anxiety										X	Anti-parasitic				
	Astringent		X	X								Immunomodulatory				
	Carminative		X	X								Inhibitory effect of xanthine oxidase				
	Wound healing	X		X			X	X		X		Skin effect				
	Cooling			X												
	Contusion		X													
	Cough	X														
S. verbenacea	Dermatological		X													[20]
	Diabetes		X													
	Digestive problems		X	X					X							
	Disinfectant		X	X												
	Diuretic			X												
	Fever			X												
	Genitourinary			X												
	Healing			X												
	Healing of burns	X		X												

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Plant name	Traditional use	Part used										Pharmacological effect	Extract			Ref.
		Cp	Ap	L	B	S	F	R	Sd	Fr	NS		Ext	Frt	IC	
S. verbenacea	Insomnia										X					[20]
	Laryngitis			X												
	Menstrual colic			X												
	Respiratory problems			X												
	Stomachache	X														
	Vulnerary		X	X												
	Wound treatment			X												
	Wound eyes			X												

Cp = Complete plant; Ap = Aerial parts, L = leaf; B = Branch; S = Steam; F = Flower; R = Root; Sd = Seed; Fr = Fruit; NS = Not specified; Ext = Extract; Fr = Fraction; IC = Isolated compound

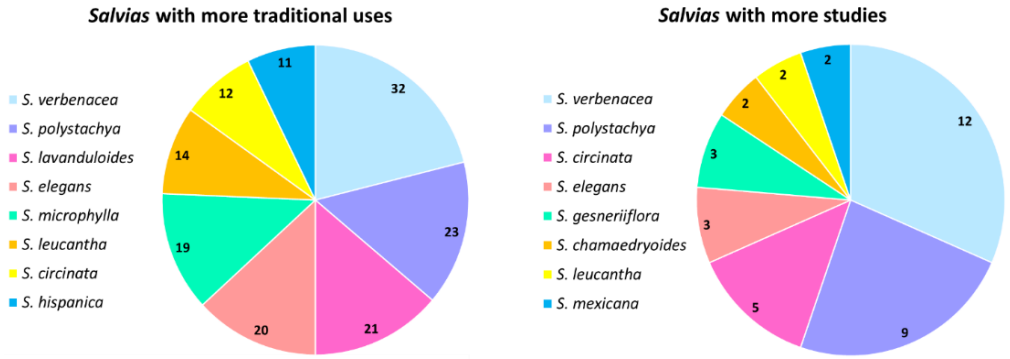


Fig. 2. Salvias traditionally more used and with more pharmacological studies.

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

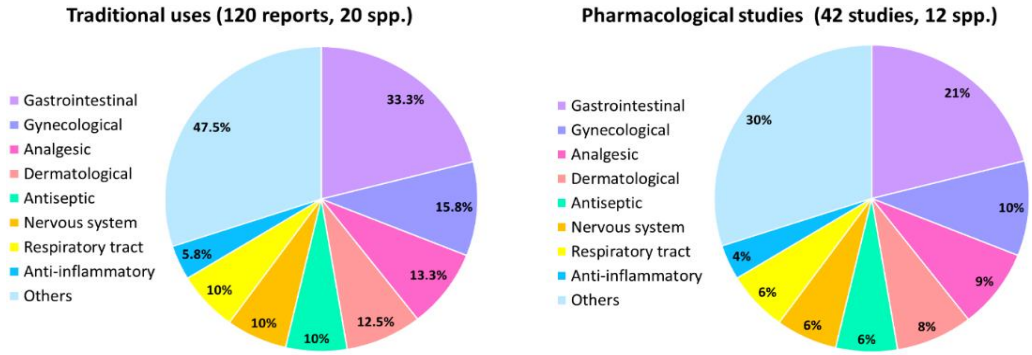


Fig. 3. More frequent traditional uses of Salvias and its most studied pharmacological effects.

Phytochemical studies

During the 1980s and 1990s, several research groups in Mexico, led by Alfredo Ortega, Lydia Rodriguez-Hahn, and Baldomero Esquivel, initiated innovative research focused on identifying compounds from extracts of Mexican sages. These first studies laid the foundation for subsequent research due to the rich content of secondary metabolites, including terpenoids and flavonoids. [43-47]. The aerial parts of these *Salvia* species, especially the flowers and leaves, harbor phenolic compounds, including flavonoids and terpenoids (such as monoterpenoids, diterpenoids, and triterpenoids); interestingly, diterpenoids were predominantly localized in the roots [46].

In conjunction with other phytochemical studies, we compiled information in Table 5 from 56 sources that report on compounds from 20 *Salvia* species, resulting in a total of 315 identified compounds (Fig. 4). Among these, *S. leucantha* stands out with an impressive 92 reported compounds, followed closely by *S. verbenacea* (81 compounds) and *S. circinata* (34 compounds). Notably, 43 of these compounds are described in more than one species, highlighting β-sitosterol, as well as ursolic and oleanolic acids that were reported in 8 and 7 different species of *Salvia*, respectively, compounds that have been identified as the most common terpenes in the *Salvia* genus [45,46], evidencing the phylogenetic relationships in these species.

Phenolic compounds and terpenoids are the main components in fruits, vegetables, and various spices used for nutritional purposes [48]. Interestingly, the therapeutic active principles in several plant-derived medicinal extracts are also flavonoids and terpenoids [49,50]. In plants, terpenoids exhibit the most remarkable structural diversity, which includes diverse subclassifications. For example, the diterpenoids could be classified as clerodanes, kauranes, abietanes, or casbanes, to name a few [51]. They provide a chemical defense against environmental stress and a mechanism to repair wounds and injuries. In addition, mainly monoterpenes are usually responsible for the characteristic fragrance of many plants (pollinator attraction). On the other hand, high concentrations of terpenoids can be toxic and, therefore, constitute an essential weapon against herbivores and pathogens, such as anti-food or insecticides [44,51-54].

In recent years, there has been growing pharmacological interest in these compounds due to their diverse biological activities that can focus on the prevention and therapy of various diseases, as documented in various studies. Our research data further support this trend, revealing that many of the 315 compounds documented (Table 5) are terpenoids (mainly diterpenes, sesquiterpenes, and monoterpenes). While the phytochemical studies on *Salvia* species do not explicitly focus on identifying biological effects, some working groups have determined that diterpenes stand out mainly for their anti-inflammatory, antitumor, anti-diabetic, and antiviral activities. The monoterpenes show anti-microbial activity against pathogens such as *Mycobacterium tuberculosis* [55] and inhibit the growth of fungi such as *Rhizoctonia solani* [56]. For their part, sesquiterpenes have been shown to have a broad spectrum of biological activities that include anti-microbial, cytotoxic, anti-inflammatory, anti-bacterial, anticancer, antiviral, and anti-fungal properties, in addition to exerting effects on the central nervous and cardiovascular systems [57].

As previously mentioned, among the most reported compounds in these *Salvias* species are the pentacyclic triterpenes: the ursolic acid, a triterpenoid, is extensively studied and boasts a multitude of biological effects: it acts as an insulin mimetic, insulin sensitizer, anti-inflammatory, antioxidant, anticancer, anti-obesity,

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

anti-diabetic, antiangiogenic, anti-microbial, cardioprotective, neuroprotective, hepatoprotective, anti-skeletal muscle atrophy and thermogenic [31,58-60]. Likewise, oleanolic acid, an isomer of ursolic acid, has effects such as hepatoprotective, anti-inflammatory, anti-hyperglycemic, antioxidant, anticancer, and neuroprotective [42,60,61]. Another noteworthy compound reported in various *Salvias* species is β-sitosterol, a phytosterol whose chemical structure is similar to cholesterol, which has diverse biological actions described that include anxiolytic, sedative, analgesic, angiogenic, anthelmintic, antimutagenic, immunomodulatory, anti-bacterial, anticancer, anti-inflammatory, genotoxic, hypolipidemic, hypocholesterolemic, hepatoprotective, and respiratory diseases; furthermore, β-sitosterol promotes wound healing and exhibits antioxidant and anti-diabetic effects [62,63].

Another important group of compounds in the *Salvia* species are the flavonoids, a class of polyphenolic compounds that are naturally biosynthesized in plants. The subgroups of flavonoids include flavones, flavonols, flavanones, flavanonols, anthocyanidins, flavanols, and isoflavones [64,65]. Flavonoids have long been known to be synthesized at specific sites. They are responsible for the color and aroma of flowers and fruits to attract pollinators, protect plants from different biotic and abiotic stresses, and act as unique UV filters, detoxifying agents, and defensive anti-microbial compounds [64-67]. These natural products are well known for their beneficial effects on health, such as anti-diabetic, antiulcer, antiviral, antioxidant, anti-inflammatory, antimutagenic, cytotoxic, and anticarcinogenic [64,65,68].

The diverse compounds described from the *Salvia* species (Fig. 4) are evidence of structural variability, mainly from the terpenoid structures, where a minimum change in the position or the presence and absence of some functional groups changes the type of compound reported. This, in turn, could generate a different activity that can be observed in biological assays [28]. Besides, some of the same compounds in different species could not be at the same concentration [30,69] and might affect the expected effect.

Table 5. Isolated compounds of *Salvia* species from Valle de México.

Scientific name	Parts used	Extract(s) used	No.	Classification	Compounds	Ref..
S. axillaris	Aerial parts Roots	Acetone	1	Terpenoid	20-*nor*-abietane cryptotanshinone (cryptotanshinone)	[23, 102]
S. chamaedryoides	Aerial parts	Dichloromethane	-	-	Furano diterpenes	[22]
			2	Terpenoid	7α-hydroxybacchotricuneatin A	
			3	Polyphenol	Galdosol	
			4	Polyphenol	Rosmanol	
			5	Terpenoid	Salvimicrophyllin B	
			6	Terpenoid	Splendidin C	
			7	Terpenoid	Tilifodiolide	
S. circinata	Aerial parts Flowers Leaves	Acetone: Methanol Ethyl acetate Hexane Methanol Aqueous	8	Terpenoid	(*E*)-pinocarvyl acetate	[18, 23, 29, 73, 103-105]
			9	Flavonoid	2-(3,4-dimethoxy phenyl)-5,6-dihydroxy-7-methoxy-4H-chromen-4-one	
			10	Aromatic	3-methoxy-*p*-cymene	
			11	Flavonoid	5,6,4´-trihydroxy-7,3´-dimethoxyflavone	

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Scientific name	Parts used	Extract(s) used	No.	Classification	Compounds	Ref..
S. circinata	Aerial parts Flowers Leaves	Acetone: Methanol Ethyl acetate Hexane Methanol Aqueous	12	Flavonoid	5,7-*O*-diacetylacacetin	[18, 23, 29, 73, 103-105]
			13	Flavonoid	6-hydroxy luteolin	
			14	Terpenoid	Acetylamarissinin B	
			15-21	Terpenoid	Amarisolide A-G	
			22-25	Terpenoid	Amarissinins A-D	
			26	Flavonoid	Apigenin	
			27	Flavonoid	Apigenin-7-*O*-β-D-glucoside	
			28	Polyphenol	Caffeic acid	
			29	Polyphenol	Chlorogenic acid	
			30	Phenol	Ferulic acid	
			31	Terpenoid	Germacrene D	
			32	Flavonoid	Iso-quercitrin	
			33	Terpenoid	Oleanolic acid	
			34	Flavonoid	Pedalitin	
			35	Flavonoid	Phloretin	
			36	Flavonoid	Phlorizin	
			37	Flavonoid	Quercetin	
			38	Phenylpropanoid	Rosmarinic acid	
			39	Flavonoid	Rutin	
			40	Terpenoid	Spathulenol	
			41	Terpenoid	Teotihuacanin	
			42	Terpenoid	Ursolic acid	
			43	Terpenoid	α-amyrin	
			44	Terpenoid	α-bourbonene	
			45	Terpenoid	α-caryophyllene	
			46	Terpenoid	β-caryophyllene	
			47	Terpenoid	β-selinene	

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Scientific name	Parts used	Extract(s) used	No.	Classification	Compounds	Ref..
S. circinata	Aerial parts Flowers Leaves	Acetone: Methanol Ethyl acetate Hexane Methanol Aqueous	48	Terpenoid	β-sitosterol	[18, 23, 29, 73, 103-105]
			49	Terpenoid	δ-elemene	
S. elegans	Flowers Leaves Seeds	Aqueous ethanol	50	Alcohol	2-propanol	[8,80, 82,106]
			51	Flavonoid	3-acetoxy-7-methoxyflavone	
			52	Alcohol	3-octanol	
			53	Amino acid	Cystine	
			31	Terpenoid	Germacrene D	
			54	Terpenoid	Hederagenin (3β,23-dihydroxyolean12-en-28-oic)	
			55	Terpenoid	Linalool	
			56	Fatty acid	Linoleic acid	
			57	Fatty acid	Linolenic acid	
			58	Amino acid	Lysine	
			59	Amino acid	Methione	
			33	Terpenoid	Oleanolic acid	
			40	Terpenoid	Spathulenol	
			60	Aldehyde	*trans*-3-hexenal	
			61	Terpenoid	*trans*-ocimene	
			42	Terpenoid	Ursolic acid	
			46	Terpenoid	β-caryophyllene	
S. fulgens	Aerial parts	Acetone	62	Terpenoid	10β-hydroxybacchotricuneatin A (Bacchotricuneatin A)	[19, 23, 24, 107-110]
			63	Terpenoid	*nt*-19-acetoxy-15,16-epoxy-6-hydroxy-3,13(16),14-clerodatrien-18-al	
			64	Terpenoid	*ent*-19-*O*-acetoxy-15,16-epoxy-3,13(16),14-clerodatrien-6,18-diol	
			65	Terpenoid	7α-hydroxy-neoclerodane-3,13-diene-18,19:15,16-diolide	

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Scientific name	Parts used	Extract(s) used	No.	Classification	Compounds	Ref..
S. fulgens	Aerial parts	Acetone	66	Terpenoid	Dehydrokerlin	[19, 23, 24, 107-110]
			67	Terpenoid	Salvifulgenolide	
			68	Terpenoid	Salvigenolide	
			69	Terpenoid	Sandaracopimaric acid	
			70	Terpenoid	*trans*-1,2-dihydrosalvifaricin	
			48	Terpenoid	β-sitosterol	
S. gesneriiflora	Aerial parts	Methanol Hexane Dichloromethane	-	-	Alkaloids	[85, 111]
			-	-	Anthraquinones	
			-	-	Coumarins	
			-	-	Saponins	
			28	Polyphenol	Caffeic acid	
			29	Polyphenol	Chlorogenic acid	
			38	Phenylpropanoid	Rosmarinic acid	
			42	Terpenoid	Ursolic acid	
			68	Terpenoid	Salvigenolide	
S. hirsute	Roots	Acetone	71	Terpenoid	14-deoxycoleon U	[112]
			72	Terpenoid	7α-acetoxy-royleanone	
			73	Terpenoid	8,11,13-abietatriene	
			74	Terpenoid	8,13-abietadiene	
			75	Terpenoid	Cryptojaponol	
			76	Terpenoid	Demethylcryptojaponol	
			77	Terpenoid	Royleanone	
			78	Terpenoid	Salviphlomone	
			79	Terpenoid	Sugiol	
			80	Terpenoid	Taxodione	

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Scientific name	Parts used	Extract(s) used	No.	Classification	Compounds	Ref..
S. hispánica	Seeds	Ethanol Methanol Hydrochloric acid in ethanol	28	Polyphenol	Caffeic acid	[4, 113, 114]
			29	Phenol	Chlorogenic acid	
			81	Flavonoid	Daidzin	
			82	Polyphenol	Gallic acid	
			83	Flavonoid	Kaempferol	
			84	Ethyl ester	Protocatechuic ethyl ester	
			37	Flavonoid	Quercetin	
			38	Phenylpropanoid	Rosmarinic acid	
			85	Fatty acid	α-linolenic acid	
S. keerlii	Aerial parts	Acetone	86	Terpenoid	Kerlin	[23, 108, 115]
			87	Terpenoid	Kerlinic acid	
			88	Terpenoid	Kerlinolide	
S. lavanduloides	Aerial parts Flowers Roots	Acetone Methanol	72	Terpenoid	7α-acetoxy-royleanone	[19, 23, 108, 111, 116-118]
			89	Terpenoid	Horminone	
			90-94	Terpenoid	Salvianduline A-E	
			42	Terpenoid	Ursolic acid	
			48	Terpenoid	β-sitosterol	
S. leucantha	Aerial parts Flowers	Acetone Chloroform Methanol Hexane	95	Terpenoid	1,10-di-*epi*-cubenol	[19, 21, 24, 39, 76, 88, 89, 107, 118-120]
			96	Terpenoid	1,8-cineole	
			97	Alcohol	1-octen-3-ol	
			98	Terpenoid	20-hydroxydugesin B	
			99	Terpenoid	2-*epi*-6,7-dihydrosalviandulin E	
			100	Terpenoid	3-*epi*-tilifodiolide	
			101	Ketone	3-octanone	
			102	Terpenoid	3β-methoxyisopuberulin	
			103	Ketone	4-methylene-isophorone	
			104	Terpenoid	6,7-dehydrodugesin A	

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Scientific name	Parts used	Extract(s) used	No.	Classification	Compounds	Ref..
S. leucantha	Aerial parts Flowers	Acetone Chloroform Methanol Hexane	105	Terpenoid	6,7-dehydrodugesin B	[19, 21, 24, 39, 76, 88, 89, 107, 118-120]
			106	Terpenoid	6,7-dihydrosalviandulin E	
			107	Terpenoid	7-*epi*-α-eudesmol	
			108	Aromatic	Apiole	
			109	Terpenoid	Aromadendrene	
			110	Terpenoid	Bicyclogermacrene	
			111	Terpenoid	Borneol	
			112	Terpenoid	Bornyl acetate	
			113	Terpenoid	Camphene	
			114	Terpenoid	Cedrene	
			115	Terpenoid	*cis*-cadin-4-en-7-ol	
			116	Terpenoid	*cis*-muurola-3,5-diene	
			117	Terpenoid	Citral	
			118	Terpenoid	Citronellal	
			119	Terpenoid	Citronellol	
			120	Ketone	Dehydrosabinaketone	
			121	Terpenoid	De-*O*-acetylsalvigenolide	
			122	Benzodioxol	Dillapiol	
			123	Terpenoid	Dugesin B	
			100	Terpenoid	3-*epi*-tilifodiolide	
			124	Terpenoid	Eremoligenol	
			125	Terpenoid	Eudesma-4(15)7-dien-1β-ol	
			126	Terpenoid	Geraniol	
			127	Terpenoid	Geranyl acetate	
			128-129	Terpenoid	Germacrene A, B	
			31	Terpenoid	Germacrene D	
			130	Terpenoid	Globulol	

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Scientific name	Parts used	Extract(s) used	No.	Classification	Compounds	Ref..
S. leucantha	Aerial parts Flowers	Acetone Chloroform Methanol Hexane	131	Terpenoid	Guaiol	[19, 21, 24, 39, 76, 88, 89, 107, 118-120]
			132	Alcohol	Heptanol	
			133	Terpenoid	Hinesol	
			134	Terpenoid	Isocaryophyllene	
			135	Flavonoid	Isosalipurpol	
			136	Terpenoid	Isosalvipuberulin (Isopuberulin)	
			137	Terpenoid	Isothujanol	
			139-142	Terpenoid	Leucansalvialin F-J	
			55	Terpenoid	Linalool	
			143	Terpenoid	Linalyl acetate	
			144	Terpenoid	Linalyl formate	
			145	Terpenoid	*neo*-α-clovene	
			146	Aldehyde	Nonanal	
			147	Terpenoid	*p*-cymene	
			148	Flavonoid	Quercetin-3-*O*-α-L-rhamnopyranosyl-(1→6)-β-D-glucopyranoside	
			90-94	Terpenoid	Salvianduline A-E	
			149	Terpenoid	Salvifaricin	
			150-153	Terpenoid	Salvileucalin A-D	
			154	Terpenoid	Salvileucantholide	
			155-158	Terpenoid	Salvileucanthsin A-D	
			40	Terpenoid	Spathulenol	
			159	Terpenoid	Spiroleucantholide	
			160	Terpenoid	Terpinen-4-ol	
			161	Terpenoid	Terpinolene	
			7	Terpenoid	Tilifodiolide	
			162	Terpenoid	Tiliifolin C	
			163	Terpenoid	*t*-muurolol	

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Scientific name	Parts used	Extract(s) used	No.	Classification	Compounds	Ref..
S. leucantha	Aerial parts Flowers	Acetone Chloroform Methanol Hexane	164	Terpenoid	*trans*-calamenen-10-ol	[19, 21, 24, 39, 76, 88, 89, 107, 118-120]
			165	Terpenoid	*trans*-calamenene	
			166	Terpenoid	*trans*-β-farnesene	
			167	Terpenoid	Viridiflorol	
			168	Terpenoid	α-bulnesene	
			169	Terpenoid	α-cadinene	
			170	Terpenoid	α-cadinol	
			171	Terpenoid	α-copaene	
			172	Terpenoid	α-guaiene	
			173	Terpenoid	α-humulene	
			174	Terpenoid	α-muurolol	
			175	Terpenoid	α-pinene	
			176	Terpenoid	α-terpineol	
			177	Terpenoid	β-acoradiene	
			178	Terpenoid	β-atlantol	
			179	Terpenoid	β-bourbonene	
			46	Terpenoid	β-caryophyllene	
			180	Terpenoid	β-copaen-4α-ol	
			181	Terpenoid	β-elemene	
			182	Terpenoid	β-gurjunene	
			183	Terpenoid	β-phellandrene	
			184	Terpenoid	β-pinene	
			185	Terpenoid	β-thujone	
			186	Terpenoid	γ-cadinene	
			187	Terpenoid	γ-terpinene	
			188	Terpenoid	δ-cadinene	
			49	Terpenoid	δ-elemene	

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Scientific name	Parts used	Extract(s) used	No.	Classification	Compounds	Ref..
S. melissodora	Aerial parts	Acetone Ethyl acetate	189	Terpenoid	1-isopropyl-4b,8,8-trimethyl-9-oxo-4b,5,6,7,8,8a,9,10-octahydrophenanthrene-2,3,10-triyl triacetate	[19, 23, 108, 122, 123]
			190	Terpenoid	2α-hydroxy-7α-acetoxy-12-oxo-15:16-epoxy-neoclerodan-3,13(16),14-trien-18: 19-olide	
			191	Terpenoid	2β-7α-dihydroxy-*ent*-cleroda-3,13-diene-18,19:16,15-diolide	
			192	Terpenoid	2β-acetoxy-7α-hydroxy-*ent*-cleroda-3,13-diene-18,19:16,15-diolide	
			193	Terpenoid	2β-hydroxy-7-oxo-*ent*-cleroda-3,13-diene-18,19:16,15-diolide	
			194	Terpenoid	2β-hydroxy-*ent*-cleroda-3,13-diene-18,19:16,15-diolide	
			195	Terpenoid	7-oxo-*ent*-cleroda-3,13-diene-18,19:16,15-diolide	
			196	Terpenoid	7α-acetoxy-2β-hydroxy-*ent*-cleroda-3,13-diene-18,19:16,15-diolide	
			197	Terpenoid	7α-acetoxy-*ent*-cleroda-3,13-diene-18,19:16,15-diolide	
			198	Terpenoid	7α-hydroxy-*ent*-cleroda-3,13-diene-18,19:16,15-diolide	
			65	Terpenoid	7α-hydroxy-neoclerodane-3,13-diene-18,19:15,16-diolide	
			199	Terpenoid	7β-18,19-trihydroxy-*ent*-cleroda-3,13-dien-16,15-olide	
			200	Terpenoid	7β-hydroxy-*ent*-cleroda-3,13-diene-18,19:16,15-diolide	
			201	Terpenoid	Brevifloralactone	
			202	Terpenoid	Maytenoquinone	
			203	Terpenoid	Melisodoric acid	
			33	Terpenoid	Oleanolic acid	
			204	Terpenoid	Portulide C	
			42	Terpenoid	Ursolic acid	
			48	Terpenoid	β-sitosterol	

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Scientific name	Parts used	Extract(s) used	No.	Classification	Compounds	Ref..
S. mexicana	Aerial parts Flowers Leaves	Acetone Chloroform Hexane Methanol	205	Terpenoid	Arbutin	[92]
			206	Terpenoid	Betulinic acid	
			207	Terpenoid	Betulinol	
			208	Terpenoid	Salvimexicanolide	
			209	Terpenoid	Salviolide	
			42	Terpenoid	Ursolic acid	
			48	Terpenoid	β-sitosterol	
S. microphylla	Aerial parts Leaves Stems Roots	Acetone	210	Terpenoid	12-methoxycarnosic acid	[19, 25, 108, 124, 125]
			211	Terpenoid	14α-18-dihydroxyisopimaradiene	
			212	Terpenoid	14α-hydroxyisopimaric acid	
			213	Phenolic ester	2-(*p*-hydroxyphenyl) ethyl eicosaheptanoic acid ester	
			214	Terpenoid	7,15-isopimaradien14α, 18-diol	
			215	Terpenoid	7-oxo-sandaracopimarate	
			216	Terpenoid	7-oxo-sandaracopimaric acid	
			217	Terpenoid	7α-acetoxyisopimara-8(14),15-diene-18-oic acid	
			218	Terpenoid	7α-acetoxysandaracopimaric acid	
			65	Terpenoid	7α-hydroxy-neoclerodane-3,13-diene-18,19:15,16-diolide	
			219	Terpenoid	7α-hydroxysandaracopimaric acid	
			220	Terpenoid	8(14),15-sandaracopimaradien-7α,18-diol	
			221	Carcocyclic	8α-hydroxy-β-eudesmol	
			222	Ester	Eicosaheptanoic acid 2-(*p*-hydroxyphenyl) ethyl ester	
			223	Terpenoid	Erithrodiol 3-acetate	
			224	Cumaric acid	Hexacosylferulate	
			225	Terpenoid	Lupeol	

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Scientific name	Parts used	Extract(s) used	No.	Classification	Compounds	Ref..
S. microphylla	Aerial parts Leaves Stems Roots	Acetone	215	Terpenoid	Methyl 7-oxosandaracopimarate	[19, 25, 108, 124, 125]
			226	Terpenoid	Methyl 7α-hydroxysandaracopimarate	
			227	Terpenoid	Microphyllandiolide	
			33	Terpenoid	Oleanolic acid	
			5	Terpenoid	Salvimicrophyllin B	
			228-230	Terpenoid	Salvimicrophyllins A, C, D	
			220	Terpenoid	Sandaracopimara-8(14),15-diene-7α,18-diol	
			42	Terpenoid	Ursolic acid	
			231	Terpenoid	β-eudesmol	
			48	Terpenoid	β-sitosterol	
S. patens	Flowers	Aqueous	232	Flavonoid	Protodelphin	[126]
S. polystachya	Aerial parts Flowers Leaves Steams	Acetone Acetone: Methanol Ethanol	233	Terpenoid	15-*epi*-polystachyne G	[17, 23, 42, 98, 100, 107]
			234	Flavonoid	3',5,6,7-tetrahydroxy-4´-methoxyflavone	
			66	Terpenoid	Dehydrokerlin	
			235	Terpenoid	Linearolactone	
			33	Terpenoid	Oleanolic acid	
			236-243	Terpenoid	Polystachines A-H	
			149	Terpenoid	Salvifaricin	
			244-247	Terpenoid	Salvifilines A–E	
			42	Terpenoid	Ursolic acid	
S. reflexa	Leaves	Acetone	248	Terpenoid	15,16-epoxy-8α-hydroxyneocleroda-2,13(16),14-triene-17,12R:18,19-diolide	[127]
			249	Terpenoid	6β-hydroxysalviarin	
			250	Terpenoid	8α-hydroxysalviarin	

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Scientific name	Parts used	Extract(s) used	No.	Classification	Compounds	Ref..
S. reflexa	Leaves	Acetone	33		Oleanolic acid	[127]
			251	Terpenoid	Salviarin	
			48	Terpenoid	β-sitosterol	
S. reptans	Aerial parts Roots	Acetone n-hexane	252	Terpenoid	1α,2α-epoxy-3,4α-dihydrolinearolactone	[23, 19, 93, 108, 128]
			253	Terpenoid	8α,9α-epoxy-7-ketoroyleanone	
			254	Terpenoid	Diosmetin	
			89	Terpenoid	Horminone	
			235	Terpenoid	Linearolactone	
			33	Flavonoid	Oleanolic acid	
			255	Terpenoid	Salvireptanolide	
			42	Terpenoid	Ursolic acid	
			48	Terpenoid	β-sitosterol	
S. tiliifolia	Aerial parts Roots	Acetone	104	Terpenoid	6,7-dehydrodugesin A	[76, 101, 23, 108, 129, 130]
			256-257	Terpenoid	Dugesins A, B	
			258	Phenol	Ferruginol	
			136	Terpenoid	Isosalvipuberulin (Isopuberulin)	
			259	Terpenoid	Puberulin	
			94	Terpenoid	Salvianduline E	
			149	Terpenoid	Salvifaricin	
			260	Terpenoid	Salvifolin	
			261	Terpenoid	Salyunnanins I	
			262	Terpenoid	Tilifolidione	
S. verbenacea	Fruits Leaves Roots Seeds Steams	Essential oils Methanol Petroleum ether	263	Aldehyde	(*E*)-2-hexenal	[23]
			264	Terpenoid	(*E*)-caryophyllene	
			265	Terpenoid	(*E*)-β-caryophyllene	
			266	Terpenoid	(*E*)-β-farnesene	
			267	Terpenoid	(*E*)-β-ionone	

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Scientific name	Parts used	Extract(s) used	No.	Classification	Compounds	Ref..
S. verbenacea	Fruits Leaves Roots Seeds Steams	Essential oils Methanol Petroleum ether	268	Terpenoid	(*E*)-β-ocimene	[23]
			269	Carboxylic acid	(*Z*)-9-octadecenoic acid	
			270	Terpenoid	(*Z*)-β-ocimene	
			95	Terpenoid	1,10-di-*epi*-cubenol	
			96	Terpenoid	1,8-cineole	
			271	Terpenoid	13-*epi*-manool	
			272	Terpenoid	2,3-dihydro-1,4-cineol	
			273	Terpenoid	4-terpeniol	
			274	Flavonoid	5-hydroxy-3,4',7-trimethoxyflavone	
			275	Flavonoid	5-hydroxy-7,4'-dimethoxyflavone	
			276	Terpenoid	6-13-hydroxy-7a-acetoxyroyleanone	
			277	Aldehyde	9,12,15-Octadecatrienal	
			26	Flavonoid	Apigenin	
			278	Aromatic	Benzaldehyde	
			110	Terpenoid	Bicyclogermacrene	
			28	Polyphenol	Caffeic acid	
			113	Terpenoid	Camphene	
			279	Terpenoid	Camphor	
			280	Terpenoid	Carnosic acid	
			281	Terpenoid	Caryophyllene oxide	
			282	Flavonoid	Cirsilineol	
			283	Flavonoid	Cirsiliol	
			116	Terpenoid	*cis*-muurola-3,5-diene	
			184	Terpenoid	*cis*-muurola-4(14),5-diene	
			164	Terpenoid	*E*-Caryophyllene	
			181	Terpenoid	*epi*-13-manool	

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Scientific name	Parts used	Extract(s) used	No.	Classification	Compounds	Ref..
S. verbenacea	Fruits Leaves Roots Seeds Steams	Essential oils Methanol Petroleum ether	185	Terpenoid	*epi*-α-cadinol	[23]
			186	Acetate	Ethyl hexadecanoate	
			30	Terpenoid	Ferulic acid	
			31	Flavonoid	Germacrene D	
			287	Flavonoid	Hesperidin	
			288	Fatty acid	Hexadecanoic acid	
			89	Terpenoid	Horminone	
			289	Terpenoid	Limonene	
			55	Terpenoid	Linalool	
			56	Fatty acid	Linoleic acid	
			290	Flavonoid	Luteolin	
			291	Terpenoid	Manool	
			292	Terpenoid	Methyl carbonate	
			293	Fatty acid	Methyl ester of 6-octadecenoic acid	
			294	Terpenoid	Methyl eugenol	
			295	Flavonoid	Naringenin	
			296	Alkane	Nonane	
			297	Alkane	Octane	
			298	Fatty acid	Oleic acid	
			147	Terpenoid	*p*-cymene	
			299	Aromatic	Phenyl acetaldehyde	
			300	Aromatic	*p*-hydroxybenzoic acid	
			301	Terpenoid	Phytol	
			302	Flavonoid	Retusin	
			38	Phenylpropanoid	Rosmarinic acid	
			303	Terpenoid	Sabinene	
			304	Flavonoid	Salvigenin	

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

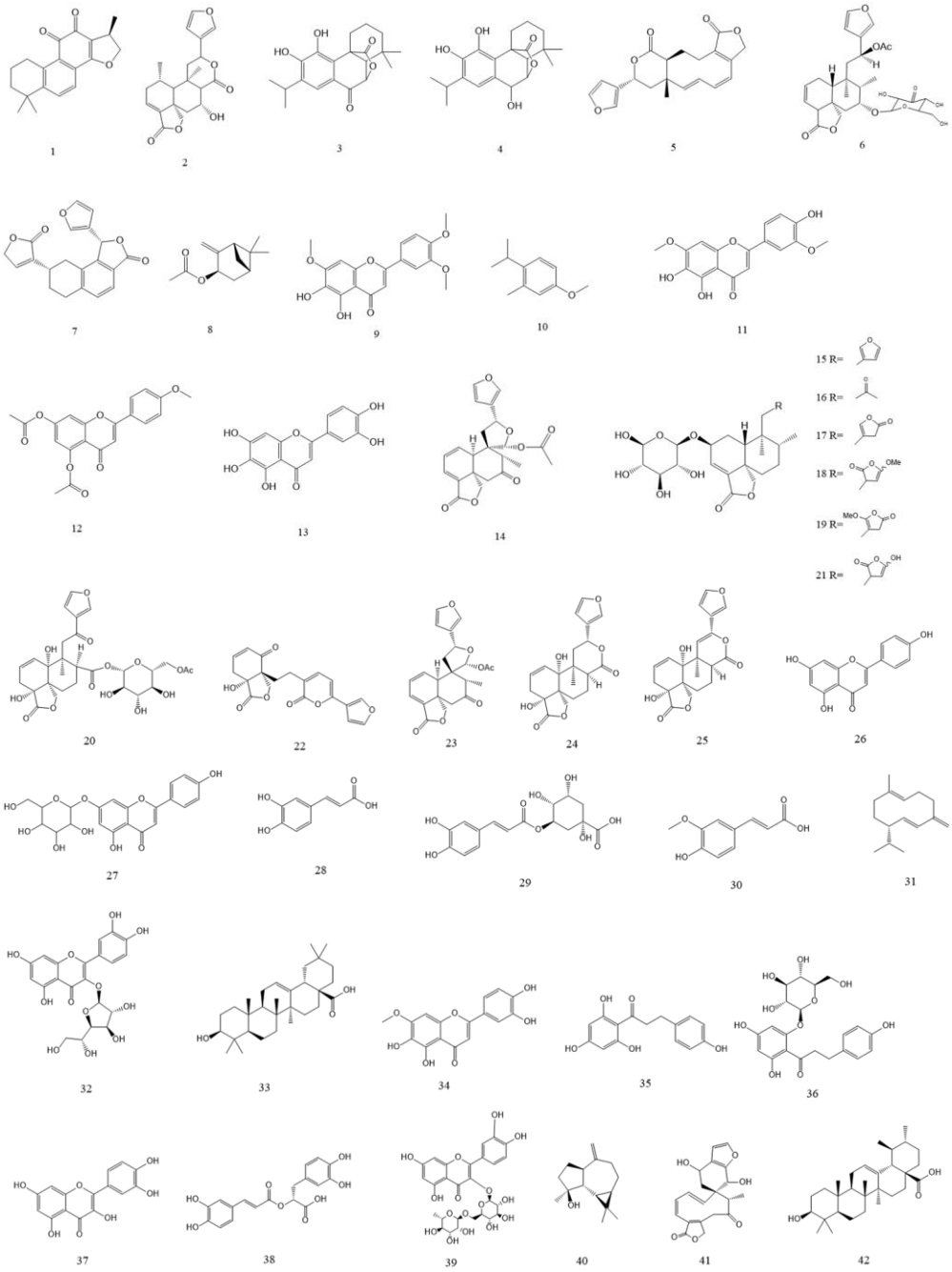
ISSN-e 2594-0317

Scientific name	Parts used	Extract(s) used	No.	Classification	Compounds	Ref..
S. verbenacea	Fruits Leaves Roots Seeds Steams	Essential oils Methanol Petroleum ether	305	Terpenoid	Salvinine	[23]
			40	Terpenoid	Spathulenol	
			80	Terpenoid	Taxodione	
			161	Terpenoid	Terpinolene	
			306	Terpenoid	*trans*-sabinene hydrate	
			307	Alkane	Tricosane	
			308	Terpenoid	Tricyclene	
			309	Terpenoid	Verbenacine	
			310	Flavonoid	Verbenacoside	
			167	Terpenoid	Viridiflorol	
			171	Terpenoid	α-copaene	
			173	Terpenoid	α-humulene	
			175	Terpenoid	α-pinene	
			311	Terpenoid	α-terpinyl acetate	
			312	Terpenoid	α-thujene	
			46	Terpenoid	β-caryophyllene	
			231	Terpenoid	β-eudesmol	
			193	Terpenoid	β-phellandrene	
			313	Terpenoid	γ-amorphene	
			186	Terpenoid	γ-cadinene	
			188	Terpenoid	δ-cadinene	
			314	Terpenoid	δ-selinene	

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

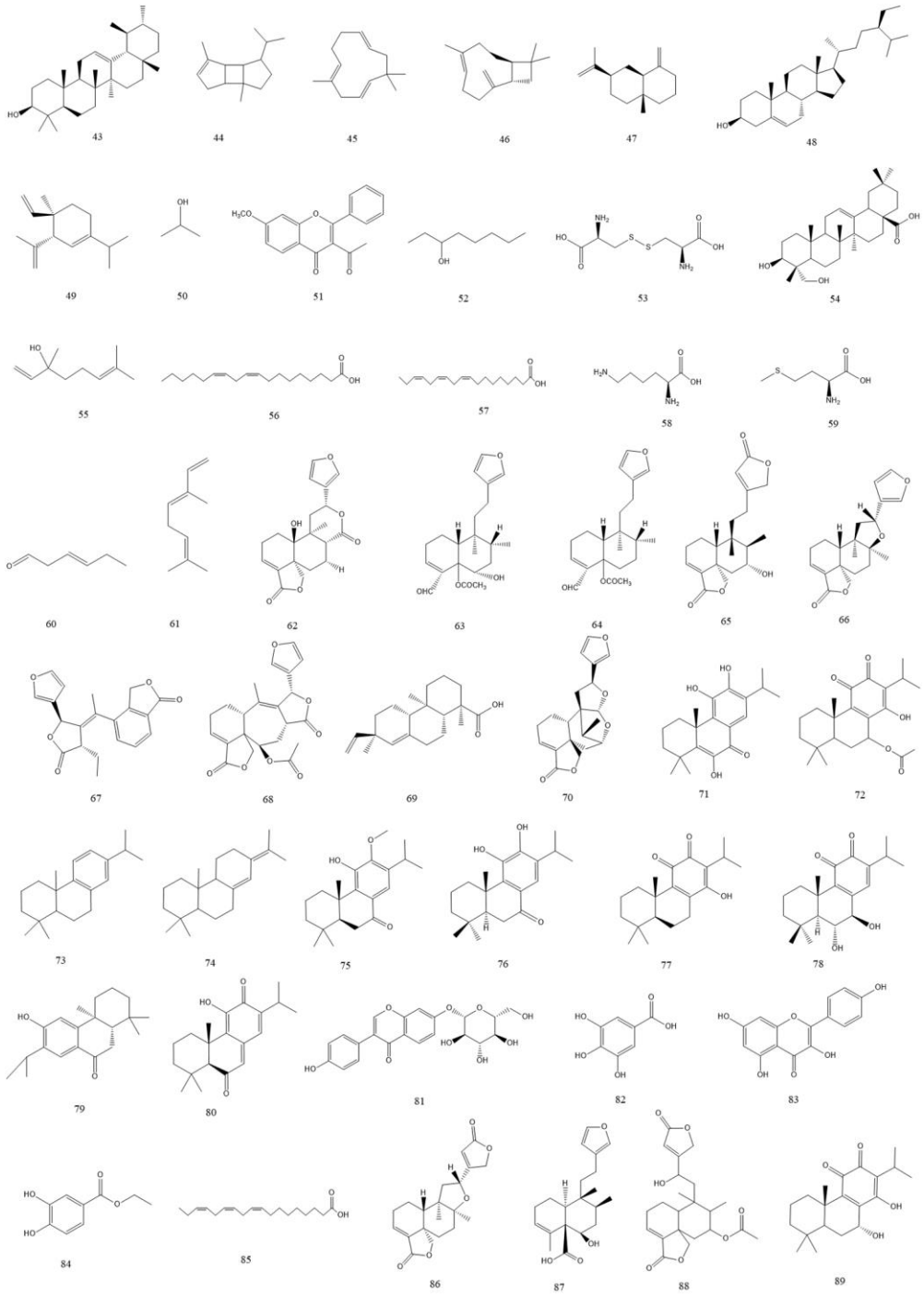
Fig. 4.



J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

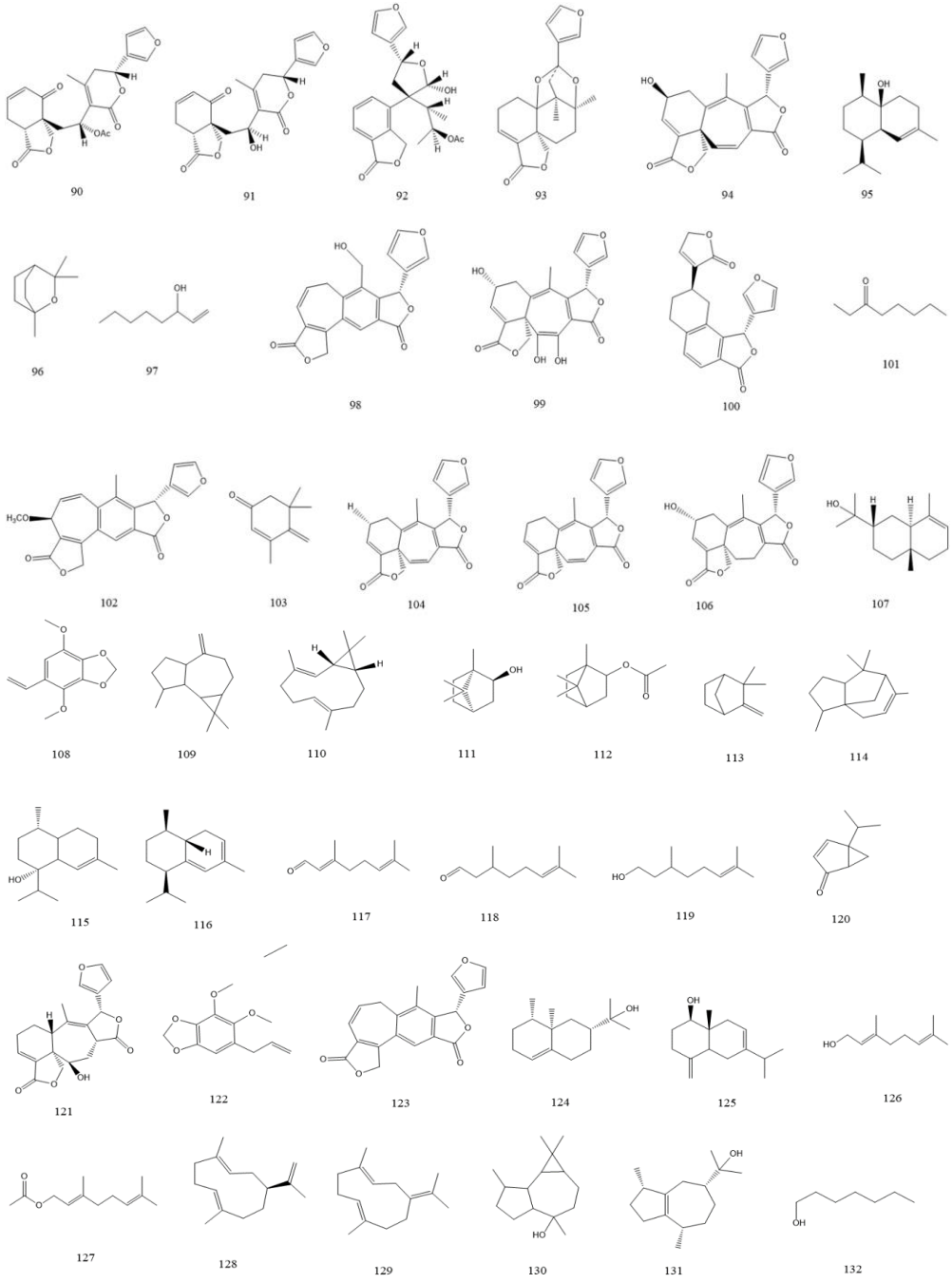
Fig. 4.



J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

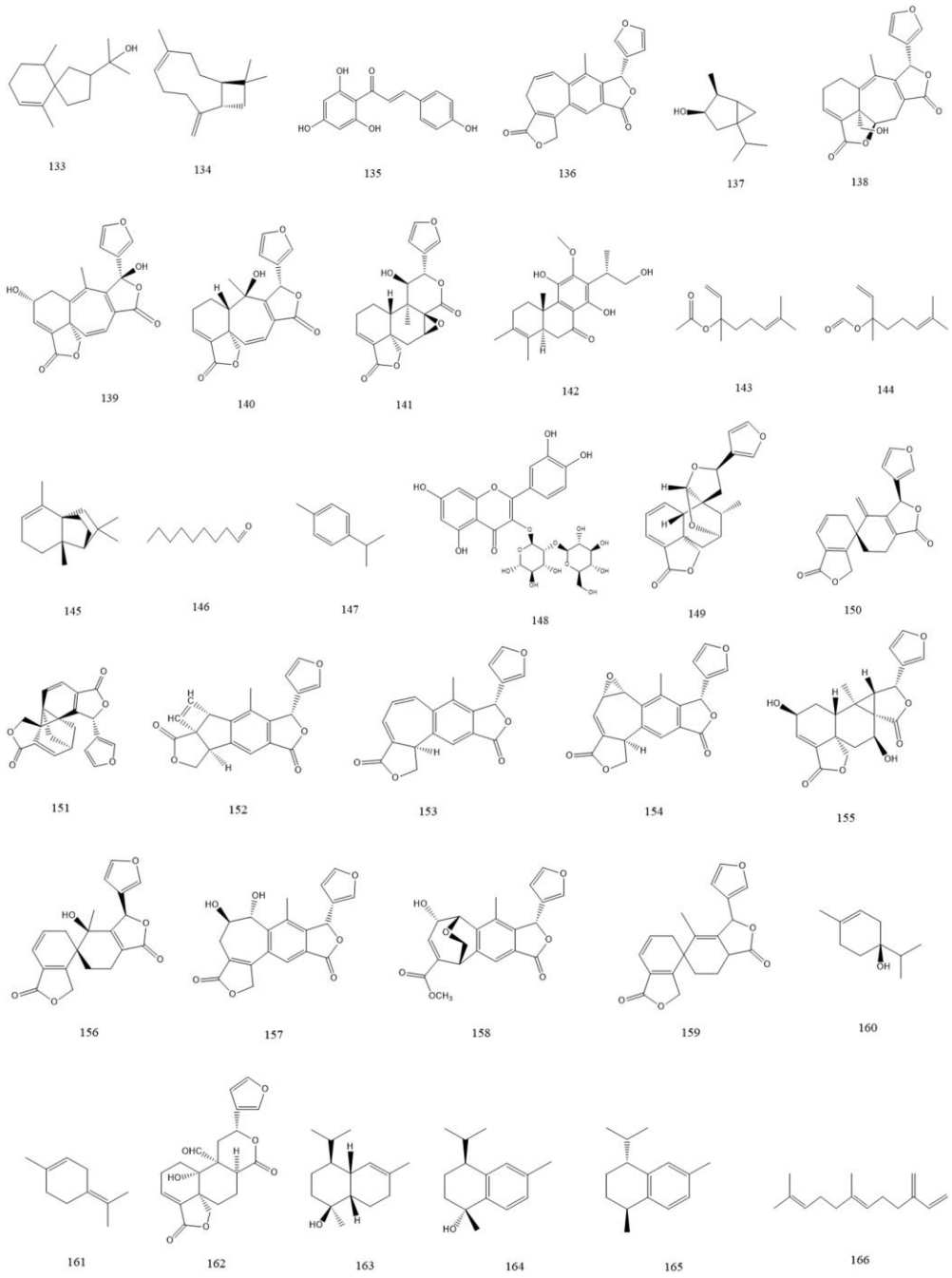
Fig. 4.



J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

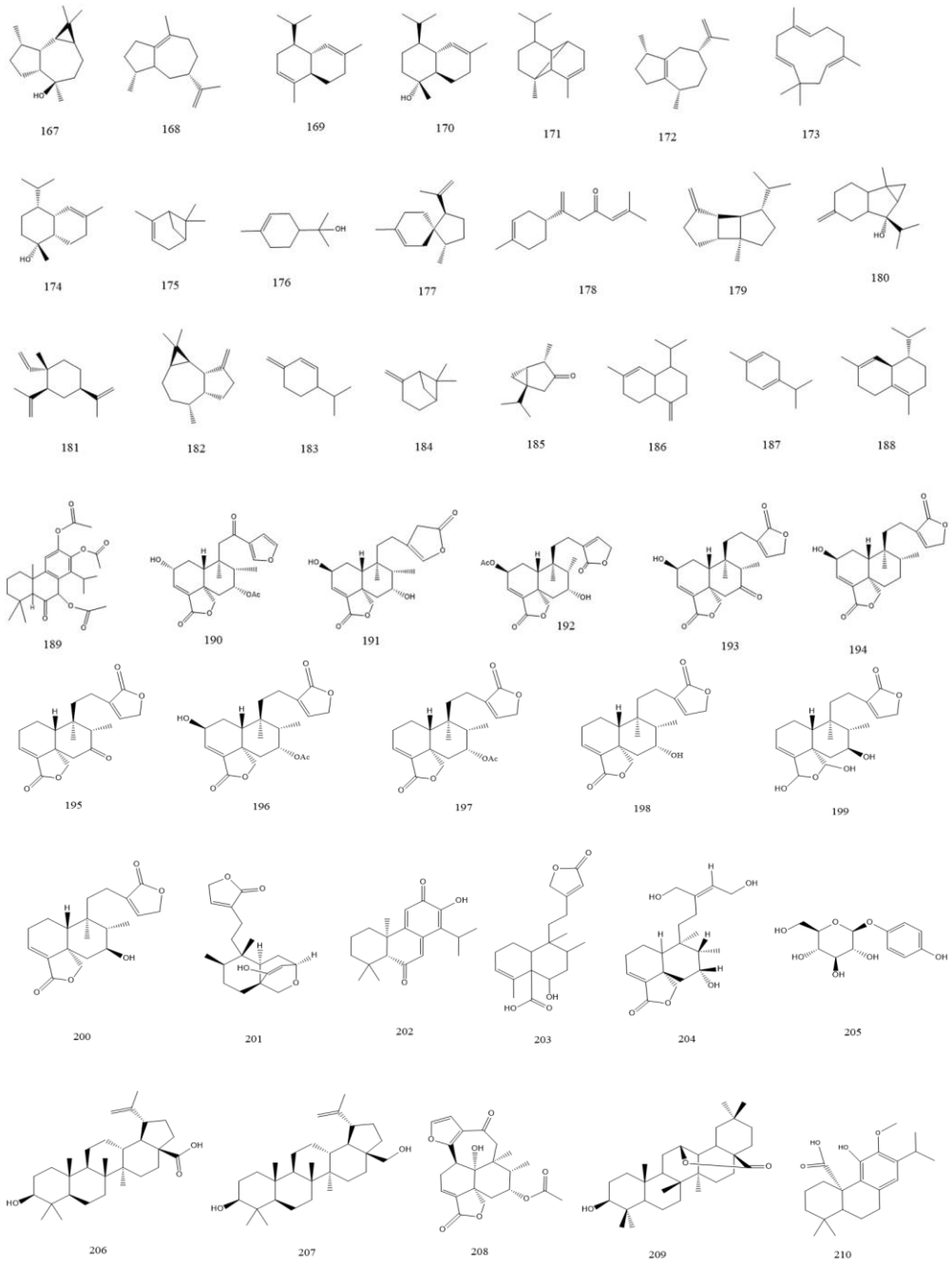
Fig. 4.



J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

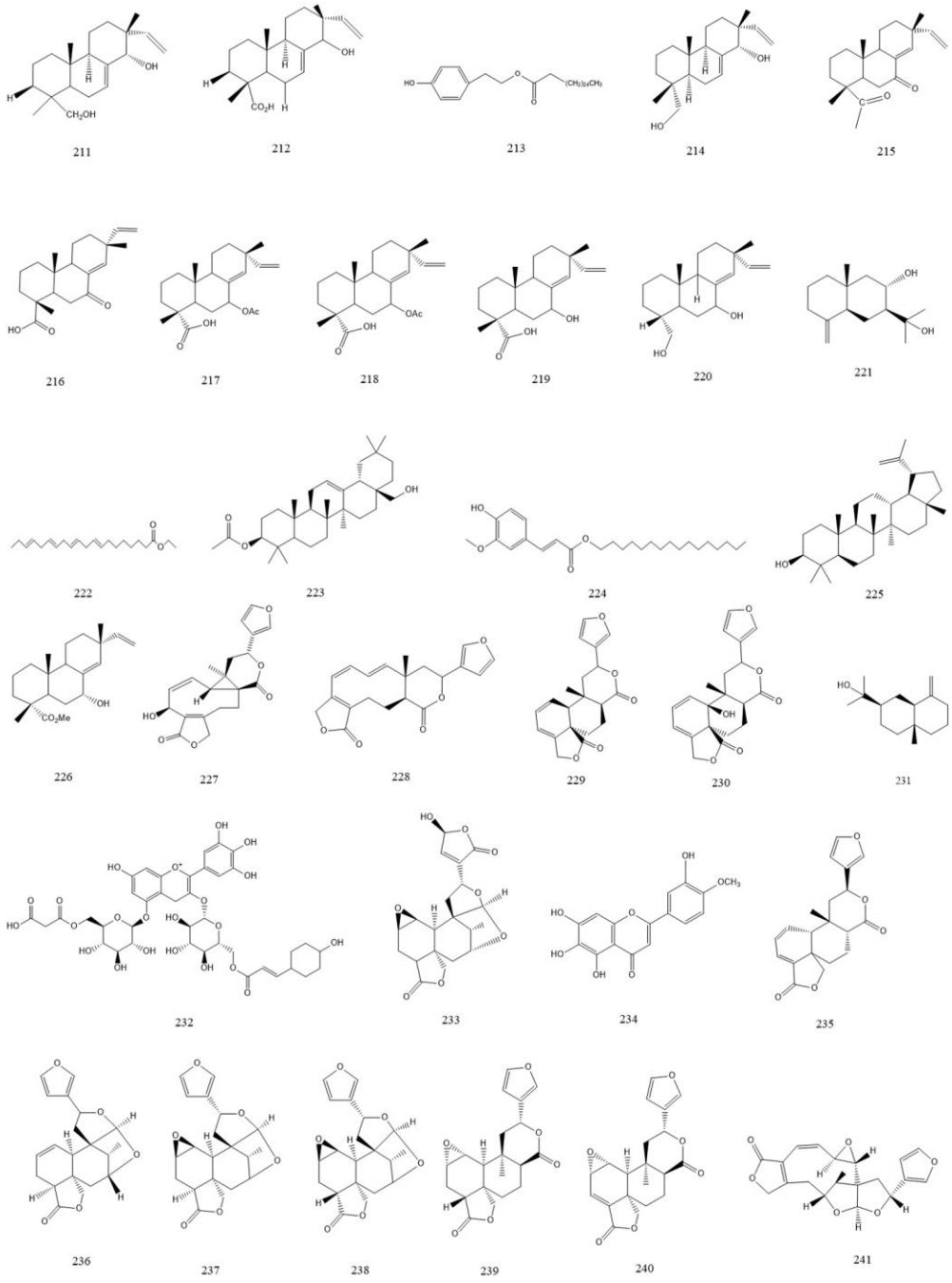
Fig. 4.



J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

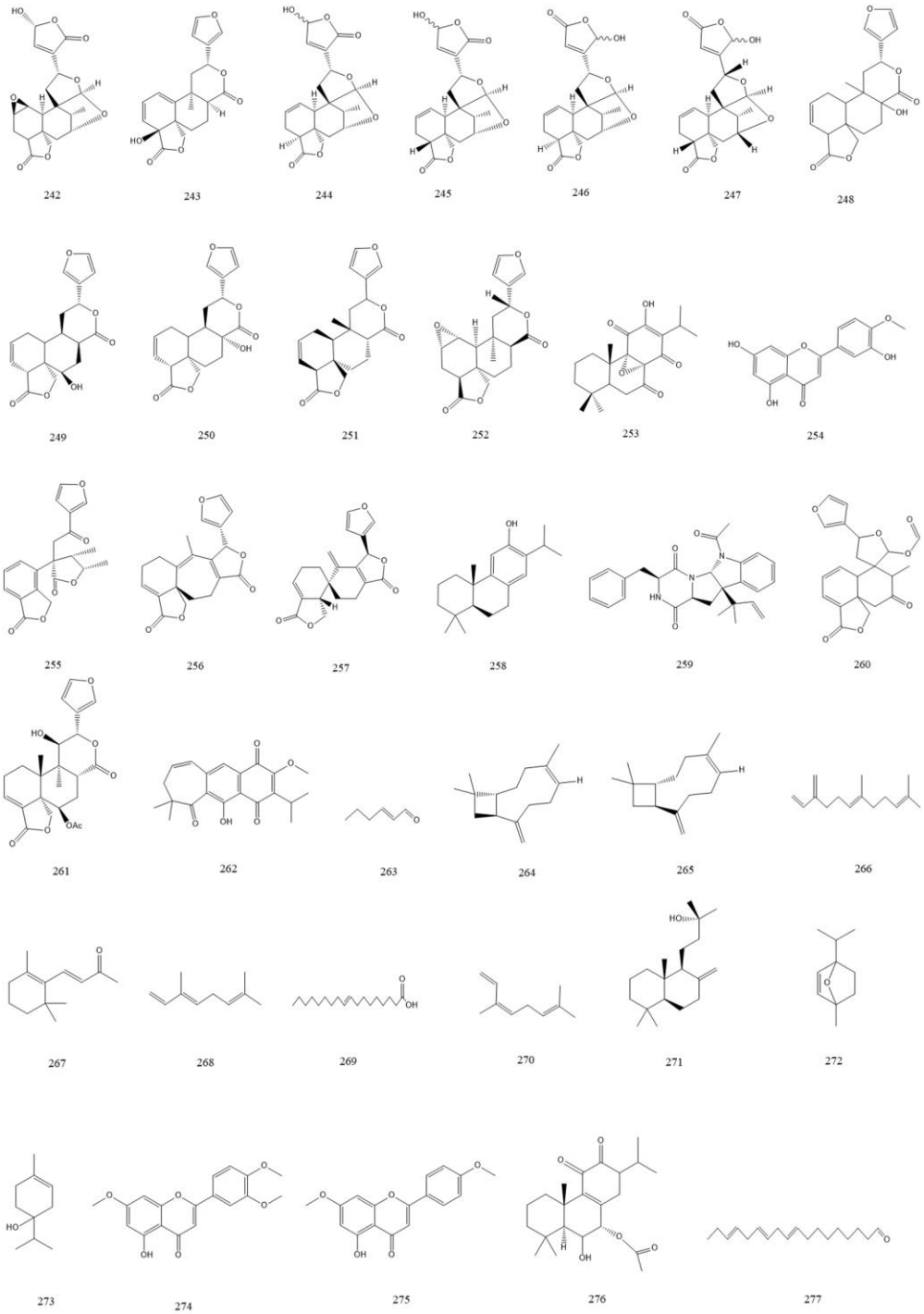
Fig. 4.



J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Fig. 4.



J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

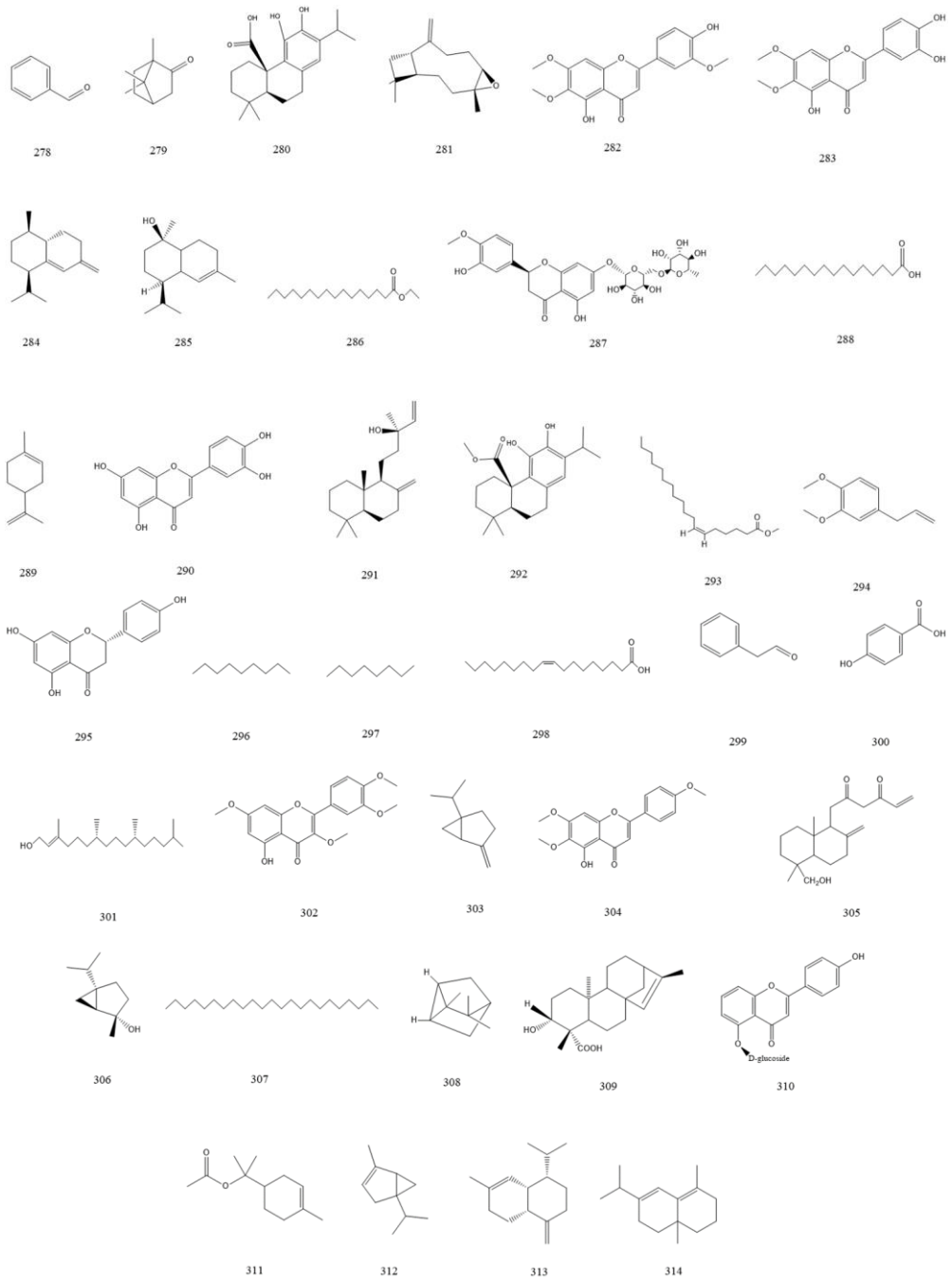


Fig. 4. Chemical components from *Salvia* spp. from Valle de México.

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

Conclusions

The several *Salvia* species in the Valle de México represent a vast plant resource with metabolites of pharmacological interest that play a significant role in Mexican Traditional Medicine. *Salvia* species represent a vast therapeutic use and have great potential for developing new bioactive compounds for treating diverse diseases due to the great variety of metabolites generated under diverse conditions, even in different populations of the same species. The data presented seek to promote research into these species through bio-assay-guided chemical studies that support their empirical use and the development of new herbal treatments. Enlarging the identification of new metabolites present in these plant species, taking into consideration that the variations of metabolites structures, the wide variety of *Salvias* and the poor study with some of them, could also generate new research opportunities in diverse areas of study. Finally, expanding the chemical, biological and pharmacological information might serve to develop methods of production of these plants, preserve them and improve their production and economic impact.

References

1. Tjitraresmi, A.; Moektiwardoyo, M.; Susilawati Y.; Shiono, Y. *Sys. Rev. Pharm*. **2020,** *11*, 324-333.
2. Manjarréz, R.; Frontana-Uribe, B. A.; Cárdenas, J. *Rev. Soc. Quím. Méx*. **2003**, *47*, 207–209.
3. Pérez, S.; De La, R.; Canavaciolo, G.; Victor, L.; Delange, M.; Rodríguez-Leyes, E. A. *Rev. Cub. Plant. Med*. **2011**, *16*, 54–59.
4. Reyes-Caudillo, E.; Tecante, A.; Valdivia-López, M. A. *Food Chem*. **2008**, *107*, 656–663. DOI: https://doi.org/10.1016/j.foodchem.2007.08.062.
5. Mendoza, E. I. O.; García, B. Y. B.; Cabrera, S. I. L. *Acta Bot. Méx*. **2017**, *118*, 7–40.
6. Sierra-Pérez, R.; González-Canavaciolo, V. L.; Marrero-Delange, D.; Rodríguez-Leyes, E. A. *Revista CENIC: Ciencias Biológicas*. **2013**, *44*, 124-127.
7. Kumar, P. M.; Sasmal, D.; Mazumder, P. M. *Pharmacogn. Res.* **2010**, *2*, 190–194. DOI: http://dx.doi.org/10.4103/0974-8490.65520.
8. Angerhofer, C. K. *J. Nat. Prod*. **2001**, *64*, 1258 DOI: 10.1021/np000756b
9. Ramamoorthy, T. P. in: *Flora Fanerogámica del Valle de México*, Rzedowski, G. C. de, Ed., Instituto de Ecología, A.C. y Comisión Nacional para el Conocimiento y Uso de la Biodiversidad: Pátzcuaro, **2001**, 632-644.
10. Cornejo-Tenorio, G.; Ibarra-Manríquez, G. *Rev. Mex. Biodiv*. **2011**, *82*, 1279-1296. DOI: http://dx.doi.org/10.22201/ib.20078706e.2011.4.668.
11. Villaseñor, J. L. *Bot. Sci*. **2004**, *75*, 105–135. DOI: http://dx.doi.org/10.17129/botsci.1694.
12. Martínez-Gordillo, M.; Lozada-Pérez, L. *Brittonia*. **2011**, *63*, 211–214. DOI: http://dx.doi.org/10.1007/s12228-010-9152-2.
13. Valdés, L.J.; Díaz, J.; Paul, A.G. *J. Ethnopharmacol*. **1983**. *7*, 287-312. DOI:10.1016/0378-8741(83)90004-1.
14. Tavera-Hernández, R.; Jiménez-Estrada, M.; Alvarado-Sansininea, J. J.; Huerta-Reyes, M. *Molecules*. **2023**, *28*, 8069. DOI: https://doi.org/10.3390/molecules28248069.
15. OECD. OECD Territorial Reviews: Valle de México, Mexico. OECD: **2015**.
16. Castro, J. C. J.; Villa, R. N.; Ramírez G. S. A.; González, C. *Rev. Cub. Plantas Med.* **2014,** *19*, 101–120.
17. Ortega, A.; Bautista, E.; Maldonado, E. *Chem. Pharm. Bull*. **2006,** *54*, 1338–1339. DOI: http://dx.doi.org/10.1248/cpb.54.1338.
18. Salinas-Arellano, E.; Pérez-Vásquez, A.; Rivero-Cruz, I.; Torres-Colin, R.; González-Andrade, M.; Rangel-Grimaldo, M.; Mata, R. *Molecules.* **2020**, *25*, 3530. DOI: http://dx.doi.org/10.3390/molecules25153530.
19. Wu, Y. B.; Ni, Z. Y.; Shi, Q. W.; Dong, M.; Kiyota, H.; Gu, Y. C.; Cong, B. *Chem. Rev*. **2012**, *112*, 5967–6026. DOI: http://dx.doi.org/10.1021/cr200058f.

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

20. Khouchlaa, A.; Et-Touys, A.; Lakhdar, F.; Laasri, F. E.; El-Idrissi, A. E. Y.; Zaakour, F. *Biointerface Res. Appl. Chem*. **2021**, *12*, 1437–1469
21. Li, L. W.; Qi, Y. Y.; Liu, S. X.; Wu, X. D.; Zhao, Q. S. *Fitoterapia*. **2018**, *127*, 367–374. DOI: http://dx.doi.org/10.1016/j.fitote.2018.03.007.
22. Bisio, A.; De Mieri, M.; Milella, L.; Schito, A. M.; Parricchi, A.; Russo, D.; Alfei, S.; Lapillo, M.; Tuccinardi, T.; Hamburger, M.; et al. *J. Nat. Prod*. **2017**, *80*, 503–514. DOI: http://dx.doi.org/10.1021/acs.jnatprod.6b01053.
23. Kabouche, A.; Kabouche, Z. *Bioactive Nat. Prod*. **2008**, 753–833, DOI: https://doi.org/10.1016/S1572-5995(08)80017-8.
24. Narukawa, Y.; Fukui, M.; Hatano, K.; Takeda, T. *J. Nat. Med*. **2006**, *60*, 58–63. DOI: http://dx.doi.org/10.1007/s11418-005-0007-1.
25. Aydoğmuş, Z.; YeşİlyurtV.; Topcu, G. *Nat. Prod. Res*. **2006**, *20*, 775–781. DOI: http://dx.doi.org/10.1080/14786410500462843.
26. Bennett, B. C.; Balick, M. J. *J. Ethnopharmacol*. **2014**, *152*, 387–392. DOI: http://dx.doi.org/10.1016/j.jep.2013.11.042.
27. Rao, M. V. *Curr. Sci*. **2004**, *87*, 602–606.
28. Solares-Pascasio, J. I.; Ceballos, G.; Calzada, F.; Barbosa, E.; Velazquez, C. *Molecules*. **2021,** *26*, 947. DOI: http://dx.doi.org/10.3390/molecules26040947.
29. Flores-Bocanegra, L.; González-Andrade, M.; Bye, R.; Linares, E.; Mata, R. *J. Nat. Prod*. **2017**, *80*, 1584-1593. DOI: http://dx.doi.org/10.1021/acs.jnatprod.7b00155.
30. Sepúlveda-Cuellar, L.; Duque-Ortiz, A.; Yáñez-Espinosa, L.; Calzada, F.; Bautista, E.; Pastor-Palacios, G.; García, B. Y. B.; Flores-Rivas, J.; Badano, E. I.; Douterlungne, D. *Rev. Bras. Farmacogn*. **2021**, *31*, 676–688. DOI: http://dx.doi.org/10.1007/s43450-021-00168-z.
31. Rouhan, G.; Gaudeul, M. *Methods. Mol. Biol*. **2014**, *1115*, 1-37. DOI: http://dx.doi.org/10.1007/978-1-62703-767-9_1.
32. Lara-Cabrera, S. I.; Bedolla-García, B. Y.; Zamudio, S.; Domínguez-Vázquez, G. *Acta Bot. Mex*. **2016**, *116*, 107-149. DOI: http://dx.doi.org/10.21829/abm116.2016.1120.
33. Ionescu, I. A.; Møller, B. L.; Sánchez-Pérez, R. *J. Exp. Bot*. **2016**, *68*, 369-382. DOI: http://dx.doi.org/10.1093/jxb/erw427.
34. Chailakhyan, M. K. *Ann. Rev. Plant. Physiol*. **1968**, *19*, 1–37. DOI: http://dx.doi.org/10.1146/annurev.pp.19.060168.000245.
35. Kessler, A. *Curr. Opin. Insect. Sci*. **2015**, 8, 47–53. DOI: http://dx.doi.org/10.1016/j.cois.2015.02.002.
36. Figueiredo, A. C.; Barroso, J. G.; Pedro, L. G.; Scheffer, J. J. C. *Flavour Fragr. J*. **2008**, *23*, 213–226. DOI: http://dx.doi.org/10.1002/ffj.1875.
37. Cruz-Pérez, A.L.; Barrera-Ramos, J.; Bernal-Ramírez, L. A.; Bravo-Avilez. D.; Rendón-Aguilar B. *J. Ethnobiol. Ethnomed*. **2021**, *17*, 7. DOI: http://dx.doi.org/10.1186/s13002-020-00431-y.
38. Mata, R.; Figueroa, M.; Navarrete, A.; Rivero-Cruz, I. *Prog. Chem. Org. Nat. Prod*. **2019**, *108*, 1–142. DOI: http://dx.doi.org/10.1007/978-3-030-01099-7_1.
39. Zolla, C.; Argueta, A. Biblioteca digital de la medicina tradicional mexicana; *Landsteiner Scientific, Comisión Nacional para el Desarrollo de los Pueblos Indígenas, Programa Universitario México Nación Multicultural, Universidad Nacional Autónoma de México*: México. **2009**. http://www.medicinatradicionalmexicana.unam.mx/index.php.
40. Calzada, F.; Bautista, E. *J. Ethnopharmacol*. **2020**, *253*, 112676. DOI: http://dx.doi.org/10.1016/j.jep.2020.112676.
41. Sousa, A. C.; Pádua, I.; Gonçalves, V. M. F.; Ribeiro, C.; Leal, S. *Heliyon*. **2024**, *10*, e28779. DOI: http://dx.doi.org/10.1016/j.heliyon.2024.e28779.
42. Ortega, R.; Valdés, M.; Alarcón-Aguilar, F. J.; Fortis-Barrera, Á.; Barbosa, E.; Velazquez, C.; Calzada, F. *Plants.* **2022**, 11, 575. DOI: http://dx.doi.org/10.3390/plants11050575.
43. Harikrishnan, R.; Balasundaram, C., in: *The Role of Phytoconstitutents in Health Care*, Megh, R. G., Ed., Apple Academic Press: Canada, **2020**. 3-158. DOI: https://doi.org/10.1201/9780429284267.
44. Yazaki, K.; Arimura, G. I.; Ohnishi, T. *Plant Cell Physiol*. **2017**, *58*, 1615–1621. DOI: http://dx.doi.org/10.1093/pcp/pcx123.

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

45. Jash, S. K.; Gorai, D.; Roy, R. *Intern. J. Pharm. Sci. Res.* **2016**, *7*, 4710.
46. Topçu, G. *J. Nat. Prod.* **2006**, *69*, 482–487. DOI: http://dx.doi.org/10.1021/np0600402.
47. Theis, N.; Lerdau, M. *Int. J. Plant Sci*. **2003**, *164*, S93–S102. DOI: http://dx.doi.org/10.1086/374190.
48. Wagner, K. H.; Elmadfa, I. *Ann. Nutr. Metab*. **2003**, *47*, 95–106. DOI: http://dx.doi.org/10.1159/000070030.
49. Salminen, A.; Lehtonen, M.; Suuronen, T.; Kaarniranta, K.; Huuskonen, J. *Cell Mol. Life Sci*. **2008**, 65(19), 2979–2999.
50. Chinou, I. *Curr. Med. Chem*. **2005**, *12*, 1295–1317. DOI: http://dx.doi.org/10.2174/0929867054020990.
51. Alves, A. L.V.; Da Silva, L. S.; Faleiros, C. A.; Silva, V. A.; Reis, R. M. *Nat. Prod. Comm*. **2022,** *17*. DOI: https://doi.org/10.1177/1934578X2211056.
52. Nagegowda, D. A.; Gupta, P. *Plant Sci*. **2020,** *294*, 110457. DOI: http://dx.doi.org/10.1016/j.plantsci.2020.110457.
53. Gurado, O. A. A.; Cuéllar, A. C. *Rev. Cub. Plantas Med*. **2008**, *13*.
54. Paduch, R.; Kandefer-Szerszeń, M.; Trytek, M.; Fiedurek, J. *Arch. Immunol. Ther. Exp*. **2007,** *55*, 315–327. DOI: http://dx.doi.org/10.1007/s00005-007-0039-1.
55. Bueno-Sánchez, J. G.; Martínez-Morales, J. R.; Stashenko, E. *Rev. Univ. Ind. Sant. Salud*. **2009,** *41*, 231–235.
56. Vaillant, F. D.; Romeu, C. C.; Ramos, R. E.; González, G. M.; Ramírez, O. R.; González, P. J. *Fitosanidad*. **2009**, *13*, 197–200.
57. Ruiz-Reyes, E.; Suarez, M. Rev. *CENIC Ciencias Biológicas*. **2015**, *46*, 9–24.
58. Seo, D. Y.; Lee, S.R.; Heo, J. W.; No, M. H.; Rhee, B. D.; Ko, K. S.; Han, J. *Korean J. Physiol. Pharmacol.* **2018**, *22*, 235-248.
59. Kashyap, D.; Tuli, H. S.; Sharma, A. K. *Life Sci*. **2016**, *146*, 201–213. DOI: http://dx.doi.org/10.1016/j.lfs.2016.01.017.
60. Liu, J. *J. Ethnopharmacol*. **2005**, *100*, 92–94. DOI: http://dx.doi.org/10.1016/j.jep.2005.05.024.
61. Pollier, J.; Goossens, A. *Phytochemistry*. **2012**, *77*, 10–15. DOI: http://dx.doi.org/10.1016/j.phytochem.2011.12.022.
62. Babu, S.; Jayaraman, S. *Biomed. Pharmacother*. **2020**, *133*, 193-200. DOI: http://dx.doi.org/10.1016/j.biopha.2020.110702.
63. Saeidnia, S.; Manayi, A.; Gohari, A. R.; Abdollahi, M. *Eur. J. Med. Plants*. **2014**, *4*, 590-609.
64. López, J. G. E. *Curr. Med. Chem*. **2019**, *26*, 6972–6975. DOI: http://dx.doi.org/10.2174/0929867326391912130954O5.
65. Samanta, A.; Das, G.; Das, S. K. *Int. J. Pharm. Sci. Tech*. **2011,** *100*, 12-35.
66. Panche, A. N.; Diwan, A. D.; Chandra, S. R. *J. Nutr. Sci*. **2016**, *5*, 1-15. DOI: http://dx.doi.org/10.1017/jns.2016.41.
67. Janicijevic, J.; Tosic, S.; Mitrovic, T. *Proceeding* of *9th symposium on flora of Southeastern Serbia and neighbouring regions*. **2007**, 153–156.
68. Tiwari, S.C.; Husain, N. *Indian J. Sci. Res*. **2017**, *12*, 193–196.
69. Janicsák, G.; Veres, K.; Zoltán, K. A., Máthé, I. *Biochem. Syst. Ecol*. **2006**, *34*, 392–396. DOI: http://dx.doi.org/10.1016/j.bse.2005.12.004.
70. Noriega, J. M. *Curso de Historia de Drogas*, Ed., Oficina Tipográfica de la Secretaría de Fomento, México, **1902**, 372-373.
71. Pérez, E. B. E. *Lista de las plantas útiles del estado de Hidalgo*. Ed., UAEH, Hidalgo, **2003**.
72. Aguilar, A.; Camacho, J. R.; Chino, S.; Jácquez, P.; López, M. E. Herbario Medicinal del Instituto Mexicano del Seguro Social. Información Etnobotánica; Instituto Mexicano del Seguro Social, México, **1994.**
73. Fragoso-Serrano, M.; Ortiz-Pastrana, N.; Luna-Cruz, N.; Toscano, R. A.; Alpuche-Solís, A. G.; Ortega, A.; Bautista, E. *J. Nat. Prod*. **2019**, *82*, 631–635. DOI: http://dx.doi.org/10.1021/acs.jnatprod.8b00565.

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

74. Moreno-Pérez, G. F.; González-Trujano, M. E.; Martínez-Gordillo, M. J.; San Miguel-Chávez, R.; Basurto-Peña, F. A.; Dorazco-González, A.; Aguirre-Hernández, E. *Bot. Sci*. **2019**, 97, 355–365. DOI: http://dx.doi.org/10.17129/botsci.2187.
75. Moreno, U.V. *Herbolaria y tradición en la región de Xico, Veracruz*. Ed., Gobierno del Estado de Veracruz, Secretaría de Educación y Cultura, Consejo Veracruzano de Arte Popular, Universidad Veracruzana, Xalapa, Veracruz, **2004**, 1-202.
76. Guzmán, G.O. Evaluación de la actividad antiinflamatoria y estudios quimiométricos de especies de *Salvia* de Xalapa, Veracruz y municipios aledaños [master's thesis]. Universidad Veracruzana: México, **2014**.
77. Molina, M. J. L.; Villanueva, R.; Fernández, N. R.; Siciliano, A. *Polibotánica*. **2012**, 34, 259–291.
78. Jiménez-Ferrer, E.; Hernández-Badillo, F.; González-Cortazar, M.; Tortoriello, J.; Herrera-Ruiz, M. *J. Ethnopharmacol*. **2010,** *130*, 340–346. DOI: http://dx.doi.org/10.1016/j.jep.2010.05.013.
79. Bello, G. M. Á.; Salgado, G. R. *Biológicas*. **2007**, *9*, 126–138.
80. Herrera-Ruiz, M.; García-Beltrán, Y.; Mora, S.; Díaz-Véliz, G.; Viana, G. S. B.; Tortoriello, J.; Ramírez, G. *J. Ethnopharmacol*. **2006**, *107*, 53–58. DOI: http://dx.doi.org/10.1016/j.jep.2006.02.003.
81. Moreno, M.; Alvarado, F.D.; Mendoza C.R.; Basurto, P.M. *Bot. Sci*. **2006**, *79*, 79–87.
82. Mora, S.; Millán, R.; Lungenstrass, H.; Díaz-Véliz, G.; Morán, J.A.; Herrera-Ruiz, M.; Tortoriello, J. *J. Ethnopharmacol*. **2006**, *106*, 76–81. DOI: http://dx.doi.org/10.1016/j.jep.2005.12.004.
83. Hurtado-Rico, N. E.; Rodríguez-Jiménez, C.; Aguilar-Contreras, A. *Polibotánica*. **2006**, 22, 21-50.
84. Calzada, F.; Bautista, E.; Yépez-Mulia, L.; García-Hernandez, N.; Ortega, A. *Phytother. Res*. **2015**, *29*, 1600–1604. DOI: http://dx.doi.org/10.1002/ptr.5421.
85. Gómez-Rivera, A.; González-Cortazar, M.; Gallegos-García, A. J.; Escobar-Ramos, A.; Flores-Franco, G.; Lobato-García, C. E. *Afr. J. Trad. Compl. Altern. Med*. **2018**, *15*, 72–82.
86. Navarro, P. L. D. C.; Avedaño, R. S. *Polibotánica*. **2002**, *14*, 67-84.
87. Aoyagi, Y.; Yamazaki, A.; Nakatsugawa, C.; Fukaya, H.; Takeya, K.; Kawauchi, S.; Izumi, H.; Salvileucalin, B. *Org Lett.* **2008**, *10*, 4429–4432. DOI: http://dx.doi.org/10.1021/ol801620u.
88. Jiang, Y. J.; Su, J.; Shi, X.; Wu, X. D.; Chen, X. Q.; He, J.; Shao, L. D.; Li, X. N.; Peng, L. Y.; Li, R. T. et al. *Tetrahedron*. **2016**, *72*, 5507–5514. DOI: http://dx.doi.org/10.1016/j.tet.2016.07.037.
89. Rajamanickam, M.; Kalaivanan, P.; Sivagnanam, I. *Int. J. Pharm. Sci. Rev. Res*. **2013**, *22*, 264–268.
90. González-Elizondo, M.; López-Enríquez, I. L.; González-Elizondo, M. S.; Tena-Flores, J. A. *Plantas medicinales del estado de Durango y zonas aledañas*. Ed., IPN, México, **2004.**
91. Domínguez-Vázquez, G.; Castro-Ramírez, A. E. *Etnobiología*. **2015**, *2*, 19–31.
92. Argumedo Delira, R.; Parra-Delgado, H.; Ramírez-Apan, M. T.; Nieto, C. A.; Martínez-Vázquez, M. *Rev. Soc.Quím. Méx.* **2003**, *47*, 167–172.
93. Molina, M. J. L.; Villanueva, R.; Fernández, N. R.; Siciliano, A. *Polibotánica*. **2012,** *34*, 259–291.
94. Martínez-Vázquez, M.; Miranda, P.; Valencia, N. A.; Torres, M. L.; Miranda, R.; Cárdenas, J.; Salmón, M. *Pharm. Biol*. **1998**, 36, 77–80. DOI: http://dx.doi.org/10.1076/phbi.36.2.77.4611.
95. Hersch, M. *Estado del desarrollo económico y social de los pueblos indígenas de Guerrero, Volumen 2;* Universidad Nacional Autónoma de México PUMC: México, **2009**.
96. Cavin, A.; Dyatmyko, W.; Hostettmann, K. *Pharm. Biol*. **1999,** 37, 260–268. DOI: http://dx.doi.org/10.1076/phbi.37.4.260.5800.
97. Pineda-Ramírez, N.; Calzada, F.; Alquisiras-Burgos, I.; Medina-Campos, O. N.; Pedraza-Chaverri, J.; Ortiz-Plata, A.; Pinzón, E. E.; Torres, I.; Aguilera, P. *Antioxidants.* **2020**, 9, 253. DOI: http://dx.doi.org/10.3390/antiox9030253.
98. Bautista, E.; Ortiz-Pastrana, N.; Pastor-Palacios, G.; Montoya-Contreras, A.; Toscano, R. A.; Morales-Jiménez, J.; Salazar-Olivo, L. A.; Ortega, A. *J. Nat. Prod*. **2017,** 80, 3003–3009. DOI: http://dx.doi.org/10.1021/acs.jnatprod.7b00591.
99. Ramírez-Zea, G.; Chávez-Servia, J.L.; Archundia-Garduño, E.; López-Hernández, *V. Salvias del Estado de México, una perspectiva general*. Ed., Instituto de Investigación y Capacitación Agropecuaria, Acuícola y Forestal del Estado de México (ICAMEX), Secretaría de Desarrollo Agropecuario del Estado de México. Metepec, México, **2016.**

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

100. Calzada, F.; Yepez-Mulia, L.; Tapia-Contreras, A.; Bautista, E.; Maldonado, E.; Ortega, A. *Phytother. Res*. **2010**, 24, 662–665. DOI: http://dx.doi.org/10.1002/ptr.2938.
101. Fan, M.; Bao, Y.; Zhang, Z. J.; Zhang, H. B.; Zhao, Q. S. *Fitoterapia*. **2017**, *123*, 44–50. DOI: http://dx.doi.org/10.1016/j.fitote.2017.09.013.
102. Esquivel, B.; Calderón, J.; Flores, E.; Sánchez, A. A.; Rosas, R. R. *Phytochemistry*. **1997**, *46*, 531–534. DOI: http://dx.doi.org/10.1016/s0031-9422(97)00310-5.
103. Bautista, E.; Fragoso-Serrano, M.; Ortiz-Pastrana, N.; Toscano, R. A.; Ortega, A. *Fitoterapia*. **2016**, *114*, 1–6. DOI: http://dx.doi.org/10.1016/j.fitote.2016.08.007.
104. Bautista, E.; Fragoso-Serrano, M.; Toscano, R. A.; García-Peña, M. del R.; Ortega, A. *Org. Lett*. **2015**, *17*, 3280–3282. DOI: http://dx.doi.org/10.1021/acs.orglett.5b01320.
105. Maldonado, E.; Cárdenas, J.; Bojórquez, H.; Escamilla, E. M.; Ortega, A. *Phytochemistry*. **1996**, *42*, 1105–1108. DOI: http://dx.doi.org/10.1016/0031-9422(96)00147-1.
106. Marquina, S.; García, Y.; Alvarez, L.; Tortoriello, J. *Nat. Prod. Commun*. **2008**, *3*, 185-188. DOI: http://dx.doi.org/10.1177/1934578x0800300215.
107. Esquivel, B. *Nat. Prod. Commun*. **2008**, *3*, 989-1002. DOI: http://dx.doi.org/10.1177/1934578x0800300628.
108. Arnason, J. T.; Mata, R. Phytochemistry of Medicinal Plants, Ed., Springer, New York, NY, **1995.** DOI: https://doi.org/10.1007/978-1-4899-1778-2.
109. Esquivel, B.; Cardenas, J.; Rodriguez-Hahn, L.; Ramamoorthy, T. P. *J. Nat. Prod*. **1987**, *50*, 738–740. DOI: http://dx.doi.org/10.1021/np50052a029.
110. Esquivel, B.; Cardenas, J.; Toscano, A.; Soriano-Garcia, M.; Rodriguez-Hahn, L. *Tetrahedron.* **1985**, *41*, 3213–3217. DOI: http://dx.doi.org/10.1016/s0040-4020(01)96672-4.
111. Mendoza-Espinoza, J. A.; Pena-Miranda, I.; Aarland, R. C.; Peralta-Gómez, S.; Sierra-Palacios, E.; García-Ocón, B. *Indian J. Tradit. Knowle*. **2016**, *15*, 62–67.
112. Hueso-Rodriguez, J.; Jimeno, M.; Rodriguez, B.; Savona, G.; Bruno, M. *Phytochemistry*. **1983**, *22*, 2005–2009. DOI: http://dx.doi.org/10.1016/0031-9422(83)80033-8.
113. Martínez-Cruz, O.; Paredes-López, O. *J. Chromatogr. A*. **2014**, *1346*, 43–48. DOI: http://dx.doi.org/10.1016/j.chroma.2014.04.007.
114. Sandoval-Oliveros, M. R.; Paredes-López, O. *J. Agric, Food Chem*. **2013**, *61*, 193–201. DOI: http://dx.doi.org/10.1021/jf3034978.
115. Rodríguez-Hahn, L.; García, A.; Esquivel, B.; Cárdenas, J. *Can. J. Chem*. **1987**, *65*, 2687–2690. DOI: http://dx.doi.org/10.1139/v87-445.
116. Maldonado, E.; Ángeles-Flores, M. de los.; Salazar, B.; Ortega, A. *Phytochemistry*. **1994**, *37*, 1480–1482. DOI: http://dx.doi.org/10.1016/s0031-9422(00)90438-2.
117. Maldonado, E.; Cardenas, J.; Salazar, B.; Toscano, R. A.; Ortega, A.; Jankowski, C. K.; Aumelas, A.; Van-Calsteren, M. R. *Phytochemistry.* **1992**, *31*, 217–220. DOI: http://dx.doi.org/10.1016/0031-9422(91)83039-n.
118. Ortega, A.; Cárdenas, J.; Toscano, A.; Maldonado, E.; Aumelas, A.; Van Calsteren, M. R.; Jankowski, C. *Phytochemistry*. **1991**, *30*, 3357–3360. DOI: http://dx.doi.org/10.1016/0031-9422(91)83209-4.
119. Aoyagi, Y.; Yamazaki, A.; Kato, R.; Tobe, F.; Fukaya, H.; Nishikawa, T.; Nakahashi, A.; Miura, N.; Monde, K.; Takeya, K. *Tetrahedron Lett*. **2011**, *52*, 1851–1853. DOI: http://dx.doi.org/10.1016/j.tetlet.2011.02.003.
120. Rojas, L. B.; Visbal, T.; Morillo, M.; de Rojas, Y. C.; Arzola, J. C.; Usubillaga, A. *Nat. Prod. Commun*. **2010**, *5*, 937–938.DOI: http://dx.doi.org/10.1177/1934578x1000500627.
121. Negi, A.; Javed, M. S.; Melkani, A. B.; Dev, V.; Beauchamp, P. S. *J. Essent. Oil Res*. **2007,** *19*, 463–465. DOI: http://dx.doi.org/10.1080/10412905.2007.9699953.
122. Esquivel, B.; Hernández, L. M.; Cárdenas, J.; Ramamoorthy, T. P.; Rodríguez-Hahn, L. *Phytochemistry*. **1989**, *28*, 561–566. DOI: http://dx.doi.org/10.1016/0031-9422(89)80051-2.
123. Esquivel, B.; Vallejo, A.; Gaviño, R.; Cárdenas, J.; Sánchez, A. A.; Ramamoorthy, T. P.; Rodriguez-Hahn, L. *Phytochemistry.* **1988**, *27*, 2903–2905. DOI: http://dx.doi.org/10.1016/0031-9422(88)80685-x.

J. Mex. Chem. Soc. **2024**, *68*(4)
Special Issue

ISSN-e 2594-0317

124. Bautista, E.; Toscano, R. A.; Ortega, A. *J. Nat. Prod*. **2014**, *77*, 1088–1092. DOI: http://dx.doi.org/10.1021/np4009893.
125. Bautista, E.; Toscano, R. A.; Ortega, A. *Org Lett*. **2013**, *15*, 3210–3213. DOI: http://dx.doi.org/10.1021/ol401022c.
126. Takeda, K.; Yanagisawa, M.; Kifune, T.; Kinoshita, T.; Timberlake, C. F. *Phytochemistry*. **1994**, *35*, 1167–1169. DOI: http://dx.doi.org/10.1016/s0031-9422(00)94815-5.
127. Nieto, M.; Gallardo, O. V.; Rossomando, P. C.; Tonn, C. E. *J. Nat. Prod*. **1996**, 59(9), 880–882. DOI: http://dx.doi.org/10.1021/np960515x.
128. Esquivel, B.; Esquivel, O.; Cárdenas, J.; Sánchez, A.; Ramamoorthy, T. P.; Toscano, R. A.; Rodríguez-Hahn, L. *Phytochemistry*. **1991**, *30*, 2335–2338. DOI: http://dx.doi.org/10.1016/0031-9422(91)83644-z.
129. Luis, J. G.; Quiñones, W.; Echeverri, F. *Phytochemistry*. **1994**, *36*, 115–117. DOI: http://dx.doi.org/10.1016/s0031-9422(00)97023-7.
130. Rodriguez-Hahn, L.; O'Reilly, R.; Esquivel, B.; Maldonado, E.; Ortega, A.; Cardenas, J.; Toscano, R. A.; Chan, T. M.; *J. Org. Chem*. **1990**, *55*, 3522–3525. DOI: http://dx.doi.org/10.1021/jo00298a026.