Review

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New Compounds from Plants: A Perspective View

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Abstract: In view of the diminishing contribution of natural products from plants to the discovery of new chemical structues, the aim of this study was to compile the articles from 2021 to 2022, assessing: (1) which classes of compounds these new structures belong to; (2) which plants and families these compounds belong to and (3) assessing the degree of novelty of the compound compared with an already known structure. The review was elaborate following the Preferred Reporting Items for Systematics Reviews and Meta-analyses (PRISMA) statement checklist for guide reporting of systematic reviews. A total of 464 articles were selected for the new compounds of natural origin survey. We included 117 complete articles in this review and reported approximately 109 new structures elucidated during the years 2021 and 2022. Many of the compounds showed small structural variations in relation to already known molecules. For some, however, this small modification was decisive for the biological activity reported, demonstrating the importance of descriptive phytochemical studies.

Keywords: natural products; new compounds; plants

1. Introduction

Plants have always been used as a source of ingredients for developing drugs, cosmetics and several types of products [1]. The study of active plant components has given rise to or inspired the development of numerous medicines, present in our daily life [2]. One reason for that is the greatest chemically diverse structures from plant secondary metabolism, which has several functions for plant survival, such as acting as defense mechanism against predators, attracting insects for pollination and other factors that contribute to the plant's resistance [1]. Since they are substances that can act on biological receptors, humans can benefit from them in the development of bioactive products of pharmaceutical interest.

The micromolecules from secondary metabolism is also called "natural products" (NPs) [3]. NPs can come of Nature from a variety of sources, such as plants, animals, and microorganism. They can contribute enormously to the discovery of new molecular entities (NMEs) [4], being around a quarter of approved drugs by FDA.

Despite the great contribution of plants to the discovery of NMEs, several studies report a reduction of the contribution of plants for new compounds [3–5]. The decrease in the contribution of NPs to the discovery of new molecules may have several explanations, such as the high costs of research and investments, especially in the identification and isolation of molecules; re-isolation of known and most abundant molecules and several others.

The use of high-throughput screening (HTS) and metabolomics contribute to accelerate the discovery of new bioactive molecules from plants, although is still challenging to report NME [6,7]. Most of the new reported compounds are small variations of the already known ones.

In view of the diminishing contribution of natural products from plants to the discovery of new chemical structures, the aim of this study was to compile the articles from 2021 to 2022, assessing: (1) which classes of compounds these new structures belong to; (2) which plants and families these

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compounds belong to and (3) assessing the degree of novelty of the compound with an already known structure.

This review was elaborate following the Preferred Reporting Items for Systematics Reviews and Meta-analyses (PRISMA) statement checklist for guide reporting of systematic reviews [8]. The search strategy for the identification of studies was accomplished in the following steps.

Step 1—We systematically retrieved the articles from SciFinder database, using automation tools for first filtered the criteria established for the review as follow the Figure 1. The following keywords were used "natural products", "isolation", "new compounds". The selected records must have been published between 1 January 2021 and 31 December 2022. We exclude case reports, letters, other reviews, books, patent articles, meeting abstracts and non-English articles.

Step 2—The data with the title articles, abstract, author names, and DOI, were downloaded in original xlm. files directly from database. In this document, the filters used in the first step were downloaded. The tabulated tittles were divided into the years of publication, and 2 different researchers conducted a preliminary screening based on the titles and abstracts.

Step 3—The articles screened in step two, were full downloaded and codified for complete read, for prepared to assess eligibility criteria.

To compose this review, the articles were selected following the criteria: 1. original articles published between the years 2021 and 2022, reporting new compounds; 2. The new compounds must be derived from plants species, except aquatic plants; 3. Studies with evaluating of biological activity from the new compounds elucidated.

The articles were placed in folders separated by year of publication and coded numerically for organization. In a excel document, a systematize tabulation was made with relevant information about each article as, the code article, the plant species classification, plant parts used for the extract, the chemical class, and the name of the new compound, to proceed with the descriptive analysis.

Observations frequency distributions were carried out in R software, where, to prepare the new compounds review the following were in-depth: 1. The 5 botanical families with the highest number of publications between 2021 and 2022; 2. The 5 main classes of compounds with the highest number of isolated and elucidated compounds; 3. The 5 main genera with the highest rate of studies, and their species.

2. Included Studies

Figure 1 represents the systematic review study selection flow chart. Were identified 8.838 records on SciFinder database, while using the period filter and the keyword new compound products. After filtering the other criteria, 1.698 records were identified for screening phase. The data with the title articles, abstract, author names, and DOI, were downloaded in original xlm. files directly from database, and 464 studies were selected in the eligibility criteria phase. The 464 articles were previously read by 4 researchers, who collected information on: Botanical family under study, genus and species, class of compounds elucidated, plant organ from which the compounds were extracted, and journal of publication.

After tabulation, the distribution frequencies of the variables collected were observed, and after that, 117 complete articles were compiled to compose the review about new compounds, where we will present the main botanical families, genera, and their species, as well the major chemical classes of higher number of compounds elucidated, variety of species and publication of studies.

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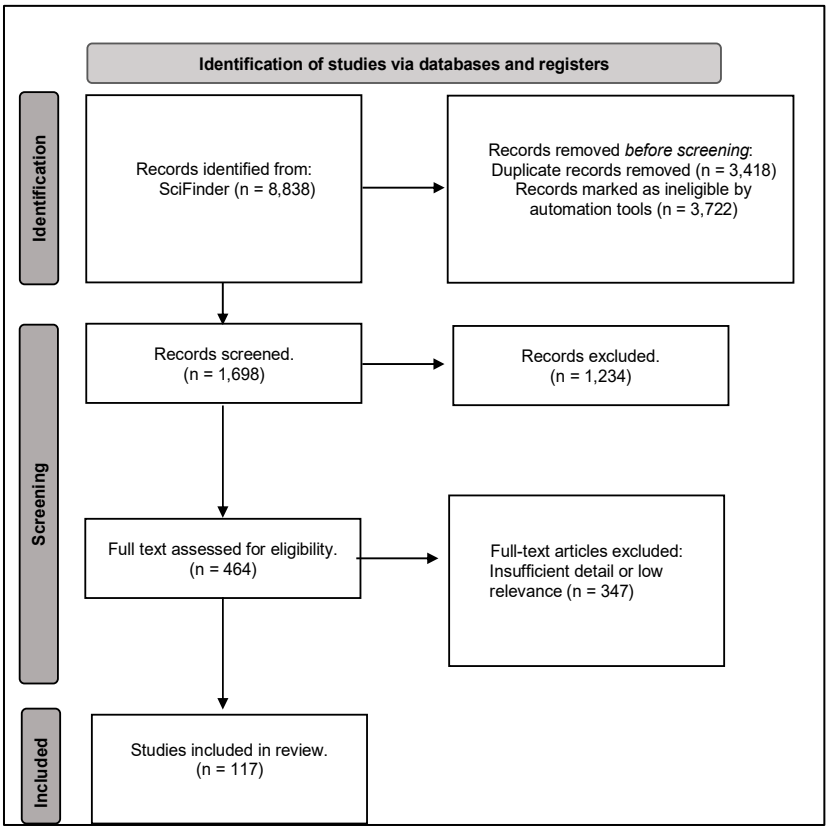

Figure 1. Systematic Review flowchart.

3. Plant Families

Regarding the plant families, we found 122 different families out of a total of 464 articles and 436 different species. The family with the highest frequency was Asteraceae with an absolute frequency of 40 and a relative frequency of 8.5% of the total of 464, followed by Lamiaceae (27 absolute frequency and 5.7% relative frequency) and Fabaceae (26 absolute frequency and 5.5% relative frequency). Other families also had significant frequencies in the study, such as Ranunculaceae (18% absolute frequency, 3.8% relative frequency), Solanaceae (16% absolute frequency and 3.4% relative frequency) and Rutaceae (16% absolute frequency and 3.4% relative frequency), Euphorbiaceae, Rubiaceae and Apocynaceae, as shown in Table 1.

Table 1. Botanical families absolute and relative frequency.

Botanical Family	Absolute Frequency	Relative Frequency (%)
Asteraceae	40	8.5%
Lamiaceae	27	5.7%
Fabceae	26	5.5%
Ranunculaceae	18	3.8%
Solanaceae	16	3.4%
Rutaceae	16	3.4%
Euphorbiaceae	14	3.0%
Rubiaceae	14	3.0%
Apocynaceae	12	2.5%

The most frequent classes of compounds in the Asteraceae were terpenes with 27 reports out of the 40 articles, followed by phenols with 3 and alkaloids with only 2. In the Fabaceae family,

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flavonoids appeared in 13 of the 26 articles, followed by alkaloids with 5 and terpenes with 4 appearances. In the Lamiaceae family, terpenes were present in 18 of the 27 articles, followed by phenols and alkaloids with 3 and 2 appearances, respectively.

It is remarkable that the families with the highest number of species also appear as source of new structures, such as the Asteraceae family, which has an estimated 24,700 species; Fabaceae, with 19,500 species; Rubiaceae, with 13,620, Lamiaceae, with 7,530 species; Euphorbiaceae, with 6,252 species; and Apocynaceae, with 5,100 species [9].

One family, however, draws special attention because, despite having a considerable number of species, it does not appear among in our list - the Orchidaceae family. With an estimated 28,000 species, this monocot family is considered the most evolved within the Asparagales order by some authors. This is also the case for the Cyperaceae (5,500 species), Myrtaceae (5,950 species), Melastomataceae (5,115 species) and Poaceae (12,000) families. Although this assessment is just a snapshot, it is worth considering whether these families have already been exhausted by studies, whether they hardly provide any new structures, or whether more studies are needed in view of the potential they offer.

4. Plant Genera

The top five botanical genera with the highest number of published articles between 2021 and 2022, were *Hypericum*, *Piper*, *Garcinia*, *Artemisia*, and *Thalictrum* genera (Table 2). One hundred forty-six new compounds were isolated, with most part belonging to the terpene class. We report the main botanical species with new molecules elucidated from each genus, and the results found in biological studies using the new compounds.

Table 2. Five main botanical genera with the highest number of publications between the years 2021 and 2022.

Genus	Family	Order	Published Studies *	New Compounds
Piper	Piperaceae	Piperalis	7	42
Hypericum	Hypericaceaea	Malpighiales	7	34
Artemisia	Asteraceae	Asterales	6	45
Garcinia	Clusiaceae	Malpighiales	5	23
Thalictrum	Ranunculaceae	Ranunculales	4	9

* Absolute Frequency of Published Studies (2021-2022).

Piper

A member of the Piperaceae family, the genus *Piper* is the most important of the family, with approximately 2,000 species distributed throughout the temperate regions of the southern and northern hemispheres. The phytochemical investigation of the genus species has led to numerous important scientific studies into the isolation of new bioactive compounds, placing the genus in the spotlight of research to this day.

Cavalactones, aristolactams, phenylpropanoids, lignoids, chromones, terpenes, prenylated benzoic acids, monoterpenes, sesquiterpenes, aldehydes, ketones, arylpro-panoids and long-chain alcohols are the main secondary compounds produced by plants of the genus Piper, which give it economic and medicinal importance. The NPs have antifungal, insecticidal, bactericidal, antitumor, trypanocidal, antiparasitic, antimicrobial, antiprotozoal, antinociceptive and antioxidant activity, already proven in biological studies [10–14].

Between 2021 and 2022, a total of 42 new compounds were isolated from five different species of the genus: *Piper betle* L. [15–17], *Piper longum* L. [18], *Piper puberulum* Seem. [19,20], and *Piper wallichiiv* (Miq.) Hand. -Mazz [21].

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Seventeen new compounds were isolated from the leaves of the species *Piper betle* L. The new structures were described in three different studies, where two new phenolic skeletons, one sesquionelignan and fourteen neolignans were elucidated.

The new phenolics compounds showed antioxidant potential and significant cytotoxic activity against human oral cancer cell lines [15]**.** The sesquioneolignan and four neolignans elucidated in a study published in 2021, demonstrated anti-inflammatory activity against nitric oxide (NO) production in murine macrophages activated by lipopolysaccharide [16]**.** Other 10 new neolignans were isolated through a synergistic antibacterial screen conducted to elucidate the structures and absolute configurations of the metabolites, based on spectroscopic data, single crystal X-rays, diffraction analysis and experimental ECD. The study revealed potent synergistic activity on the part of the compounds in antibacterial assays against the antibiotic-resistant strain *Staphylococcus aureus* [17]**.**

In the fruits extracts of the species *Piper logum* L., three new amide alkaloids, a piperic ester, and two new natural compounds were isolated and evaluated for their biological and cytotoxic activity. Molecular docking simulations were carried out to identify the interaction and binding mechanisms of these active metabolites with proteins related to inflammation and cancer [18]**.**

In *Piper puberulum* Seem., three new tyramine-type alkamides, three new natural products and five new N-acylated/formylated aporphine alkamides with different proportions of rotational isomers have shown potential inhibitory effects against lipopolysaccharide-induced NO release in microglial cells [19,20].

The last two new compounds found in studies of the Piper genus through the review were extracted from the stems and leaves of *Piper wallichiiv* (Miq.) Hand. -Mazz. A new dioxoaporfin alkaloid skeleton showed inhibitory activity against the pathogenic bacteria *Bacillus cereus*, *Bacillus subtilis* and *Staphylococcus aureus*. In addition to this compound, an aryl alkalone has also been reported [21]**.**

Hypericum

Hypericum is the genus with the second highest number of new isolated compounds reviewed in this study. This is the largest genus in the Hypericaceae family, comprising around 500 plant species worldwide. Hypericum species are found in a wide variety of habitats; in the tropics they are usually confined to high elevations, and their greatest profusion is found in temperate and subtropical regions [22,23]. Among the compounds of greatest pharmacological importance produced by the genus species, the polycyclic polyprenylated acylphloroglucinols and naphthodianthrons (PAPPs) have received a great deal of attention for their promising antidepressant activity, for the treatment of mild to moderate depression [24].

Hypericum perfloratum L. is the most chemically and pharmacologically relevant Hypericum specie, due to its wide variety of different secondary metabolites. The species has at least ten classes of biologically active compounds and is widely used to treat diseases in folk medicine, with confirmed nephro-protective, antioxidant, antifungal, anxiolytic, antiviral and healing effects. The study compiled by this review describes the absolute configuration of a new terpenoid-based bicyclic dihydropyran enantiomers, isolated from the aerial parts of *Hypericum perfloratum* L. The study observed that the new compound promoted glucose consumption and exhibited a moderate promotion of glucose uptake activity in hepatocytes, suggesting a potential hypoglycemic activity effect [25].

Thirteen new molecular skeletons were elucidated from the *Hypericum forrestii* (Chitt.) N. Robson. Three polyprenylated acylphloroglucinol meroterpenoids were isolated from the extract of the aerial parts of the plant, with potent inhibitory effects on protein tyrosine phosphatase [26], and ten polyprenylated polycyclic acylphloroglucinols were isolated from the fruit with potential effects against nonalcoholic steatohepatitis [27].

Four new prenylated phloroglucinol isolated from the specie *Hypericum erectum* Thunb. have potential to increase the effects of various anticancer drugs [28].

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The study carried out using the extract of *Hypericum longistylum* Oliv. isolated a new Lupane-type triterpenoid with immunosuppressive activity [29], and in species of *Hypericum japonicum* Thunb., three new phloroglucinol showed important biological activity with potential ferroptosis activity [30].

Artemisia

The genus comprises approximately 200 species of economic, medicinal and food importance. Among the classes of compounds known to be produced by species of the genus are Terpenes, Phenylpropanoids, Flavonoids, Triterpenes and Sesquiterpene Lactones.

Artemisia rupestris L. was one of the species detected in this review. Two new compounds derived from thiophene and a new sesquiterpene were isolated and showed inhibitory activity against neuraminidase enzymes involved in the release of newly synthesized virions by cells infected by the influenza virus [31].

The *Artemisia scoparia* Waldst. & Kit., is an herb used in natural medicine to treat jaundice in neonates and ear problems. In the survey of studies on new compounds, two new isomers of diprenylated coumaric acid were isolated, and biological tests showed a beneficial ability to modulate adipogenesis in studies with cells [32].

Two new compounds named Integrin A and Integrin B were isolated from the supercritical fluid extract of the aerial parts of the species *A. integrifolia* L. [33]. The species is characterized by the presence of phenylpropanoids, acetylenes, terpenoids and fatty acids and is an herb of traditional use with reported antihyperlipidemic effect [34].

Artemisia atrovirens Hand. -Mazz., is a perennial herb distributed mainly in central and western China and Thailand. Studies focusing on the investigation of new sesquiterpenoids have elucidated a total of 24 compounds, sixteen are new guaiane-type sesquiterpenoids [35] and eight new sesquiterpenoid dimers [36]. The evaluation of the biological activity of the guaiane-type compounds showed cytotoxic activity against two hepatoma cell lines [35]. The study with sesqui-terpenoid dimers evaluated the anti-inflammatory effect of the new compounds on microglial cells [36].

Searching for sesquiterpenoids compounds, 14 new eudesmane sesquiterpenoids were isolated from the whole plant *Artemisia hedinii*. Eudesmane sesquiterpenoids have already been elucidated in numerous medicinal plants, especially species from the Asteraceae family. Due to their important biological anti-bacterial, anti-inflammatory, cytotoxic and immunostimulant activities, eudesmanes are an important class mainly reported in the genus Artemisia. The species *A. hedinii* is endemic to the Qinghai and Gnasu Provinces of mainland China. Among its known therapeutic effects, the herb is used to treat inflammation, olecystitis, jaundice, dysentery, chronic gastritis, diabetes, ovarian cancer, positional vertigo, herpes zoster and exudative erythema multiforme. The study published in 2021 demonstrated the consistent anti-inflammatory effects of the isolated and elucidated metabolites [37].

Garcinia

The genus *Garcinia*, is the most predominant of the family Clusiaceae, comprising 450 species. Several Garcinia species are widely used as traditional or folk medicines, and their medicinal applications are supported by the presence of chemical constituents, as mainly varieties of xanthones, flavonoids and benzophenones. These natural compounds exhibited biological activity effects, including antimicrobial, antifungal, antioxidant and antimalarial [38]. Most part of studies reporting new molecular species discovered new compounds derived from the xanthones class and polyprenylated structures.

A total of 23 new compounds were isolated and reported, from 5 different species of *Garcinia sp.* From the leaves of *Garcinia xipshuanbannaensis*, four new prenylated xanthones analogues were elucidated, and evaluated for their cytotoxicity toward human cancer cells [38]. In *Garcinia oligantha*, four new caged-polyprenylated xanthonoids, a rare class of natural products, and two new simple xanthones were isolated [39]. One new xanthone was isolated from *Garcinia nobilis* Engl. leaves extract [40]. From the flower and twig extracts of *Garcinia mckeaniana* a new biphenyl and one new simple

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xanthone was reported [41], and in studies using the fruits extract of *Garcinia cambogia,* ten new polyisoprenylated benzophenone derivatives were isolated and tested for their biological activity [42].

The special interest in natural xanthones produced by Garcinia genus, is due to the bioactive biological variety of the class. Most part of the studies seen in this review reported the excellent cytotoxic potential and antiproliferative activity in tumor cells of the new molecules.

Thalictrum

A member of the Ranunculaceae family, the *Thalictrum* genus comprises about 200 species. Approximately 67 species are recorded in the flora of China, and many of them have been used as traditional medicine for the treatment of many diseases, including influenza, gastroenteritis, cancer, dysentery, measles, and conjunctivitis. The most common class produced by the plants of Thalictrum genus, are the alkaloids [43].

Alkaloids represents an important broad spectrum of biological activities such as anticancer, antiparasites, antiplatelet aggregation, ant silicosis, and antivirus activity. Phytochemical investigations using Thalictrum genus was concentrated in describes the elucidation of their structures and preliminaries evaluation of their bioactivity potential.

In the new compounds review, 4 studies reported new molecular structures derived from the alkaloids class, totaling nine new molecules, including two new chromeno[3,2-c] pyridine alkaloids from *Thalictrum scabrifolium*, three new anti-rotavirus quinoline alkaloids from the whole plant of *Thalictrum glandulossissimun*, two new chromeno[3,2-c] pyridine derivates from *Thalictrum finetii*, and two new anti-tobacco mosaic virus alkaloids from *Thalictrum microgynum* [43–47].

5. Compounds Classes

The classes of compounds with the greatest frequency and variety in different botanical species, with new molecules elucidated in this study, were Terpenes, Alkaloids, Phenols, Flavonoids (**Figure 2**).

Terpenes dominated the ranking of new structures elucidated with 192 new compounds reported in 188 studies between 2021 and 2022, in 184 different botanical species. In second place are alkaloids, with approximately 70 new molecular skeletons described in 69 different botanical species. The Flavonoids class had 55 new molecules elucidated, in a variety of 53 botanical species. New phenolic structures were elucidated from 54 different botanical species, with 52 new molecules reported between 2021 and 2022.

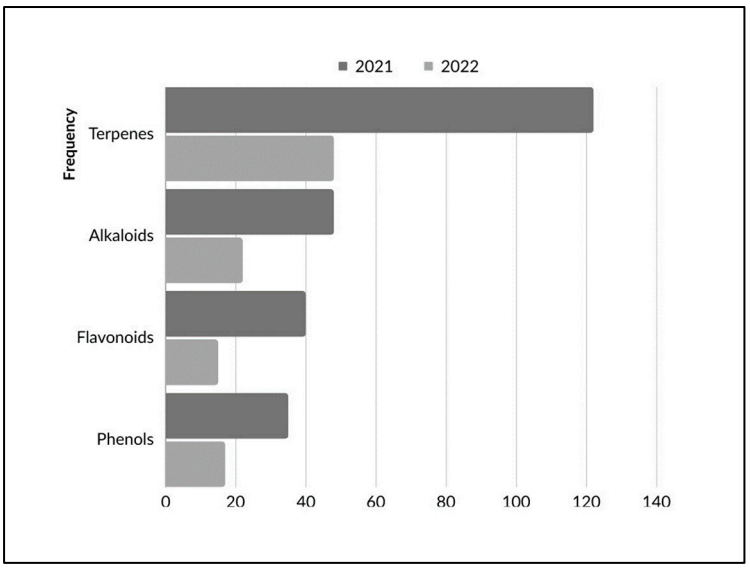

Figure 2. Distribution of compounds classes, with higher number of new structures elucidated between 2021 and 2022.

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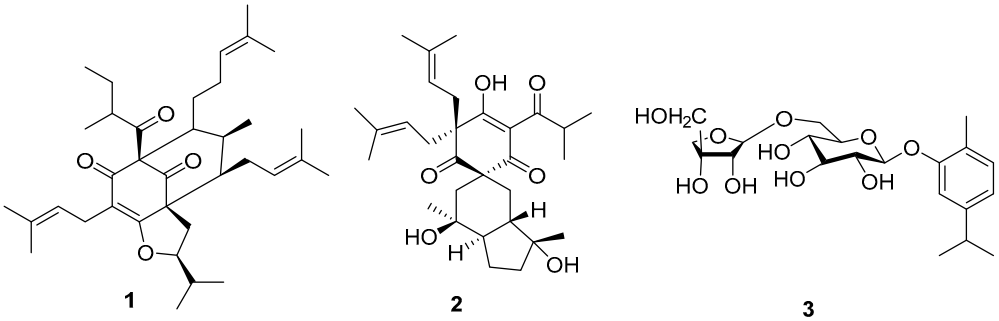
We also included the class of coumarins and anthraquinones in our compounds class section, which even with a relatively smaller number of new compounds elucidated, are among the most important studies on new natural structures.

5.1. Terpenes

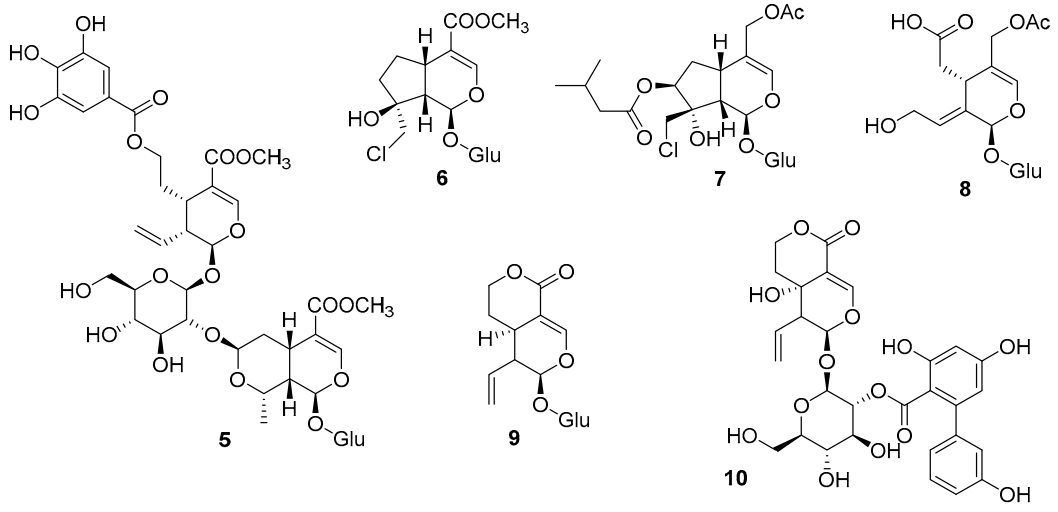
Terpenes are composed of simple hydrocarbons formed by isoprenic units from the mevalonate pathway. The classification is established by the number of isoprenic units present in the molecule, being hemiterpenes characterized by the presence of only one isoprenic unit (C5), monoterpenes by two units (C10), sesquiterpenes (C15), diterpenes (C20), triterpenes (C30) and tetraterpenes (C40).

Three new polyprenylated acylphloroglucinol meroterpenoids were obtained from the aerial parts of *Hypericum forrestii* (Chitt.) N. Robson (Hypericaceae), called hyperiforins A-C [26]. Hyperiforins A (**2**) and C (**3**) showed potent inhibitory action on the enzyme tyrosine phosphatase 1B.

Three new glycosidic monoterpene compounds (**4**) (with glucopyranosyl and apiofuranosyl groups) derived from Carvacrol were obtained from the roots of *Lilium dauricum* Ker Gawl. (Liliaceae). It is interesting to note that, despite the small structural difference (exchange of the position of the sugars and methyl), different potency in the α-glucosidase inhibitory action was found [48].



Iridoids are undoubtedly the class of monoterpenes with the greatest potential for providing new structures [49–52]. Cornusdiridoids (**4**) with unusual cornuside-morroniside secoiridoid dimers were obtained from the fruits of *Cornus officinalis*. Their small differences consisted in stereochemical and sugar position. The were tested for antidiabetic activity, but just the already known compounds were active [53]. Chlorine-containing iridoid glycosides were reported from *Plantago maxima* Juss. ex Jacq (Plantaginaceae) (**5**) [54], *Valeriana jatamansi* Jones (**6**) (Caprifoliaceae) [55], as well as secoiridoids [50,52,56].



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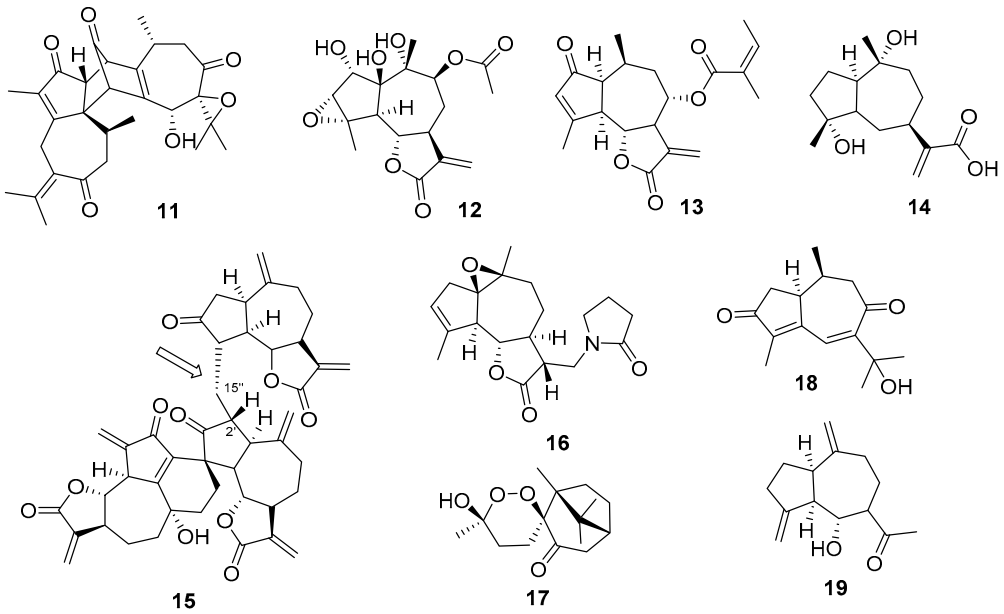
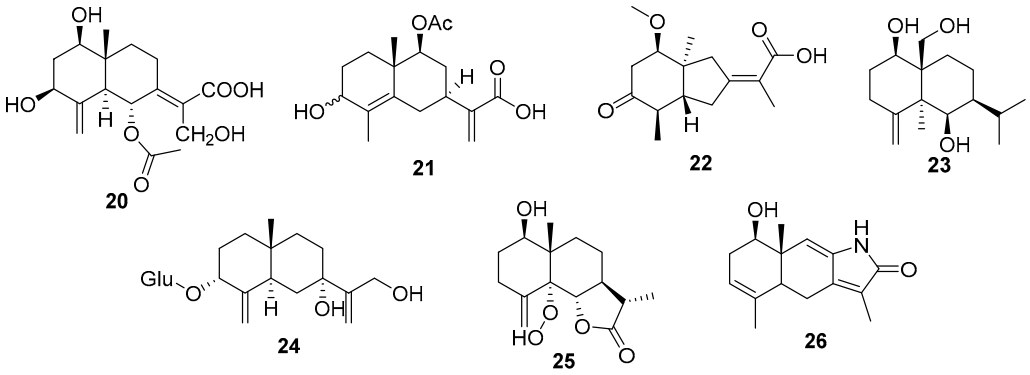
Considering sesquiterpenes, there was a wide variety of subclasses making up the new structures identified. Among the guaiane-type skeletons, a dimeric (**11**) was found from the leaves *Xylopia vielana* Pierre (Annonaceae) together with different analogues [57]. Compound **12** was obtained from the leaves of *Ammoides atlantica* (Coss &Durieu) H. Wolff (Apiaceae), together with 15 new compounds [58]. The guaianolide lactone **13** was obtained from *Chrysanthemum indicum* L. (Asteraceae), a traditional herbal medicine in South Korea [59]. It showed inhibitory effects on lipopolysaccharide (LPS)-induced nitric oxide production in RAW 264.7 cells. The guaianolide **14** was obtained from the plant *Ambrosia artemisiifolia* L. (Asteraceae), an invasive plant with known allelopathic effects [60].

An unusual guaianolide trimer (**15**) was found in *Ainsliaea fragrans* Champ. (Compositae), a plant with medicinal use as an antibacterial and anti-inflammatory [61]. The third sesquiterpene unit is attached to $C_{2'}$, providing a rare linkage ($C_{2'}$-$C_{15''}$). Cytotoxicity results showed this compound active against five cancer cell lines with IC_{50} values of 0.4–8.3 μM. Compound **16** is notable for the presence of a γ-lactam group [35], while **17** has an unusual 1,4-peroxy hemiacetal xanthanolide skeleton [62]. Other minor structural modifications can be found in the reported sesquiterpenes **18** and **19** [63].



Eudesmane-type sesquiterpenoids are another important subclass of sesquiterpenoids with several examples of new structures (**20**-**26**) [37,58,64–68]. Compounds **25** and **26** have rare peroxide-substituted group and γ-lactam ring. The first was isolated from *Sonchus arvensis* L. (Asteraceae) and showed phytotoxic activity. Compound **26** was obtained from *Sarcandra glabra* (Thunb.) Nakai (Chloranthaceae) together with five other new eudesmane-type sesquiterpenoids.



Tian and co-workers isolated 5,5-spiroketal sesquiterpenes (**27**) from the roots of *Angelica pubescens*, which possessed inhibitory activity against nitric oxide (NO) production induced by

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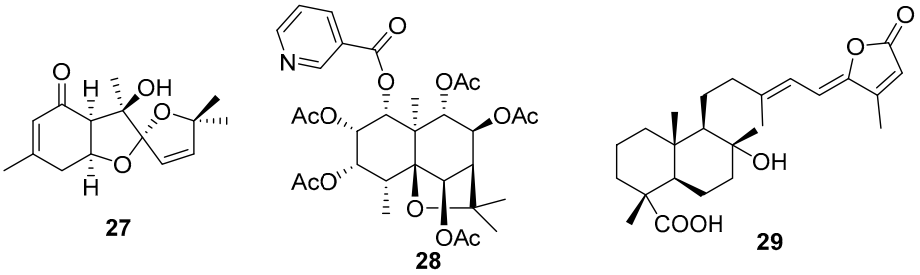
lipopolysaccharide (LPS) in RAW264.7 macrophage cells [69]. Dihydro-β-agarofuran-type sesquiterpenoids were identified from the stems of *Celastrus monospermus* Roxb. (Celastraceae) with significant inhibition of osteoclastogenesis [70]. Celasmondin C (**28**) possessed an unusual nicotinoyloxy group attached to C-1.

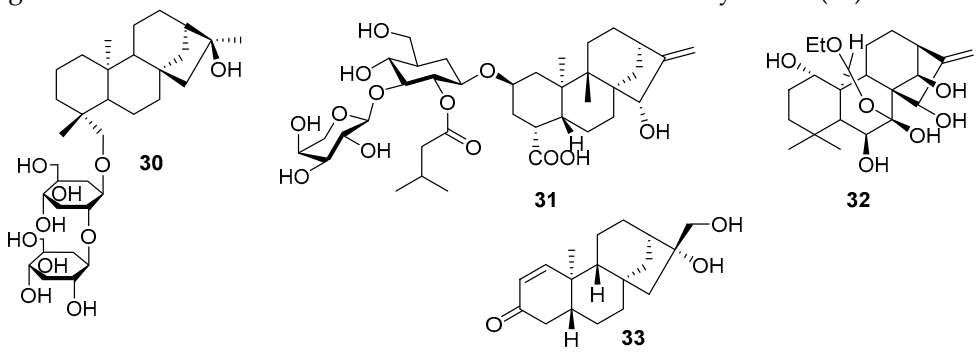


Germacrenolide-type was found in *Carpesium lipskyi* Winkl. (Asteraceae) [71], *Polydora serratuloides* (DC.) H. Rob (Asteraceae) [72], *Asteriscus graveolens* (Forsk) Less. (Asteraceae) [73] and *Carpesium divaricatum* Sieb.et Zucc (Compositae) [74].

Seterterpenoids are relatively rare in nature. Mirzania and co-workers isolated six new (**29**) from *Salvia mirzayanii* Rech. f. and Esfand [75].

Regarding diterpenes, a new ent-kaurane diterpenoid compound named daturoside A (**30**) was obtained from the pericarp of *Datura metel* L. from the Solanaceae family [76]. The author's studies indicate an anti-inflammatory action through the production of nitric oxide (NO) induced by lipopolysaccharide (LPS). The compound hupehenoside A (**31**) was obtained from *Inula hupehensis* (Y. Ling) Y. Ling and has a carbon bond in the glycosidic structure and a carboxylic acid in the cyclic structure [77]. Wang et al (2022) also identified another 15 new compounds with a similar structure, with slight variations in the hydroxyls of the sugars (mostly acetylation substitutions). The authors evaluated the neuro-anti-inflammatory activity, and only one of the compounds showed inhibition of NO production.

Other diterpenes with ent-kaurane skeletons were reported by Wei et al., 2022 [78] and Xin et al., 2022 [79]. The molecule **32** has more hydroxyls in its structure than the already known molecule Phyllanthone A. It was isolated from the ethanolic extract of the aerial parts of *Rabdosia rubescens* (Hemsl.) Hara (Lamiaceae). The study by Xin et al (2022) also reported two other ent-kaurane diterpenes from the roots and stems of *Phyllanthus acidus* (L.) Skeels (Phyllanthaceae) with cytotoxic activity against some cancer cell lines and moderate anti-inflammatory action (**33**).



Studying the plant *Euphorbia dracunculoides* Lam. belonging to the Euphorbiaceae family, Yan et al. (2022) [80] reported four new polycyclic diterpenoids. According to the author, compound **34** is the first example of a 15,16,17-trinorabietane aromatic diterpenoid, while compound **35** is an unusual 17-norabietane diterpenoid. They showed significant antiproliferative activity in four cancer cell lines, above all by inhibiting the proliferation of K562 cells.

Abietane diterpenoids are characterized by having a tricyclic chain and 20 carbons. Six new compounds were reported by Liu et al., (2022) [81], which were obtained from the heartwood of *Juniperus formosana* Hayata (Cupressaceae). Among the compounds obtained, four cadnene sesquiterpenoids Junipertriol (**34**), an abietane diterpenoid (**35**) and a β-naphthol1-(6-hydroxy-4-

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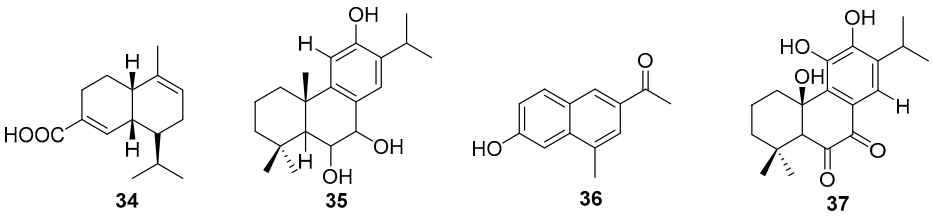
methylnaphthalen-2-yl) ethan-1-one derivative (**36**). The compound Junipertriol (**34**) showed significant NO inhibitory potential and all the new compounds showed anti-inflammatory effects, evaluating the expression of IL-1β, IL-6 and TNF-α was measured through LPS stimulation in RAW264.7 cells (Figure 19).

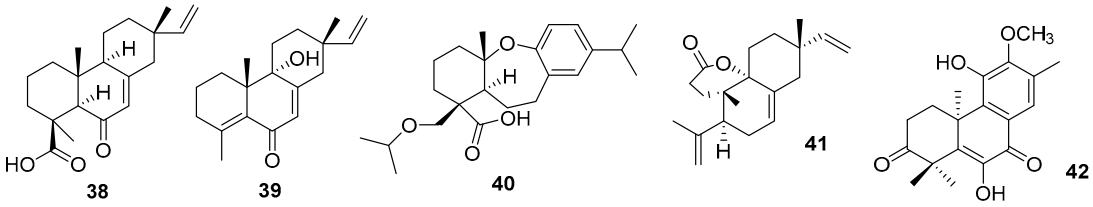
Another abietane diterpene compound was reported and named mutabilol, the compound was obtained from the leaves of Plectranthus mutabilis Codd (Lamiaceae) [82]. The chemical structure of mutabilol (**37**) shows two carbonyls in its non-aromatic cyclic structure.



Pimarane (**38** and **39**) and abietane (**40**) diterpenoids were obtained from the aerial parts of *Blumea balsamifera* (L.) DC (Asteraceae) [83]. The compounds showed anti-inflammatory action by inhibiting LPS induced by TNF-α. Among the pimarane-type structures, blusamiferoid E has a hydroxyl in the cyclic structure and an extra unsaturation, while blusamiferoid A has a carboxylic acid.

Li et al, (2022) reported three new 3,4-seco pimarane diterpene compounds from the leaves and twigs *of Isodon flavidus* (Hand.-Mazz.) H. Hara (Lamiaceae) [84]. The structure shows a δ-lactone ring and the carbon-carbon double bond of the isopropyl group seems to be related to antiviral activity. Among the compounds discovered, fladin C (**41**) was the only one to show inhibition of Ebola virus replication.

A new 15,16-dinor-ent-pimarane diterpene was obtained from *Croton yunnanensis* W.W. Sm. (Euphorbiaceae) and was named Crotonyunnan E (**42**) [85]. In addition to this compound, four other 19-cleodane diterpenes (Crotonyunnan A-D) were obtained [85]. Crotonyunnan E (**42**) showed selective cytotoxicity against three tumor cell lines SMMC-7721 (human hepatoma cells), HL-60 (pre-myelocytic leukemia) and A-549 (lung cancer cells).



Labdane diterpenes are characterized by a bicyclic structure, with decalin as the core. From the leaves of *Stevia rebaudiana* (Bertoni) Bertoni, Kang et al, (2022) [86] reported a new labdane diterpene compound (6-O-acetyl-(12R)-epiblumdane) (**43**). Studies of this compound showed stimulation of insulin secretion in INS-1 β-pancreatic cells from rats.

An unusual indolic diterpene with a C-17 norcassane structure was obtained from the roots of *Euphorbia fischeriana* Steud (Euphorbiaceae) [87], in addition to another ent-atisane-type diterpene compound. The unusual compound was named Euphkanoid H (**44**) and according to the author, it is the first example of an indolic diterpene with a C-17 norcassane structure in nature. In addition, the compound showed biological activity by inhibiting the proliferation of HEL cells, which could be effective in the development of drugs for leukemia.

A jatrophane diterpene was obtained from *Euphorbia glomerulans* (Prokh.) Prokh. (Euphorbiaceae) and was named Euphoglophane V (**45**); other jatrophane and ingenane type diterpenes have also been reported [88]. According to the author, the compound has an isobutanoyloxyl group on the C-8 carbon and this new molecule showed high efficiency in reversing resistance to multiple drugs, promoting accumulation of Rh123 and DOX in drug-resistant cells, as well as inhibiting the transport function of P-glycoprotein, such action being interesting in therapies against cancer and fungal infection.

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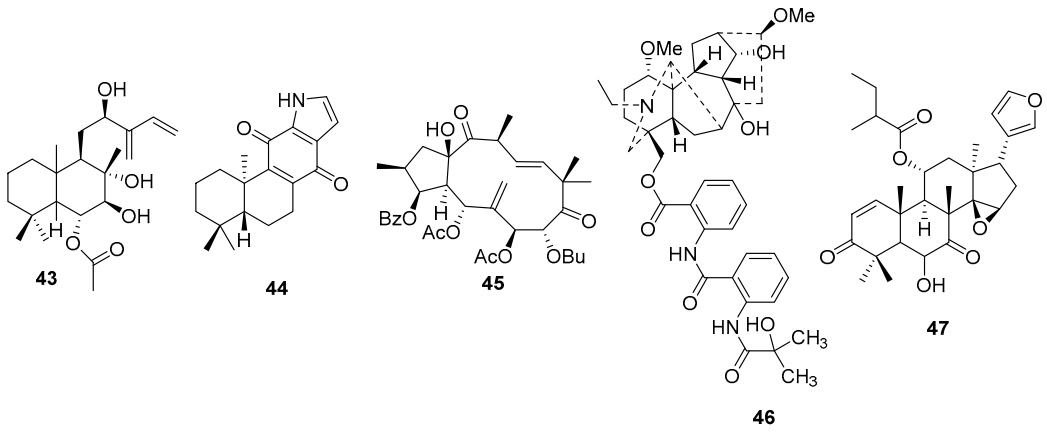

New C-19- diterpene alkaloids of the aconitine type were obtained from the aerial parts of *Aconitum apetalum* (Huth) B. Fedtsch. (Ranunculaceae) and were given the names apetalrines A-E [89]. The author's research indicates that apetalrine B (**46**) has neuroprotective action by inhibiting the production of reactive oxygen species (ROS) in SH-SY5Y cells, thereby inhibiting H2O2-induced cell apoptosis.

New limonoid (**47**) was obtained from the leaves and twigs of *Walsura yunanensis* C.Y.Wu (Meliaceae) and showed cytotoxic action on four cancer cell lines, including A549, HepG2, HCT116 p21KO and CNE-2 [90]. The α,β-unsaturated ketone and portions of the A and B rings are essential for cytotoxic activity, according to the author.

A new saponin triterpenoid (**48**) was isolated from the roots of *Gardenia ternifolia* Schumach. & (Rubiaceae) and showed antimicrobial activity against *Salmonnella typhi* [91]. The compound named ternifoliaoside A (**48**) has a saponin triterpene nucleus and two glucopyranosidic bonds.

Two new triterpenoid glycoside compounds were isolated from the fruits *of Momordica charantia* L. (Cucurbitaceae) and were named Momordicoside Y and Z [92]. Momordicoside Y (**49**), along with other known compounds, were evaluated for their antidiabetic potential, showing inhibitory activity on hepatic gluconeogenesis.

Seven new triterpenes were obtained from the aerial parts of *Elsholtzia penduliflora* W. W. Smith (Lamiaceae) [93]. Two of the new compounds, named penduloside C (**50**) and G (**51**), showed significant inhibitory activity against tumor cells.

HU et al (2022) [94] reported new triterpenoids obtained from the leaves of *Alstonia scholaris* (L.) R. Br, and were named Alstolarnoid (A - D). These compounds - Alstolarnoid A (**52**) and D (**53**) - showed a reduction in uric acid levels in vitro and *in vivo*.

Three new oleanane-type saponin triterpene compounds with a 13, 28 epoxy bridge were obtained from the roots of *Ardisia crispa* (Thunb.) A. DC. and were named Ardisiacrispin D-F [95]. These compounds showed cytotoxic action against three cancer cell lines (HeLa, HepG2 and U87 MG) *in vitro*. According to the author, these new compounds are the first examples of a monosaccharide linked directly to the C3 aglycone of saponin triterpenes in this plant genus (Ardisiacrispin D - **54**).

New triterpenic compounds were isolated from *Lepidozia reptans* (L.) Dumort. and named lepidozin A-J [96]. Lepidozin G (**55**) is a 9,10-dry cycloartane that contains a cabonyl portion in an α,β-unsaturated portion in its structure that may be related to the inhibition of cancer cell lines by inducing the death of PC-3 cells by mitochondria-related apoptosis.

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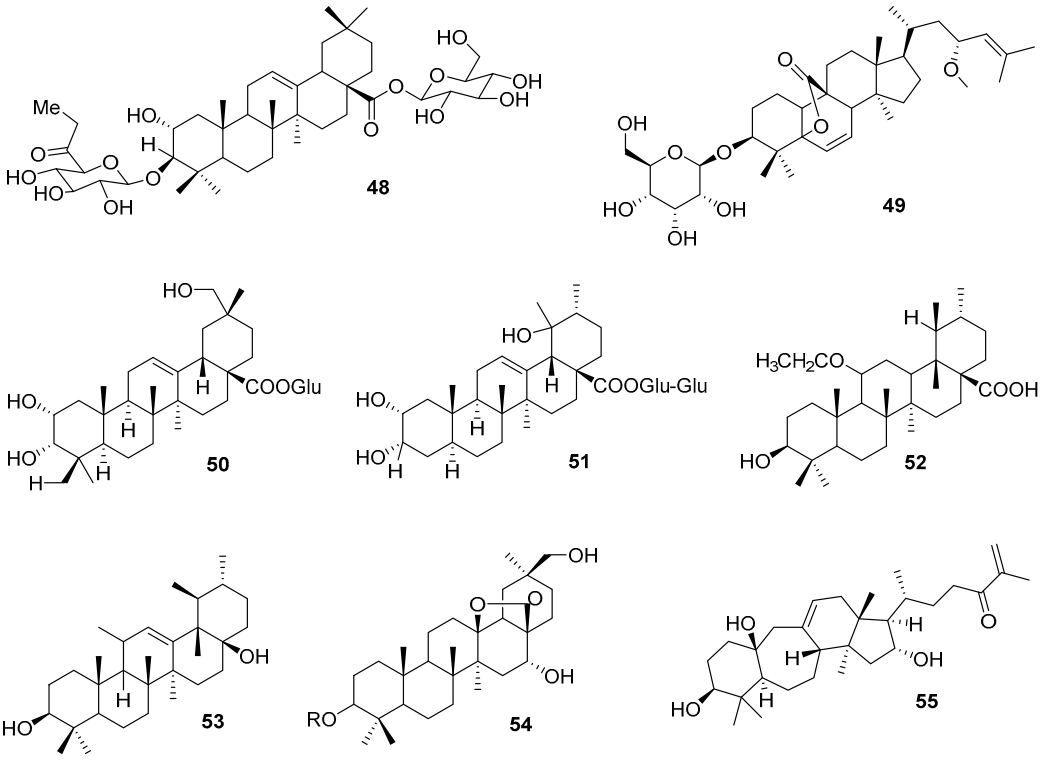
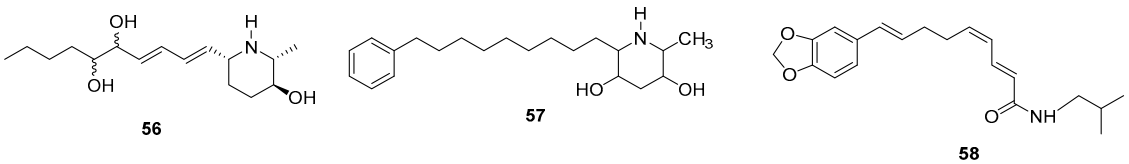


Among the terpenes, the sesqui- and diterpene subclasses have the greatest potential to present new structures, both due to the presence of atypical bonds between the carbons of the rings for the formation of extra rings, and the presence of some nitrogen derivatives. The possibility of skeleton types within sesqui- and diterpenes provides an even greater chance of finding new derivatives. In the other subclasses of terpenes, mostly minor modifications of functional groups and sugars are found.

5.2. Alkaloids

Piperidine alkaloids show various types of biological activity. Statistics considering the scaffolds of FDA-approved drugs show a widespread presence of the piperidine core [97]. Wu et al. (2022) [98] reports eight new 2,6-disubstituted piperidin-3-ol alkaloids (**56**) possessing Angiogenesis-Inhibitory activity from the plant *Microcos paniculate* L. (Tiliaceae). The variations in the structures were the number of -hydroxyls or carbonyls in the carbonic chain. Other piperidine alkaloids [99] with small stereochemical variations and the presence of -CH_3 e -OH attached to the piperidinic ring has been reported from the plant *Alocasia macrorrhiza* (L.) Schott (Araceae) (**57**). These isolated alkaloids were screened for the antiproliferative activity through MTT assay against HepG2, AGS and MCF-7 tumor cells.

New amide alkaloids were isolated from the fruits of *Piper longum* L. (Piperaceae) and given the names piperlongumamides D-F [18]. The structure of piperlongumamide E (**58**) is similar to the known compound retrofractamide A, differing by the stereochemistry of one of the double bonds. According to the author, piperlongumamide E (**58**) showed inhibitory activity against NO production.



Diterpene alkaloids are found mainly in the genera *Aconitum*, *Delphinium* and *Spiraea* in the Ranunculaceae family. Usually, they have a complex heterocycle scaffold (**3**) and a variable number of carbons (C_{18}-, C_{19}-, C_{20}-). Three new C_{20}-diterpenoid alkaloids from *Aconitum kusnezoffii* Reichb,

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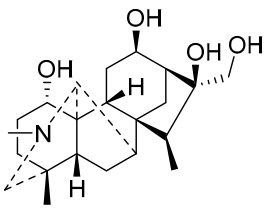
named napellines were evaluated in vitro for their proliferative activities against A549, HL-60, MCF-7, Bel-7402, BGC-823, and RAW264.7 cells, but just the already known compounds showed activity. [100] A similar new structure was found by Wang and co-workers (2021) [101] in the plant *Aconitum carmichaelii* Debx.

A rare C_{20}-type diterpene alkaloid was isolated from the plant *Delphinium gyalanum* C. Marquand & Airy Shaw [102]. This compound possesses a hemiacetal ring linking C-2 to C-19 and showed cardiotonic effect by isolated frog's hearts perfusion (**4**). Other activities were reported for diterpene alkaloids, as protective against cardiomyocytes H_2O_2-induced injurity [103], anti-inflammatory effects against NO production [104]. Kemgni et al. (2021) [105] isolate sesquiterpenes alkaloids with an unusual eight-membered lactam ring (**4**). They were obtained from the leaves of a Cameroonian medicinal plant *Greenwayodendron oliveri* (Engl.) Verdc and showed antimicrobial activity.

Steroidal alkaloids have been reported from the plants *Veratrum grandiflorum* (Maxim. ex Miq.) O.Loes. (Melianthiaceae) [106,107] with anti-inflamatory and cytotoxic activities. Two new pregnane alkaloid derivatives were obtained from *Pachysandra terminalis* Sieb. et Zucc. (Buxaceae)



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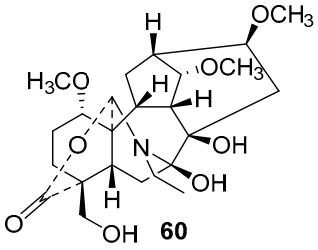

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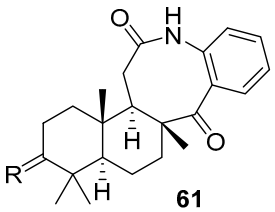

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Several alkaloids with minor structural modifications of already known alkaloids have been reported. Wu et al. (2022) [108] reports new aglain derivatives (**62**), isolated from *Aglaia odorata* Lour. However, the structural differences from the already reported aglain derivatives were the absence of methoxy's. These compounds exhibited cytotoxic activities on human leukemia cells (HEL) and human breast cancer cells with IC_{50} values in the range of 0.03–8.40 μM.

A new farnesylindole alkaloid was obtained from the flowers of *Anomianthus dulcis* (Dunal) J. Sinclair (Annonaceae) and was named (R)-3-(8′-hydroxyfarnesyl)-indole (**63**) [109]. The structure of the new compound is very similar to a known compound 3-(R)-3-(8′-hydroxyfarnesyl)-indole, differing by the presence of a hydroxyl in the new compound. According to the author, the new compound showed significant cytotoxic activity against KB cell lines.

A new phenanthroindolizidine alkaloid was obtained from the leaves of *Cryptocarya densiflora* Blume (Lauraceae) and was named (R)-13a*α*-densiindolizidine (**64**) [110]. According to the author, the new compound exhibited binding interactions with crucial amino acid residues in the active sites of severe acute respiratory syndrome coronavirus MPro (SARS-COV-MPro). The structure of the new compound resembles that of ficuseptine D, the difference being the hydroxyl present in the new compound at C-6 instead of the methoxyl.

Six new isoquinoline alkaloids were obtained from the whole plant of *Hypecoum erectum* L. (Papaveraceae) [111]. NMR data indicated that the new compound Hyperectumine B (**65**) has a similar structure to dihydrofumariline, the new compound has an acetamido group in place of the hydroxyl.

A new pyrrolofenanthridone alkaloid was obtained from the stem, root and bulb of *Crinum amabile* Donn (Amaryllidaceae) and named Amabiloid A (**66**) [112]. According to the author, the new compound showed low inhibition against acetylcholinesterase. The structure of the new compound is similar to that of pratorimine, with the difference being the position of the hydroxyl in the aromatic ring.

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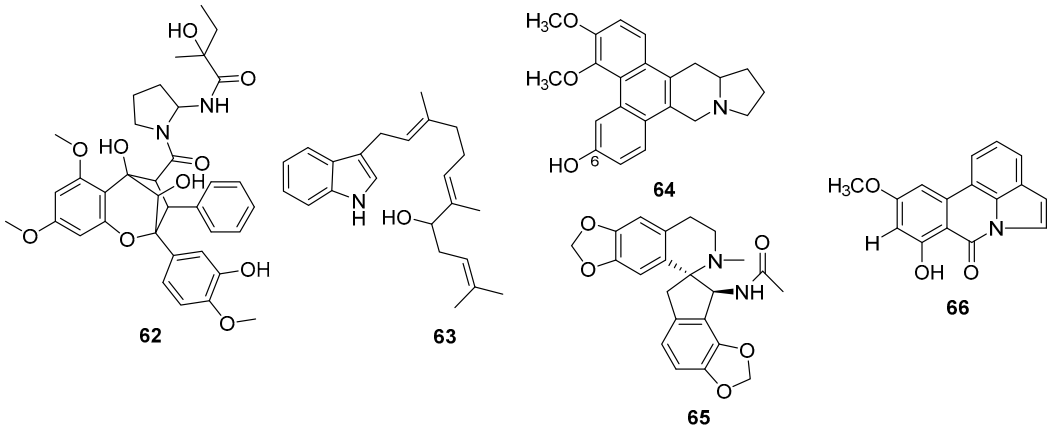


5.3. Phenols

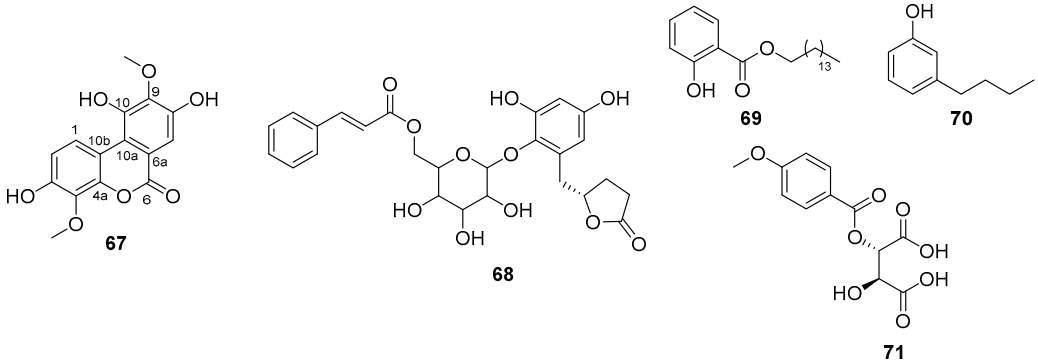
Most phenols come from the shikimate pathway and have a benzene ring in their structure containing one or more hydroxyls as substituent groups. The phenol group is present in a variety of compounds and are related to defense mechanisms in plants. Herein, we present as phenols the structures that have the chemical group and do not fit into the other chemical classes.

A polycyclic phenol with α-glucosidase inhibitory action was obtained from the leaves of *Spermacoce latifolia* Aubl. (Rubiaceae), named 3,8,10-trihydroxy-4,9-dimethoxy-6H-benzo[c]chromen-6-one (**67**) [113]. Considering the structural innovation, it has two methoxyls on the C-4 and C-9 carbons, differing from the known compound 3,4,8,9,10-pentahydroxydibenzo[b,d]pyran-6-one, which has two hydroxyls on these same carbons.

Two new compounds were obtained from the leaves of *Ardisia crenata* Sims (Primulaceae) and were named Ardisicreolides A-B (**68**) [114]. The new compounds are similar to the known compound myrsinoside A, differing in the presence of the cinnamoyl and pentadactyl lactone rings and the configuration of the double bond of the cinnamoyl group. The two novel compounds showed NO inhibitory action, as well as reducing the release of tumor necrosis factor (TNF-α), interleukin 1-β (IL-1 β), interleukin 1-4 (IL-4) and interleukin 1-10 (IL-10) in RAW264.7 macrophage cells induced by lipopolysaccharide (LPS).

Two new phenolic derivative compounds were isolated from the leaves of *Piper betle* L. (Piperaceae) and named 1-n-decanoyl hydroxy-benzoic acid/1-n-decanoyl phenol (**69**) and 3-butylphenol (**70**) [15]. According to the author, both compounds showed cytotoxic activities against two oral cancer cell lines (SCC-40 and SCC-29B) and antioxidant activity by scavenging 1, 1-diphenyl-2-picrylhydrazyl (DPPH) radicals. Compound M1 has an aliphatic chain, giving the molecule greater hydrophobicity, while compound H2 has an ester group and a long carbon chain. These carbon chains may be important for biological activity.

A new phenolic acid was obtained from the *Zanthoxylum nitidum* (Roxb.) DC. plant (Rutaceae) and named nitomentosin (**71**) [115]. The structure of the new compound is similar to that of the known compound O-p-anisoyl-D-tartaric acid, with the methoxy group replaced by hydroxyl and one more carboxylic acid than the known molecule.



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Among the selected examples of new phenols, most are small modifications of molecules already reported in the literature. The low level of structural innovation is also due to the small size characteristic of this class of molecules.

5.4. Flavonoids

New flavonoids were obtained from the roots and rhizomes of *Notopterygium incisum* C.T. Ting ex H.T. Chang (Apiaceae) and were named notoflavinols A (**50**) and B, notophenitols A - E and (2R)-5,4′ -dihydroxy-7-O-[(E)-3,7-dimethyl-2,6-octadienyl]flavanone (**51**) [116]. According to the author, the carbonyl group on carbon 4, the side chain on carbon 7 and the oxygen on carbon 5 may be related to the anti-inflammatory action by inhibiting nitric oxide (NO).

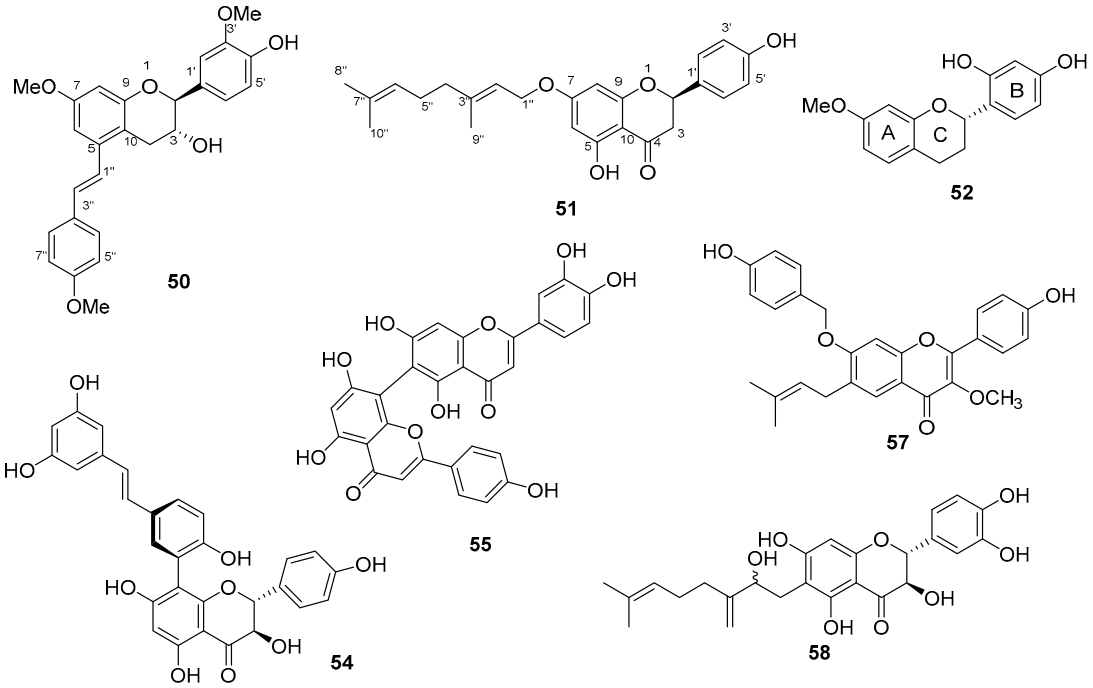
Four new catechins were obtained from the aerial parts of *Dianella ensifolia* (L.) Redouté (Asphodelaceae) [117]. The 2(S)-20,40-dihydroxy-7-methoxyflavan (**52**) is similar to a known compound 2(S)-3,′4′-dihydroxy-7-methoxyflavan, differing only in the position of the hydroxyl in the B ring.

Eleven new flavonostilbenes were obtained from the stem of *Rhamnoneuron balansae* (Drake) Gilg (Thymelaeaceae) and named rhamnoneuronal D - N [118]. According to the author, the compound rhamnoneuronal D (**54**) was shown to be a potential anti-aging agent in in vitro results for sirtuin 1 (SIRT1).

A new biflavonoid was isolated from the leaves of *Schinus polygama* (Cav.) Cabrera (Anacardiaceae) and named luteolin-(6→8′′)-apigenin (**55**), showing anti-inflammatory activity through its membrane-stabilizing effect on erythrocytes [119]. The new compound is similar to agathisflavone, differing by the presence of luteolin in the new compound instead of apigenin.

A new flavonoid called 4′-hydroxy-7-O-(4-hydroxybenzyl)-3-methoxy-6-prenylflavone (**57**) was isolated from the leaves of *Apocynum venetum* L. (Apocynaceae) [120]. According to the author, the new compound exhibited moderate inhibitory action on NO production.

Ten new flavonoid derivatives were obtained from the fruits of *Paulownia tomentosa* (Thunb.) Steud. (Paulowniaceae) [121]. According to the author, among the compounds Paulodiplacol A (**58**) showed better anti-inflammatory activity by decreasing the action of NF-κβ after addition of LPS. The new compound is similar to a known compound called paulodiplacone A (**59**), differing by the presence of an extra hydroxyl at C-ring.



Two new C-benzylated chalcones were obtained from the twigs and leaves *of Caesalpinia digyna* Rottler (Fabaceae) and were identified as 2′,4′-dihydroxy-3′-(2- hydroxylbenzyl) chalcone and 2′,4′-

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dihydroxy-5′-(2-hydroxybenzyl) chalcone (**59**) [122]. Both compounds showed cytotoxicity against SMMC-7721, A-549 and MDA-MB-231 cell lines. Compound **59** is similar to a compound known as 2′,4′-Dihydroxy-3′-(2-hydroxybenzyl)-6′-methoxychalcone, with one change of methoxyl to hydroxyl in the new compound.

A new flavonoid was obtained from the aerial parts of *Polygonum tinctorium* Aiton (Polygonaceae) and was identified as 3,5,3′,4′-Tetrahydroxy-6,7-methylendioxyflavone-3-O-β-D-glucopyranoside (**60**) [123].

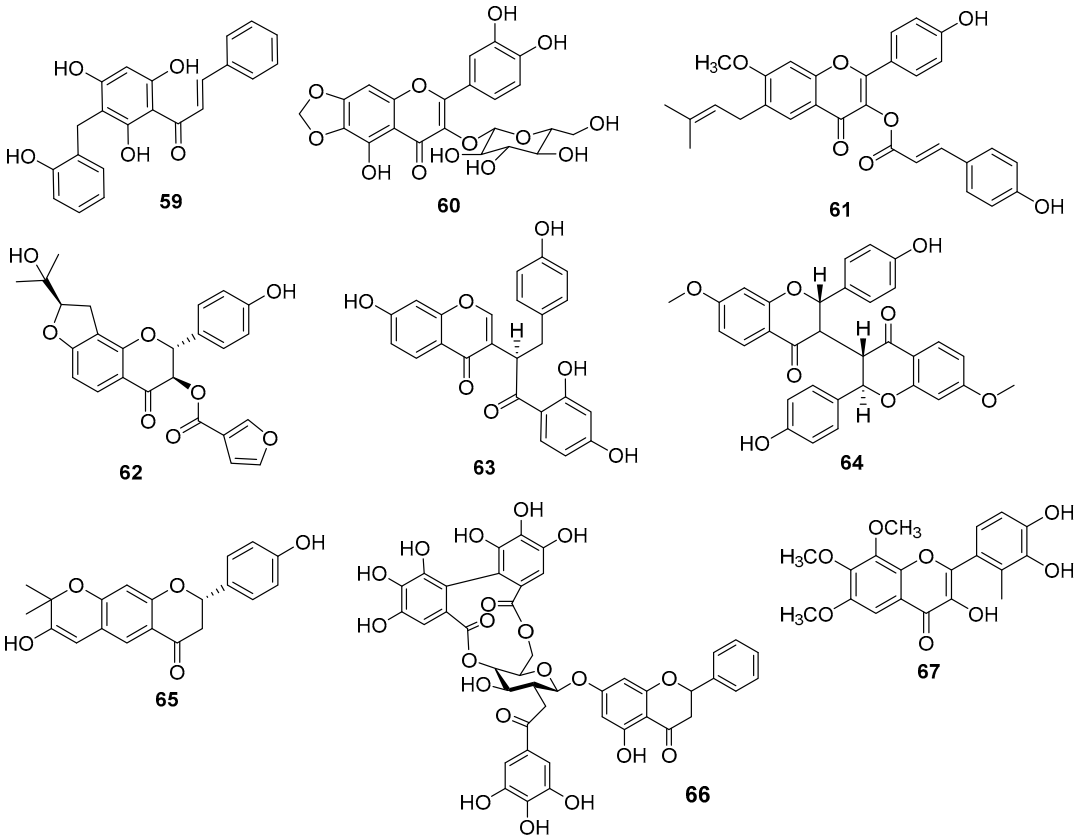
Two new compounds were isolated from the whole plant of *Centella asiatica* (L.) Urb. (Apiaceae) and were identified as 4′-hydroxyl-7-methoxyl-6-prenyl-3-O-trans-p-coumaroyl-flavonol (61) and (2R,3R,2″S)-3-furanoyl-brosimacutin E (**62**) [124]. According to the author, both molecules exhibited high cytotoxic activity in HepG2 and SGC-7901 cells.

A new isoflavonoid was obtained from the bark and roots of *Ochna kirkii* Oliv. (Ochnaceae) and named kirkinone A (**63**) [125]. The structural difference with the well-known compound lophirone A is an aromatic ring less in the new compound. The author also reported a new biflavonoid kirkinone B (**64**), similar to a known compound 4,4′,7-tri-O-methylisocampylospermone A, the difference being the presence of methoxyls instead of hydroxyls.

A new chromenoflavanone was obtained from the fruits of *Cullen corylifolium* (L.) Medik. (Ericaceae) and named corylifol H (**65**) [126]. The new compound showed dose-dependent inhibition of NO in LPS-activated RAW 264.7 macrophages. The structure of the new molecule is similar to that of an already known compound 7,8-dihydro-8-(4-hydroxyphenyl)-2,2-dimethyl-2H,6Hbenzo [1,2-b:5,4-b′]dipyran-6-one, the difference being the presence of an extra hydroxyl.

New flavonoids were obtained from the aerial parts of *Penthorum chinense* Pursh (Penthoraceae) and named Penthorumside A - C [127] (Zhao et al., 2021). The structure of the compound Penthorumside B (**66**) is similar to the known compound Pinocembrin-7-O-[3′′-O-galloyl-4″,6″-hexahydroxydiphenoyl]-b-glucose, differing by the position of the galloyl group.

Polyoxygenated flavonoids were obtained from the aerial parts of *Blumea eriantha* DC (Asteraceae) and determined as 3, 3′, 4′-trihydroxy-6, 7, 8-trimethoxy flavone (**67**) with antiproliferative activity in NCI-H23 cell lines [128].



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Flavonoids are notably the compounds with the fewest structural innovations. The new compounds mainly change from the known ones by the location of groups, the exchange of hydroxyls for methoxyls (and vice versa) or the presence of a sugar different from the one already found.

5.5. Coumarins

Coumarins are recurring compounds in various plants, but they can also be found in fungi and bacteria. Their chemical structure consists of an organic heterocyclic, fused to a benzo-α-pyrone ring, divided into subclasses such as furanocoumarins, phenylcoumarins, isocoumarins, among others.

A new prenylated coumarin ester was obtained from the leaves, fruits and twigs of *Glycosmis ovoidea* Pierre (Rutaceae) and identified as 1-(7-methoxy-2-oxo-2H-chromen-8-yl)-3-methyl-1-oxobut-2-en-2-yl (S)-2-methylbutanoate (**93**) [129].

A new coumarin was obtained from the roots of *Calophyllum pisiferum* Planch. & Triana (Calophyllaceae) and was named calopisifuran (**95**) [130]. According to the author, the new compound showed significant cytotoxicity against the MDA-MB-231 cell line.

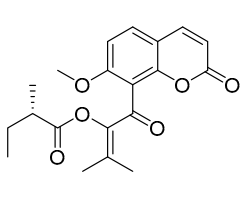
New coumarolignans were obtained from the roots of *Waltheria indica* L. (Malvaceae) and were named walthindicins A-F [131]. According to the author, among the new compounds, walthindicin A (**96**) exhibited the greatest inhibition of reactive oxygen species (ROS) and showed dose-dependent inhibition of the NF-κβ transcription factor in human embryonic kidney 293 cells (Luc-HEK-293).

Coumarin derivatives similatly to xanthumol were obtained from the whole plant of *Spermacoce latifolia* Aubl. (Rubiaceae) and identified as 2-acetyl-4-hydroxy-6H-furo[2,3-g]chromen-6-one (**97**) and 2-(1′,2′- dihydroxypropan-2′-yl)-4-hydroxy-6H-furo[2,3-g]chromen-6-one [132]. The authors also reported in vitro antimicrobial action of the new compounds against *Staphyloccocus aureus*, *Bacillus subtilis* and *Bacillus cereus*.

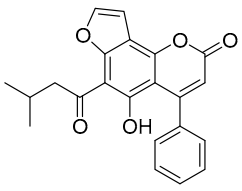
A new coumarin was isolated from the leaves and twigs of *Murraya exotica* L. (Rutaceae) and identified as 5-demethoxy-10′-ethoxyexotimarin F (**99**) [133]. According to the author, the new compound showed inhibitory activity against the enzyme monoamine oxidase B (MAO-B). The structure of the new compound resembles the known compound 10′-ethoxyexotimarin F, with the difference being the absence of the methoxy group at C-5.

A new coumarin derivative was obtained from the stem of *Ulmus elongata* L.K. Fu & C.S. Ding (Ulmaceae) and named ulmuselactone A (**101**) [134]. The structure of the compound is similar to a known coumarin, except for the presence of methoxyls at C-6 and C-7 in the novel compound instead of hydroxyls.

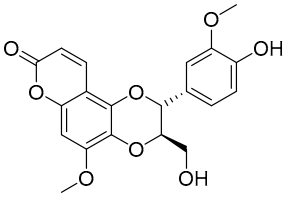
A new isocoumarin was isolated from the bark of *Fraxinus chinensis* subsp. rhynchophylla (Hance) A.E. Murray (Oleaceae) and named fraxicoumarin (**103**) [135]. The new compound showed LPS-induced NO inhibitory activity in RAW 264.7 cells.



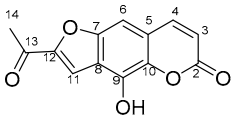
93



95



96



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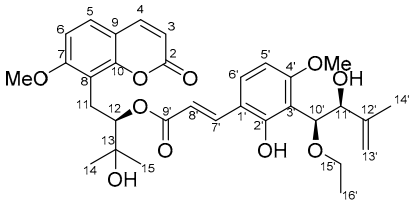
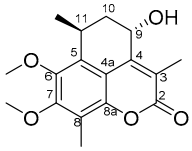
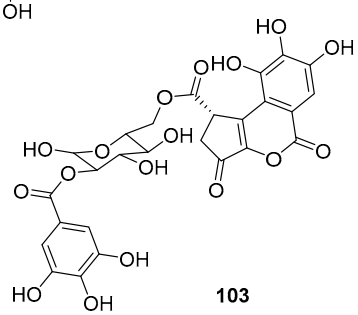


99



101



103

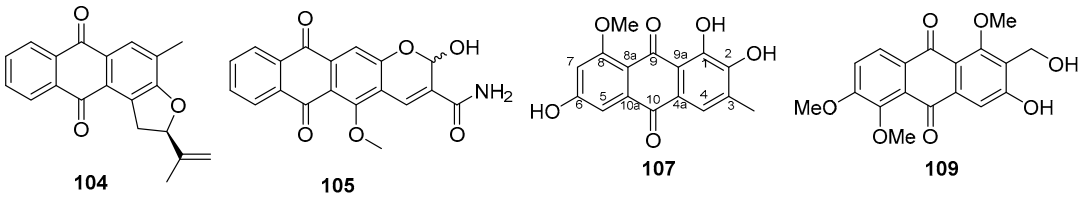
 doi:10.20944/preprints202311.1846.v1

5.6. Antraquinones

Anthraquinones are natural products composed of two aromatic rings, together with two carbonyls, forming a flat aromatic structure. New anthraquinones were isolated from *Hedyotis diffusa* Willd. (Rubiaceae) and named Diffusaquinone A - G [136]. According to the author, diffusaquinone A (**104**) showed the greatest anti-inflammatory activity by inhibiting the generation of superoxide anion and elastase. The structure of the new compound has a rare 2-isopropyldihydrofuran portion.

Two new quinones were isolated from the aerial parts of *Morinda umbellata* L. (Rubiaceae)similar to those already obtained [137]. The structure of umbellata V (**105**) resembles that of umbellata S, differing in the presence of hydroxyl instead of ethoxyl. The same had happened with the anthraquinones isolated from the roots of *Ventilago denticulata* Willd. (Rhamnaceae) [138] (**107**).

Two new anthraquinones were obtained from the roots of *Prismatomeris filamentosa* Craib (Rubiaceae) and named filaments B and C [139]. The structure of filament B (**109**) is similar to the known compound 2-hydroxymethylknoxiavaledin, the differences being the replacement of hydroxy groups on carbons 1 and 5 with methoxy groups. According to the author, the new compounds exhibited moderate antibacterial activity against a range of gram-positive and gram-negative bacteria such as *B. subtilis*, *B. cereus*, *S. aureus*, *E. coli*, *P. aeruginosa* and *S. sonnei*.



6. Conclusions

Through the compilation of articles, we had a total of 464 articles in the years 2021 and 2022 that presented new structures from plants. Among the total number of articles, 122 families and 436 species were represented, with various classes of compounds.

The Asteraceae family provided the largest number of new structures, indeed by the high number of species present. Families with many species that are not among with the new structures reported are those that deserve attention, given the potential for new structures they can provide.

Many of the compounds showed small structural variations in relation to already known molecules. For some, however, this small modification was decisive for the biological activity reported, demonstrating the importance of descriptive phytochemical studies.

Author Contributions. Conceptualization, E.S.O.; C.N.K. and D.P.D; methodology, E.S.O. and C.N.K.; formal analysis, E.S.O.; C.N.K.; M.T.H.; V.F.G. and D.P.D.; investigation, E.S.O.; C.N.K.; M.T.H. and V.F.G.; data curation, E.S.O.; C.N.K. and D.P.D.; writing—original draft preparation, E.S.O.; C.N.K. and D.P.D.; writing—review and editing, E.S.O.; C.N.K.; M.T.H.; V.F.G. and D.P.D.; supervision, D.P.D. All authors have read and agreed to the published version of the manuscript. Please turn to the CRediT taxonomy for the term explanation. Authorship must be limited to those who have contributed substantially to the work reported.

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Conflicts of Interest: The authors declare no conflict of interest.

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