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A Review of Secondary Metabolites Found in Plants of Euphorbiaceae and their Biological Aspects

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ABSTRACT

The species Euphorbia has been used to treat inflammatory diseases, cancer, and ulcers. Biological activities reported in the literature, including antiproliferative, cytotoxic and anti-inflammatory, are attributed to the chemical constituents present in its composition as terpenes and polyphenolic compounds. The most recurrently verified metabolites in the Euphorbiaceae family plant species are terpenes, of which euphol is a major constituent with broadly reported cytotoxic, antinociceptive and anti-inflammatory effects; it frequently appears in various extracts obtained from the plant. Euphol has a documented inhibitory effect on neutrophil chemotaxis and can modulate the complement system. Since complement system activation is intimately intertwined with autoimmune and inflammatory diseases, tumor growth promotion and metastasis, plant metabolites from Euphorbia might influence the outcomes of inflammatory processes.

KEYWORDS- Euphorbia, euphorbiaceae, secondary metabolites, plants, biological aspects

1. INTRODUCTION

Euphorbia plants are known for their irritant milky latex [27] and characteristic and chemically diverse diterpenoids. Among the macrocyclic and polycyclic diterpenoids from *Euphorbia*, jatrophane types are the most common [28,29,30,31]. To date, the diterpenoids reported from *Euphorbia*, have included *ent*-kaurane, *ent*-abietane, *ent*-atisane, *ent*-isopimarane, labdane, tigliane, lathyrane, and ingenane-type diterpenoids [10,11,12,13,14], but no jatrophanes were isolated from the species. In the present study, besides the new compound euphostrachenol A, one lathyrane-type, three ingenane-type, and two abietane-type diterpenoids were isolated from *Euphorbia*, all of which are known compounds and were discovered from other species of *Euphorbia*, suggesting a similar diterpenoid profile of these species. Importantly, our phytochemical investigation of *Euphorbia*, reported here also yielded no jatrophane-type diterpenoids, in accordance with the previous results.[1,2,3] This type of diterpenoid is found exclusively in the *Euphorbiaceae* family, and it has a 5/12 bicyclic pentadecane skeleton, in which the absence of a cyclopropane ring is the most obvious structural feature that differentiates it from other macrocyclic and polycyclic diterpenoids from *Euphorbia*, such as tigliane, lathyrane, and ingenane types. The absence of jatrophanes in the species may be related to the special environment in which *Euphorbia*, lives, namely, the high-altitude region, which is often associated with high loads of UV radiation and low temperatures. Jatrophane-type diterpenoids exhibit many different activities, including antitumor, antiviral, antifungal, and anti-inflammatory effects [2,3]. Many of them showed promising P-glycoprotein, a membrane protein that pumps anticancer drugs out of cells, exhibits inhibitor activity, and could be developed as a new drug to reverse multidrug resistance [2,3]. Thus, the pharmacological value of *Euphorbia*, may be influenced. Furthermore, the lack of jatrophanes implied that its biosynthetic pathway may be lost in the plant of *Euphorbia*, Currently, jatrophanes were suggested to be derived from lathyrane-type diterpenoids by combined transcriptomic, genomic, and metabolomic investigation of *Euphorbia*, a species harboring many jatrophane-type diterpenoids [32]. Thus, comparative genomic and transcriptomic analysis between these two species could provide useful clues for uncovering the biosynthesis of jatrophane-type diterpenoids.

Notably, ionones are rarely isolated from the species of *Euphorbia* [2]; however, they were reported constituents of *Euphorbia*, [8,12]. We also reported two ionones from *Euphorbia*, in agreement with previous studies. Ionones are degraded from carotenoids that play an important role in helping plants adapt to high UV light and low temperatures. During photosynthesis, carotenoids are known to protect chlorophylls and bacteriochlorophylls from sensitizing deleterious photodestructive reactions [33]. The detection of ionones in *Euphorbia*, in the present and previous studies strongly suggested that this type of secondary metabolite should be the result of high-altitude adaptation of the species. Further work should be undertaken to reveal whether other *Euphorbia* plants adapted to the harsh environments of Tibetan peaches also harbor ionones.

Notably, the planar structure of compound 1 shows high similarity to those of kansuingols A and B, except for a β–D-glucose group and a hydroxyl group present at C-15 and C-19 of kansuingol A, as well as a β–D-glucose group at C-19 of kansuingol B, respectively [17]. Notably, the relative conformations of these three compounds are also different for methyl-16, methyl-20, and hydroxyl-7. While the relative conformations of compound 1 were supported by X-ray diffraction analysis, those of kansuingols A and B were not. After checking the key ROESY correlations that determined the relative conformation assignment of methyl-16, methyl-20, and hydroxyl-7 in kansuingols A and B, we found that there are no ROESY correlations to support the claimed β-orientation of methyl-16 in both compounds. Therefore, the structures of kansuingols A and B remain to be determined.[4,5,6]

Euphorbia is a very large and diverse genus of flowering plants, commonly called spurge, in the family Euphorbiaceae. "Euphorbia" is sometimes used in ordinary English to collectively refer to all members of Euphorbiaceae (in deference to the type genus), not just to members of the genus.[2]

Euphorbias range from tiny annual plants to large and long-lived trees.[3] with perhaps the tallest being Euphorbia ampliphylla at 30 m (98 ft) or more.[4][5] The genus has roughly 2,000 members,[6][7] making it one of the largest genera of flowering plants.[8][9] It also has one of the largest ranges of chromosome counts, along with Rumex and Senecio.[8] Euphorbia antiquorum is the type species for the genus *Euphorbia*.[10] It was first described by Carl Linnaeus in 1753 in Species Plantarum.

Some euphorbias are widely available commercially, such as poinsettias at Christmas. Some are commonly cultivated as ornamentals, or collected and highly valued for the aesthetic appearance of their unique floral structures, such as the crown of thorns plant (Euphorbia milii). Succulent euphorbias from the deserts of Southern Africa and Madagascar have evolved physical characteristics and forms similar to cacti of North and South America, so they are often incorrectly referred to as cacti.[11] Some are used as ornamentals in landscaping, because of beautiful or striking overall forms, and drought and heat tolerance.[7][3]

Euphorbia all share the feature of having a poisonous, latex-like sap and unique floral structures.[7] When viewed as a whole, the head of flowers looks like a single flower (a pseudanthium).[7] It has a unique kind of pseudanthium, called a cyathium, where each flower in the head is reduced to its barest essential part needed for sexual reproduction.[7] The individual flowers are either male or female, with the male flowers reduced to only the stamen, and the females to the pistil.[7] These flowers have no sepals, petals, or other parts that are typical of flowers in other kinds of plants.[7] Structures supporting the flower head and other structures underneath have evolved to attract pollinators with nectar, and with shapes and colors that function in a way petals and other flower parts do in other flowers. It is the only genus of plants that has all three kinds of photosynthesis, CAM, C3 and C4[7,8,9]

2. RESULTS

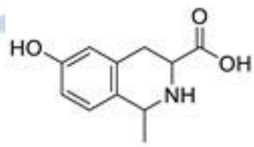
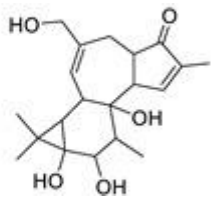
The cytotoxic activity of fifteen *Euphorbia* species against three cancer cell lines was evaluated (Table 1). Results reveal that five *Euphorbia* species display activity against HepG2 where *E. lactea* Haw. and *E. obesa* Hook. are the most active (IC_{50} 5.2 and 6.3 µg/mL, respectively). Moreover, five species are active against MCF-7 where *E. lactea* Haw. and *E. grandialata* R.A. Dyer exhibit highest activity (IC_{50} 5.1 and 7.5 µg/mL, respectively). On the other hand, eight *Euphorbia* species show cytotoxic activity against CACO2 where *E. officinarum* L. and *E. royleana* Boiss. are the most active (IC_{50} 7.2 and 9.1 µg/mL, respectively). Among fifteen *Euphorbia*, three species, *E. tirucalli* L., *E. horrida* Boiss., and *E. ingens* E. Mey. are inactive against the tested cell lines.

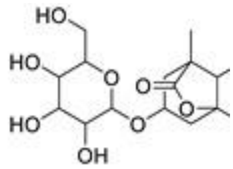
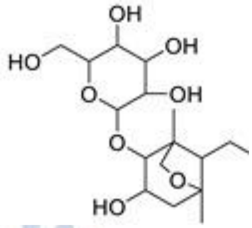
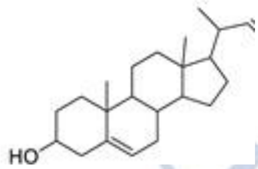
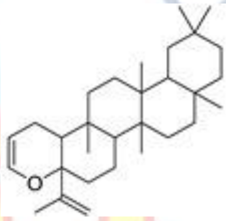
Table 1
IC_{50} µM values of methanolic *Euphorbia* extracts in different cancer cell lines.

Sample Code	HEPG2	MCF-7	CACO2
E. abyssinica J.F. Gmel.	--	--	11.3
E. caput-medusae L.	--	--	17.2
E. trigona Mill.	--	16.1	15.6
E. stenoclada Baill.	19.3	19.5	18.2
E. tithymaloides L.	--	--	13.6
E. tirucalli L.	--	--	--
E. royleana Boiss.	--	--	9.1
E. officinarum L.	--	--	7.2
E. horrida Boiss.	--	--	--
E. canariensis L.	9.8	12.7	--
E. grandialata R.A. Dyer	8.4	7.5	--
E. obesa Hook.	6.3	--	--
E. lactea Haw.	5.2	5.1	--
E. ingens E. Mey.	--	--	--
E. milli Des Moul.	--	--	9.8

The annotated compounds can be classified into: diterpenoids (21 compounds), sterols (seven compounds), triterpenoids (four compounds), flavone glycosides (four compounds), tannins (three compounds), sesquiterpenoids (two compounds), alkaloid (one compound), acetophenone glycosides (one compound), and isoquinoline-carboxylic acid (one compound).[10,11,12]

Table 2
List of secondary metabolites isolated from fifteen *Euphorbia* species.

N.	Compound	Class	Mode	Formula	m/z	Rt	Structure	Source
1	l-Methyl-6-hydroxy-l,2,3,4-tetrahydro-isoquinoline-3-carboxylic acid	Isoquinoline-3-carboxylic acid	-	$C_{11}H_{13}NO_3$	206.0824	10.37		*E. myrsinites* L. [26]
2	4-Deoxyphorbol	Diterpene	+	$C_{20}H_{28}O_5$	349.2006	9.63		*E. tirucalli* L. [27]

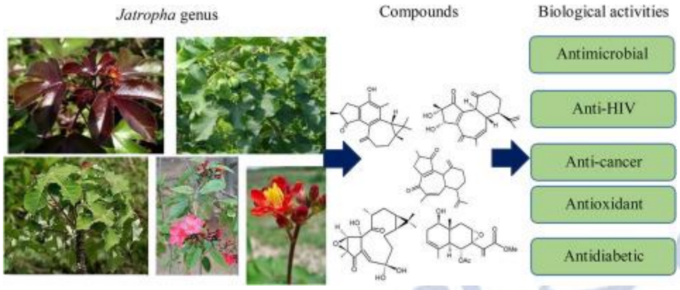
N.	Compound	Class	Mode	Formula	m/z	Rt	Structure	Source
3	Supinaionoside A	Sesquiterpene	-	$C_{19}H_{30}O_9$	401.1817	10.01		*E. supina* Raf. [28]
4	Euphorbioside B	Sesquiterpene	+	$C_{19}H_{34}O_9$	407.2271	8.12		*E. resinifera* Berg. [29]
5	Euphorbosterol	Sterol	+	$C_{29}H_{48}O$	413.3775	27.46		*E. tirucalli* L. [30]
6	Euphorbiane	Triterpene	+	$C_{30}H_{48}O$	425.3775	24.48		*E. tirucalli* L. [31]
7	Cycloeuphordenol	Sterol	+	$C_{30}H_{50}O$	427.3931	26		

The milky sap of spurges (called "latex") evolved as a deterrent to herbivores. It is white, and transparent when dry, except in E. abdelkuri, where it is yellow. The pressurized sap seeps from the slightest wound and congeals after a few minutes in air. The skin-irritating and caustic effects are largely caused by varying amounts of diterpenes. Triterpenes such as betulin and corresponding esters are other major components of the latex.[17] In contact with mucous membranes (eyes, nose, mouth), the latex can produce extremely painful inflammation. The sap has also been known to cause mild to extreme Keratouveitis, which affects vision.[18] Therefore, spurges should be handled with caution and kept away from children and pets. Wearing eye protection while working in close contact with *Euphorbia* is advised.[18] Latex on skin should be washed off immediately and thoroughly. Congealed latex is insoluble in water, but can be removed with an emulsifier such as milk or soap. A physician should be consulted if inflammation occurs, as severe eye damage including permanent blindness may result from exposure to the sap.[19]

The poisonous qualities were well known: in the Ethiopian Kebra Nagast, the serpent king Arwe is killed with juice from the *Euphorbia*.[13,14,15]

3. DISCUSSION

The genus Jatropha belongs to the Euphorbiaceae family and has about 175 species. Originally from tropical America, the *Jatropha* genus can be found all over the tropics and subtropics of Asia and Africa. *Jatropha* species are recognized to be important sources of secondary metabolites with a broad spectrum of biological functions. Extracts and isolated compounds from species of this genus have been known to have properties of cytotoxicity, antimicrobial, antifungal, anti-inflammatory, antioxidant, insecticidal, larvicidal, inhibition AChE, and toxicity activities. Investigations on the chemical aspects of the genus *Jatropha* have led to the identification of cyclic peptides, lignans, flavonoids, coumarins, alkaloids, eudesmenoic acids, and mainly terpenes. In this review, we provide a comprehensive picture of the phytochemical and biological characteristics of *Jatropha* species. [16,17]



Medicinal plants are a source of great economic value. In the earliest Indian records of Indian medicine (Ayurveda) include the detailed information about hundreds of medicinal plants. India has rich heritage of knowledge of plants based drugs preventive and curative medicines (Trivedi, P.C 2007). In India many exotic plants are introduced from other countries through civilization, social forestry and gardening .Now these plants are naturalized along roadsides, in forest as weed occurring regularly in cultivated fields and in gardens. From the large number of diverse types of plants here are studied some plants from the family Euphorbiaceae. The family Euphorbiaceae is assessed taxonomically and phylogenetically in the light of different disciplines of Botany. It is heterogeneous palynologically chemically and embryologically. Euphorbiaceae is generally distinguished by the milky sap. (When present) unisexual (evolved) flower, ovary trilocular and superior, Placentation axile. Gibbs (1974) summarized and reviewed phytochemical constituents of Euphorbiaceae. He pointed out peculiar interest in the stinging hairs. Webster (1966) recognized that the seed fats of Euphorbiaceae reveal the heterogeneity of the family. Evan and Kinghorn (1977) made a comparative phytochemistry of diterpenes of some species of Euphorbia. Acharya, Hemlata and Radhakrishnan, (1997) Studied 10 species of *Euphorbia*. Seigler & David S. (1994) recorded large number of compounds from different chemical classes from the members of Euphorbiaceae. In his opinions, chemistry of the family is the most diverse and interesting and is comparable to be biological diversity of the family. He further stated that of all chemical classes the alkaloids, cyanogenic glycosides, diterpenes, glucosinolates, seed and other lipids, tannins and triterpenes are the useful for chemotaxonomic purpose at the generic level. [18,19,20]

4. CONCLUSION

It is concluded that, the genera studies for phytochemical screening shows that they show closely resemblance with each other by the presence of phenolics and alkaloids. While, Saponin and tannin are lacking in all genera. Steroids are found to be present in all except *Ricinus communis* L. and Iridioides are found in *Jatropa* species.[21]

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

REFERENCES

[1] "Euphorbia L." Plants of the World Online. Board of Trustees of the Royal Botanic Gardens, Kew. 2017. Retrieved 7 July 2020.

[2] ^ "Definition of Euphorbia". Merriam-Webster Online Dictionary. Merriam-Webster, Inc. Retrieved 1 Feb 2019.

[3] ^ a b "Euphorbia". Fine Gardening. The Taunton Press, Inc.

[4] ^ Brenan, J.P.M.; Greenway, P.J. (1949). Check-lists of the Forest Trees and Shrubs of the British Empire #5 - Tanganyika Territory. Oxford, England: Imperial Forestry Institute. p. 214 (part 2).

[5] ^ Hargreaves, Bruce (n.d.). "Euphorbia ingens in Malawi...etc". Euphorbia Journal. 7: 78 plus diagram p. 63.

[6] ^ "World Checklist of Selected Plant Families (WCSP)". Kew Science. Royal Botanic Gardens, Kew. Retrieved 16 Apr 2011.

[7] ^ a b c d e f g h i j "Euphorbia PBI - Project Description". Planetary Biodiversity Inventory (PBI). Retrieved 1 Feb 2019.

[8] ^ a b Stebbins GL, Hoogland RD (1976). "Species diversity, ecology and evolution in a primitive Angiosperm genus:Hibbertia (Dilleniaceae)". Plant Syst. Evol. 125 (3): 139–154. doi:10.1007/BF00986147. S2CID 27820065.

[9] ^ "Euphorbia botany lesson". Houzz. 30 Jun 2010. Retrieved 1 Feb 2019.

[10] ^ Carter S (2002). "Euphorbia". In Eggli U (ed.). Dicotyledons. Illustrated Handbook of Succulent Plants. Vol. 5. Springer. p. 102. ISBN 978-3-540-41966-2.

[11] ^ "Cacti or Not? Many succulents look like cacti, but are not". CactiGuide.com. Retrieved 1 Feb 2019.

[12] ^ a b c Dale N (1986). Flowering Plants of the Santa Monica Mountains. California Native Plant Society. p. 107. ISBN 978-0-88496-239-7.

[13] ^ Linnaeus C (1753). "Euphorbia". Species Plantarum (1st ed.). p. 450.

[14] ^ Karsten and Schenk , Vegetationsbilder, Volume 15 (1924) Photoplate 6 with caption

[15] ^ a b "About the genus Euphorbia". Planetary Biodiversity Inventory (PBI). Retrieved 1 Feb 2019.

[16] ^ a b Stein, G. (22 Apr 2011). "Euphorbia "Flowers," an introduction to the amazing Cyathia". Dave's Garden. Retrieved 1 Feb 2019.

[17] ^ Hodgkiss, RJ. "Research into euphorbia latex and irritant ingredients". www.euphorbia.de. Retrieved 2 Nov 2013.

[18] ^ a b Basak, Samar K.; Bakshi, Partho K.; Basu, Sabitabrata; Basak, Soham (2009). "Keratouveitis caused by Euphorbia plant sap". Indian Journal of Ophthalmology. 57 (4):

311–313. doi:10.4103/0301-4738.53060. ISSN 0301-4738. PMC 2712704. PMID 19574703.

[19] ^ Eke T, Al-Husainy S, Raynor MK (2000). "The spectrum of ocular inflammation caused by Euphorbia plant sap". Arch. Ophthalmol. 118 (1): 13–16. doi:10.1001/archopht.118.1.13. PMID 10636407.

[20] ^ Manzo, Andrea (2014). "Snakes and Sacrifices: Tentative Insights into the Pre-Christian Ethiopian Religion". Aethiopica. 17: 7–24. doi:10.15460/aethiopica.17.1.737. ISSN 2194-4024.

[21] ^ Adamson J (2011). Born Free: The Full Story. Pan Macmillan. p. 23. ISBN 9780330536745. Retrieved 6 Oct 2014.