The Journal of Phytopharmacology 2024; 13(1):70-76
Online at: www.phytopharmajournal.com

Review Article

ISSN 2320-480X
JPHYTO 2024; 13(1): 70-76
January- February
Received: 25-12-2023
Accepted: 26-02-2024

doi: 10.31254/phyto.2024.13110

Abigail Wambui Waweru
Chemistry Department, Egerton University, Nakuru, Kenya

Eric Kibagendi Osoro
1. Chemistry Department, Egerton University, Nakuru, Kenya
2. Basic Sciences Department, Tharaka University, Marimanti, Kenya

Josiah Ouma Omolo
Chemistry Department, Egerton University, Nakuru, Kenya

Correspondence:
Eric Kibagendi Osoro
Chemistry Department, Egerton University, Nakuru, Kenya
Email: erickibash@gmail.com

A review on the Phytochemistry and Pharmacological Activities of some Species from Genus *Dodonaea* (Sapindaceae Family)

Abigail Wambui Waweru, Eric Kibagendi Osoro, Josiah Ouma Omolo

ABSTRACT

This review focuses mainly on findings of the chemistry and pharmacological activities of some plant species from genus *Dodonaea*. The continued chemical studies of *Dodonaea* species such as *D. viscosa*, *D. angustifolia*, *D. spatulata*, *D. polyandra* and *D. ceratocarpa* and the related plants have resulted in isolation of flavonoids, terpenoids, coumarins and their glycosides, among other classes of compounds. The presence of these compounds is thought to be responsible for the various pharmacological activities the plant species possess. Extracts and isolated compounds from various species of *Dodonaea* plants have been reported to exhibit a range of activities including but not limited to antioxidant, anti-inflammatory, antimicrobial, antiplasmodial, anticancer, antidiabetic and antiviral activities.

Keywords: *Dodonaea*, Flavonoid, Terpenoid, Antimicrobial, Anti-inflammatory, Antioxidant.

INTRODUCTION

Medicinal plants have received great attention in the recent past as an alternative form of therapy and medication that supports local health care systems of both developed and developing communities [1]. Published World Health Organization (WHO) reports reveal that about 80% of the world's population uses medicinal plants to manage and cure diseases [2]. Their application in therapy and medication has increasingly gained public acceptance and interest from scientific community owing to their good therapeutic performance and minimum adverse effects on humans and the environment [1,3]. These plants are processed and taken in different forms, including as whole herbs, concoctions, plant concentrates, essential oils, and formulations into tablets and capsules that contain a powdered form of a raw herb or crude extract [4]. Many plant-derived compounds have also been used as drugs, either in their original or semi-synthetic form, in addition to serving as drug precursors, drug prototypes and pharmacological probes [3].

Dodonaea species are among medicinal plants whose leaves, stems and fruits are widely used in traditional medicine formulations [1]. *Dodonaea* is a genus in the *Sapindaceae* family comprised of more than 70 recorded species [1]. The species are majorly flowering plants whose ethnobotanical reports attach great value on leaves, stems and fruits. The plants are widely distributed in tropical and temperate region of Africa, America, Asia and Australia [1]. The most extensively studied species of *Dodonaea* genus are, *D. viscosa* and *D. angustifolia*. Both of them are medium-sized shrubs widely distributed in in Australia, Africa, Asia and South America. *D. viscosa* originated from Australia but it also occurs throughout the tropics, subtropics and temperate regions of Africa, North America, South America and Asia [1, 5-8]. Other fairly studied species are *D. spatulata*, *D. polyandra* and *D. ceratocarpa*.

Most of these plants from *Dodonaea* genus have been traditionally used in the treatment of scurvy, inflammation, kidney pain, sore throat, intestinal parasite, herpes, wounds burn, rheumatism, cough, backache, toothache, skin burn, skin infection, tumor and wound healing [1,5,6]. Scientific investigations have reported a good number of pharmacological activities associated with *Dodonaea* plant species. The pharmacological activities of these plants have been attributed to the presence of bioactive compounds. This paper reviews the studies on *Dodonaea* species with respect to their isolated chemical compounds and their pharmacological activities.

Phytochemicals Isolated from *Dodonaea* Species

Flavonoids

Flavonoids are secondary metabolites of plants whose basic structure consists of a 15 –carbon skeleton (C6-C3-C6), comprising of two 6-carbon benzene rings linked by a 3-carbon oxygen heterocyclic ring (Figure 1) [9]. Flavonoids can be classified into 12 subgroups based on the degree of oxidation of the

heterocyclic ring and the number of hydroxyl or methyl groups on the benzene ring. These subgroups include flavanones, flavones, isoflavones, chalcones, stilbenes, aurones, phlobaphenes, dihydroflavonols, flavonols, leucoanthocyanidins, proanthocyanidins, and anthocyanins [9]. Most of the plants from *Dodonaea* genus have been reported to contain flavonoids, the secondary metabolites which are responsible for a number of pharmacological activities associated with *Dodonaea* plant species.

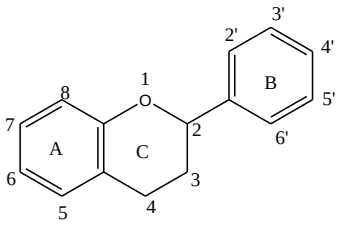


Figure 1: General structure of flavonoid

A number C-alkylated flavonoids have been reported as having been isolated from *Dodonaea viscosa*, including Viscosine (1) [10,11], 5,7-dihydroxy-3'-(4"-acetoxy-3"-methylbutyl)-3,6,4'-trimethoxy- flavone (2), 5,7-dihydroxy-3'-(3-hydroxymethyl-butyl)-3,6,4'-trimethoxyflavone (3), 5,7,4'-trihydroxy-3'-(3-hyroxymethylbutyl)-3,6-dimethoxy-flavone (4), 5,7-dihydroxy-3'-(2-hydroxy-3-methyl-3-butenyl)-3,6,4'-trimethoxyflavone (5), together with 5,7,4'-trihydroxy-3,6-dimethoxy-3'-isoprenyl-flavone (6) [12]. In another study, flavonoids related to kaempferol were purified from the dichloromethane and acetone fractions of *Dodonaea viscosa* [13]. They include 5, 7-trihydroxy-4'-methoxyflavone (7); 5, 7, 4'-trihydroxy-3, 6-dimethoxyflavone (8); 5, 7-dihydroxy-3, 6, 4'-trimethoxyflavone (santin) (9); and 5-hydroxy -3, 7, 4'-trimethoxyflavone (10) and 3,4',5,7-tetrahydroxy flavone (kaempferol) (11) [13]. In more recent but separate studies, 3,5,7,3′,4′-pentahydroxyflavone (12) [14] and 3,3′,4′,5,7-pentahydroxyflavane (13) [15] have been reported as having been isolated from the leaves of *Dodonaea viscosa*. The structures of these compounds are shown in figure 2.

Flavonoids have also been isolated from *Dodonaea angustifolia* (figure 3). In separate studies, 5-hydroxy-7,4′-dimethoxyflavone (14) [16], pinocembrin (15), santin (16), 5,7,4'-trihydroxy-3,6-dimethoxyflavone (17), and 5,6,7-trihydroxy-3,4'-dimethoxyflavone (18) [17] have been reported to have been isolated from the leaves of *Dodonaea angustifolia*. In another study, methylated flavonoids which included 5-hydroxy-3, 4′,7-trimethoxyflavone (19), and derivatives (20-26), were isolated from the leaves of *Dodonaea angustifolia* [8].

In recent studies, prenylated flavonoids bearing malonic acid moiety (figure 4) were reported as having been isolated from the leaves of *Dodonaea filiformis* and flowers of *Dodonaea spatulata* [18]. This sub-class of compounds has also been reported in *Dodonaea viscosa* [18-20]. Prenylation of flavonoids is thought to provide enhanced biological properties due to lipophilicity of the prenyl chains, which leads to higher affinity for biological membranes and enhanced interactions with target proteins [21]. This makes this subclass of flavonoids good at offering a wide range of pharmacological activities.

Terpenoids

Terpenoids are structurally diverse class of natural products derived from mevalonic acid and composed of several isoprene (5-carbons) structural units [22]. Based upon the number of isoprene units, these have mainly been classified into monoterpene (C10), sesquiterpene (C15), diterpene (C20), triterpene (C30), tetraterpene (C40), and polyterpene (C > 40) [22]. These subclasses of terpenoids may exist as hydrocarbons or as oxygen derived compounds such as alcohols, ethers and carbonyl compounds. In most plants, these compounds vary from those which are volatile to those which are non-volatile [23]. This class of natural products has also been reported in *Dodonaea* genus, and the compounds are thought to be responsible for a number of pharmacological properties exhibited by their various species.

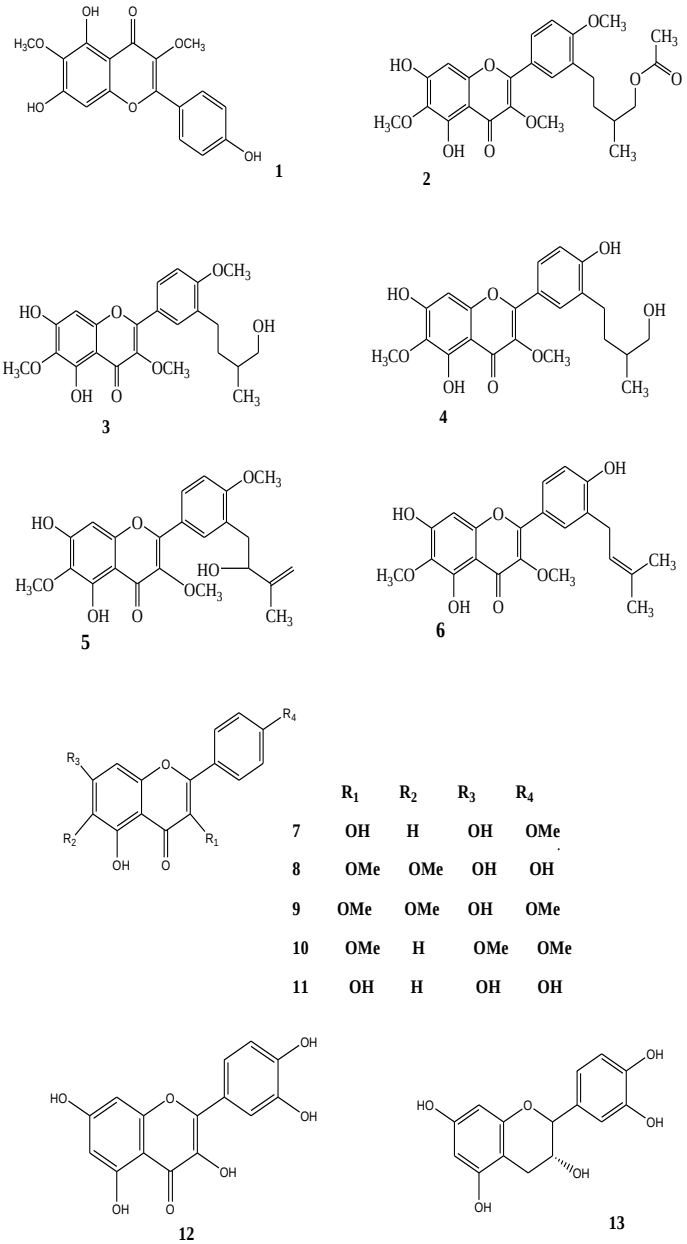


Figure 2: Flavonoids isolated from *Dodonaea viscosa*

A number terpenoids have been reported as having been isolated from *Dodonaea viscosa*, including diterpene, 6-hydroxy-5, 8, 9-trimethyl-18-carboxylclerodane (36) (Al Bimani and Hossain, 2020), clerodane-diterpene (37), two labdane diterpenes (38 and 39), labd-13(E)-en-8,15-diol and (40) ent-15,16-epoxy-9αH-labda-13(16),14-diene-3β,8α-diol (41) and 6-hydroxyhardwickjic acid (42) [24], tamarixetin, ent-labdane diterpenoids (43-50) (Gyeltshen, et al., 2023), ent-labdanes (51-58), ent-kauranes (59-62), Monoterpenoid wax esters (63-64) Viridiflorol (65) and Norhopene (66) [25]. Some terpenoid compounds isolated from *Dodonea* species are presented in figure 6 below.

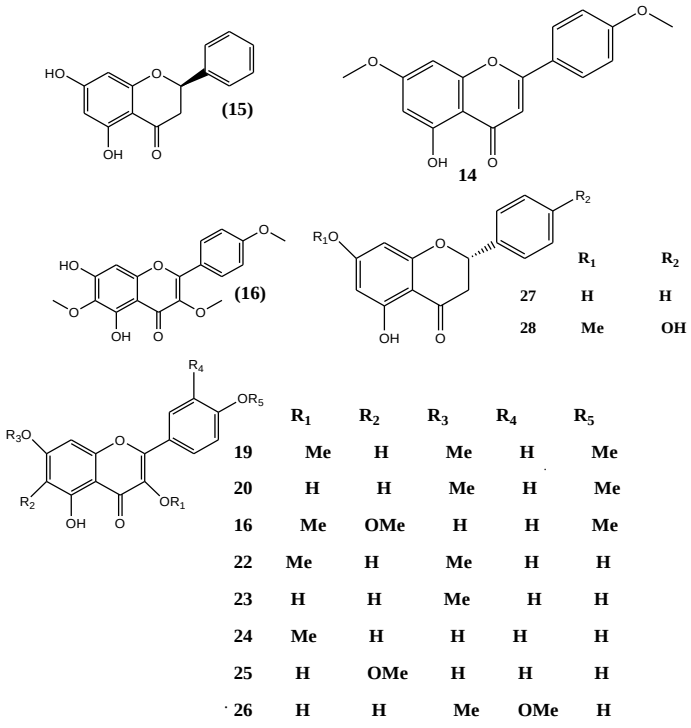


Figure 3: Flavonoids isolated from *Dodonaea angustifolia*

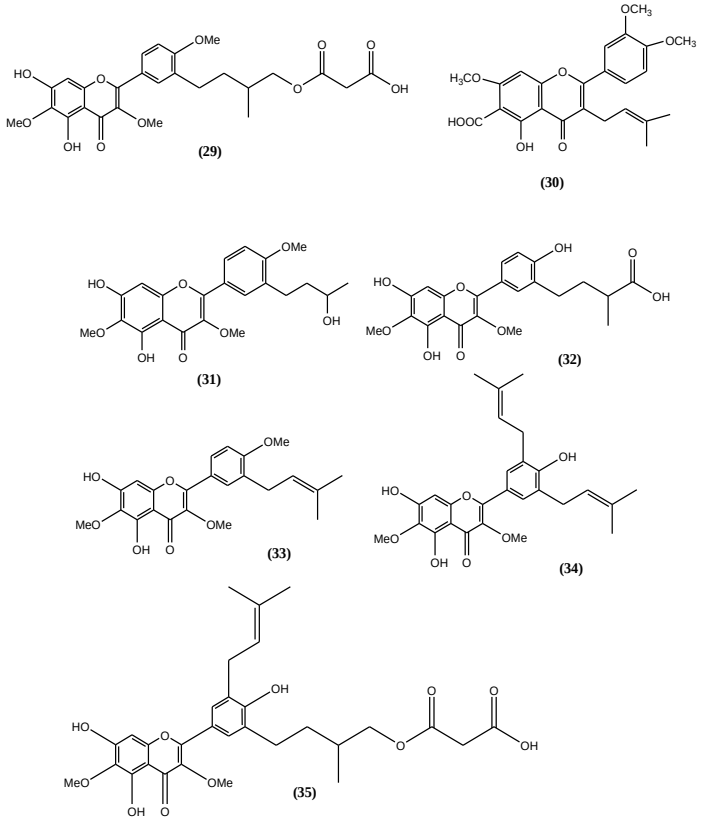


Figure 4: Prenylated flavonoids isolated from leaves of *Dodonaea filiformis* and flowers of *Dodonaea spatulate*

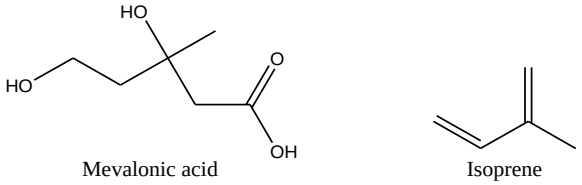


Figure 5: Structures of Mevalonic acid and Isoprene unit

Coumarins

Three coumarins: scopoletin (67), isofraxidin (68) and fraxetin (69) have been isolated from the stems of *Dodonaea viscosa*. (Sagara, et al., 2021). One other class of compounds predominantly reported among the *Dodonaea* species is glycosides.

Pharmacological Activities

Antioxidant

Methanolic extracts and the subsequent ethyl acetate and chloroform fractions of *Dodonaea* species have been reported to show good antioxidant capacity in research investigations using various in vitro assays including 1,1-Diphenyl-2-picrylhydrazyl (DPPH) scavenging assay, Ferric Reducing Antioxidant Power (FRAP) assay, and ferric thiocyanate assay, among others [15,20,26-30]. The antioxidant activity of these extracts has been associated with the presence of phenolic compounds such as flavonoids and coumarins in *Dodonaea* species [30]. In one study, 3,3′,4′,5,7-pentahydroxyflavane (13), a flavonoid isolated from the leaves of *Dodonaea viscosa* showed significant antioxidant activity against DPPH as compared to standard gallic acid [15]. In another study, 5-Hydroxy-7,3′4’-trimethoxy-6-acetoxy-3-prenylflavone (30) isolated from the leaves of *Dodonaea viscosa* also showed good antioxidant activity against DPPH [20].

Anti inflammatory

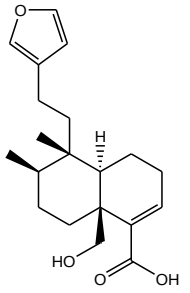
Plant extracts and even purified compounds from *Dodonaea* species have been reported to possess anti-inflammatory activities [31,32]. In one research study, crude extracts from powdered leaves of *Dodonaea viscosa* showed *in vivo* anti-inflammatory activity against carrageenan-induced rat paw edema at a dosage as low as 100mg/kg body weight [33]. In another study, an aqueous extract from the leaves of *Dodonaea angustifolia* formulated into silver nanoparticles inhibited in vitro anti-inflammatory effect against the denaturation of protein in a concentration dependent manner [34]. Other studies on in vitro anti-inflammatory activities of extracts from *Dodonaea* plants have also reported positive results [5,35,36]. Isolated compounds from *Dodonaea* plants such as Nebrodenside A, (glycoside) [37], Hautriwaic Acid (43) [38], among others have been reported to possess anti-inflammatory activities.

Antimicrobial

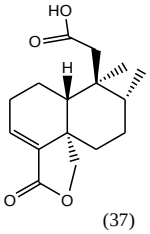
Plant extracts and pure compounds obtained from various *Dodonaea* species have been reported to possess good antimicrobial activities against various microorganisms including bacteria and fungi [13,16, 39-41]. In one study, crude extracts, fractions of ranging polarity and ensuing purified compounds (12 & 36) from the leaves of *Dodonaea viscosa* showed in vitro antimicrobial activity when assayed using agar diffusion technique [14]. In another study, compounds isolated from *Dodonaea angustifolia* were reported to possess good antibacterial and antifungal activity [8,16]. Many other compounds, fractions and crude extracts have reported good antimicrobial activity.

Antiplasmodial

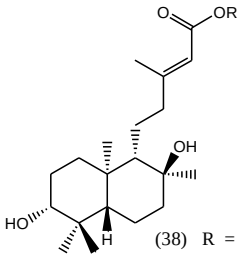
Pinocembrin (15) and three other compounds isolated from the leaves of *Dodonaea angustifolia* were reported to possess significant antiplasmodial activities [17]. Another study reported a significant *in vivo* antiplasmodial activity of methanolic extract and its subsequent different polarity fractions obtained from the roots of *Dodonaea*



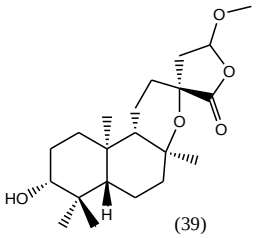
(36)



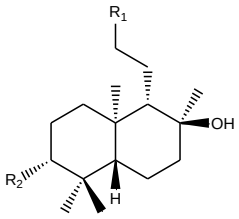
(37)



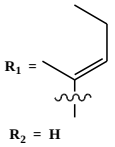
(38) R = H



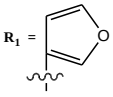
(39)

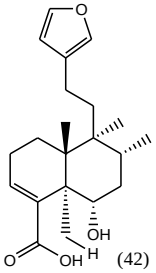


(40)

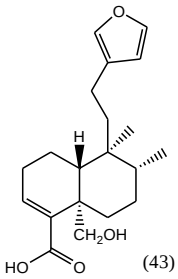


(41)

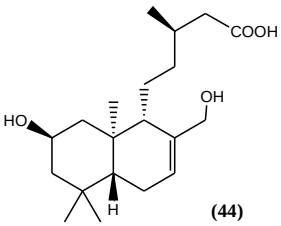




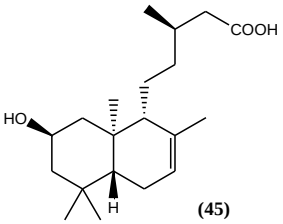
(42)



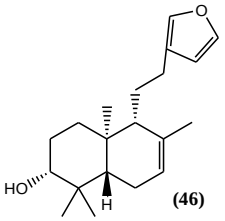
(43)



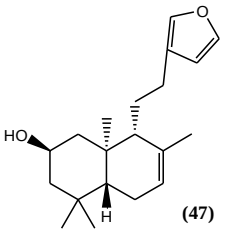
(44)



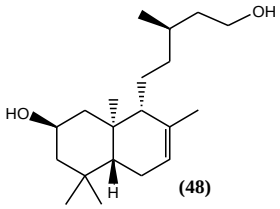
(45)



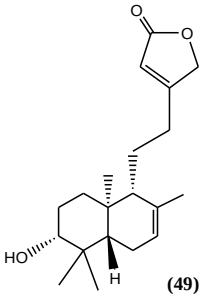
(46)



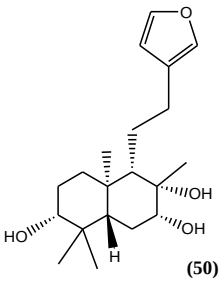
(47)



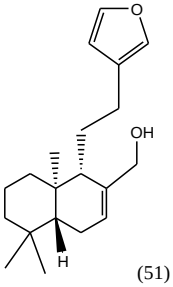
(48)



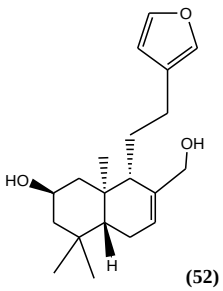
(49)



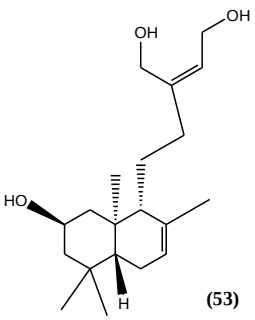
(50)



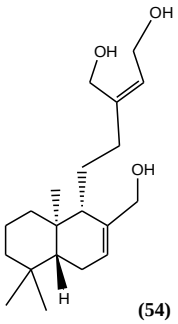
(51)



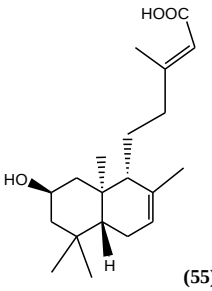
(52)



(53)



(54)



(55)

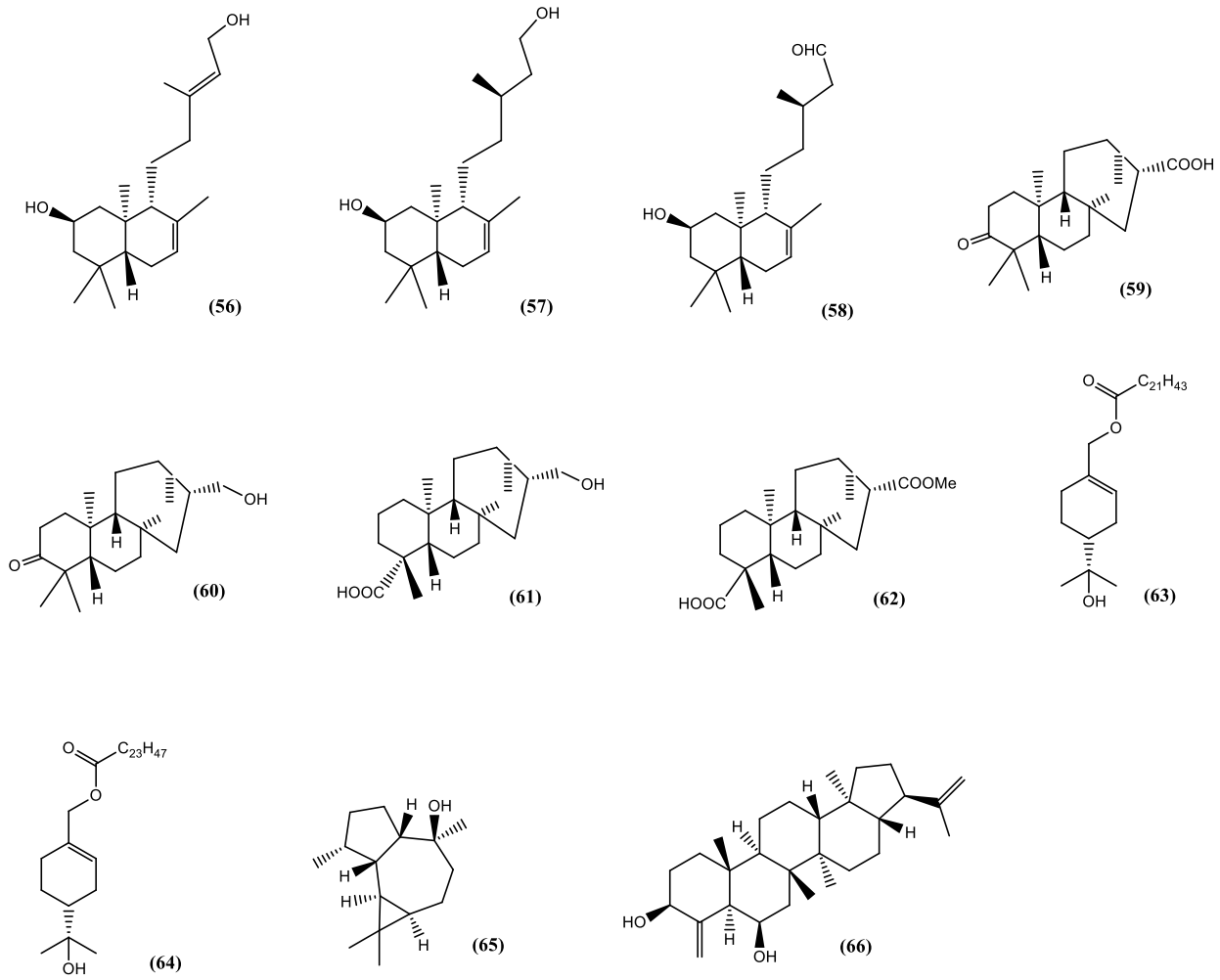
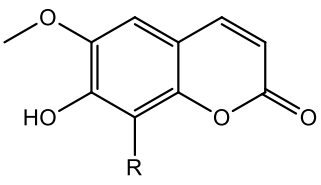


Figure 6: Terpenoids isolated from *Dodonaea* species

angustifolia [42]. A seed extract of *Dodonaea angustifolia* has also been reported to show *in vivo* activity against *P. berghei* in mice [43]. Other studies have reported potential of *Dodonaea* species' application in management of plasmodium infections [1,44].

Other Pharmacological Activities

The other reported pharmacological activities possessed by *Dodonaea* species include anticancer [1,45], antiviral [1,46-48] and antidiabetic [1,49], among others.



(67) R = H
(68) R = OCH_3
(69) R = OH

Figure 7: Coumarins isolated from *Dodonaea viscosa*

CONCLUSION

In conclusion, *Dodonaea* species contain various phytochemicals such as flavonoids, terpenoids, coumarins and glycosides, among others. These photochemicals are thought to be responsible for the various pharmacological activities the plant species possess. Extracts from various species of *Dodonaea* plants have been reported to possess a range of activities including but not limited to antioxidant, anti-inflammatory, antimicrobial, antiplasmodial, anticancer, antidiabetic and antiviral activities.

Conflicts of Interest

The authors declare no conflict of interest.

Funding

None declared.

ORCID ID

Abigail Wambui Waweru: https://orcid.org/0009-0009-7873-2205

Eric Kibagendi Osoro: https://orcid.org/0000-0002-5459-1497

Josiah Ouma Omolo: https://orcid.org/0000-0001-9876-0179

REFERENCES

1. Beshah F, Hunde Y, Getachew M, Bachheti RK, Husen A, Bachheti A. Ethnopharmacological, phytochemistry and other potential applications of Dodonaea genus: A comprehensive review. Current Research in Biotechnology. 2020;2:103-19.
2. World Health Organization. Global tuberculosis report 2013. World Health Organization; 2013.

3. Osoro EK, He YZ, Ndagijimana A, Imbenzi PS. A review on phenolic compounds in Illicium species and their pharmacological effects.
4. Wachtel-Galor S. Herbal medicine: biomolecular and clinical aspects. CRC press; 2011.
5. Al-Snafi AE. A review on Dodonaea viscosa: A potential medicinal plant. IOSR Journal of Pharmacy. 2017;7(2):10-21.
6. Muqaddas RA, Tahir A, Nadeem F. Historical origin, chemical constituents and therapeutic potentials of sanatha (Dodonaea viscose)–A brief review. International Journal of Chemical and Biochemical Sciences. 2018;14:48-54.
7. Alamri MA, ul Qamar MT. Network pharmacology based virtual screening of Flavonoids from Dodonea angustifolia and the molecular mechanism against inflammation. Saudi Pharmaceutical Journal. 2023;31(11):101802.
8. Omosa LK, Amugune B, Ndunda B, Milugo TK, Heydenreich M, Yenesew A, Midiwo JO. Antimicrobial flavonoids and diterpenoids from Dodonaea angustifolia. South African journal of botany. 2014;91:58-62.
9. Liu W, Feng Y, Yu S, Fan Z, Li X, Li J, Yin H. The flavonoid biosynthesis network in plants. International journal of molecular sciences. 2021;22(23):12824.
10. Khan AZ, Mohammad A, Iqbal Z, Anis I, Shah MR, Nadeem S, Rabnawaz M, Shahidullah A, Khan H, Khan I. Molecular docking of viscosine as a new lipoxygenase inhibitor isolated from Dodonaea viscosa. Bangladesh Journal of Pharmacology. 2013;8(1):36-9.
11. Siddiqui NA, Almarfadi OM, Shahat AA, Alqahtani AS, El Gamal AA, Raish M, Iqbal M. Isolation of new compound and neuroprotective studies from Dodonaea viscosa. Journal of King Saud University-Science. 2023;35(5):102704.
12. Muhammad A, Anis I, Khan A, Marasini BP, Choudhary MI, Shah MR. Biologically active C-alkylated flavonoids from Dodonaea viscosa. Archives of pharmacal research. 2012;35:431-6.
13. Teffo LS, Aderogba MA, Eloff JN. Antibacterial and antioxidant activities of four kaempferol methyl ethers isolated from Dodonaea viscosa Jacq. var. angustifolia leaf extracts. South African Journal of Botany. 2010;76(1):25-9.
14. Al Bimani BM, Hossain MA. A new antimicrobial compound from the leaves of Dodonaea viscosa for infectious diseases. Bioactive Materials. 2020;5(3):602-10.
15. Al Habsi AA, Hossain MA. Isolation, structure characterization and prediction of antioxidant activity of two new compounds from the leaves of Dodonaea viscosa native to the Sultanate of Oman. Egyptian journal of basic and applied sciences. 2018;5(2):157-64.
16. Mcotshana ZK, McGaw LJ, Kemboi D, Fouche G, Famuyide IM, Krause RW, Siwe-Noundou X, Tembu VJ. Cytotoxicity and antimicrobial activity of isolated compounds from Monsonia angustifolia and Dodonaea angustifolia. Journal of Ethnopharmacology. 2023;301:115170.
17. Melaku Y, Worku T, Tadesse Y, Mekonnen Y, Schmidt J, Arnold N, Dagne E. Antiplasmodial compounds from leaves of Dodonaea angustifolia. Current bioactive compounds. 2017;13(3):268-73.
18. Gyeltshen T, Olivier WJ, Dutra-Nobre AR, Kilah NL, Smith JA, Bissember AC. Terpenoids and Unusual Flavonoids Bearing Prenylated Malonic Acids in Dodonaea Species. Asian Journal of Organic Chemistry. 2023;12(7):e202300259.
19. Niu HM, Zeng DQ, Long CL, Peng YH, Wang YH, Luo JF, Wang HS, Shi YN, Tang GH, Zhao FW. Clerodane diterpenoids and prenylated flavonoids from Dodonaea viscosa. Journal of Asian Natural Products Research. 2010;12(1):7-14.
20. Al-Aamri KK, Hossain MA. New prenylated flavonoids from the leaves of Dodonea viscosa native to the Sultanate of Oman. Pacific Science Review A: Natural Science and Engineering. 2016;18(1):53-61.
21. Botta B, Vitali A, Menendez P, Misiti D, Monache GD. Prenylated flavonoids: pharmacology and biotechnology. Current medicinal chemistry. 2005;12(6):713-39.
22. Yang W, Chen X, Li Y, Guo S, Wang Z, Yu X. Advances in pharmacological activities of terpenoids. Natural Product Communications. 2020;15(3):1934578X20903555.
23. Jiang Y, Zhang W, Chen X, Wang W, Köllner TG, Chen S, Chen F, Chen F. Diversity and biosynthesis of volatile terpenoid secondary metabolites in the Chrysanthemum genus. Critical Reviews in Plant Sciences. 2021;40(5):422-45.
24. Sagara T, Sugimoto S, Yamano Y, Nehira T, Masuda K, Otsuka H, Matsunami K. Isolation of three new diterpenes from Dodonaea viscosa. Chemical and Pharmaceutical Bulletin. 2021;69(1):40-7.
25. Dutra-Nobre AR, Olivier WJ, Deans BJ, Kilah NL, Alejandro FM, Smith JA, Bissember AC. Intraspecific variation in the terpene profiles of Dodonaea viscosa. Asian Journal of Organic Chemistry. 2023;12(4):e202300039.
26. Riaz T, Abbasi AM, Shahzadi T, Ajaib M, Khan MK. Phytochemical screening, free radical scavenging, antioxidant activity and phenolic content of Dodonaea viscosa. Journal of the Serbian Chemical Society. 2012;77(4):423-35.
27. Shoriqi MR, Touby SS, Hossain MA. Total phenols content and antioxidant activity of different polarity crude extracts of Dodonaea viscosa. Indian Drugs. 2021;58(8).
28. AL-Azawi AH. Phytochemical, Antibacterial and antioxidant activities of dodonea viscosa Jacq. extracts cultivated in Iraq. Iraqi journal of biotechnology. 2017;16(4).
29. Al-Musawi ZF, Al-Saadi NH, Ali IM. Antibacterial and antioxidant activities of silver nanoparticle synthesized from Dodonaea viscosa L. extract. InAIP Conference Proceedings 2022 (Vol. 2386, No. 1). AIP Publishing.
30. Tessema FB, Gonfa YH, Asfaw TB, Tadesse MG, Bachheti RK. Antioxidant activity of flavonoids and phenolic acids from Dodonaea angustifolia flower: HPLC profile and PASS prediction. Journal of Chemistry. 2023;2023.
31. Shahrajabian MH. Medicinal herbs with anti-inflammatory activities for natural and organic healing. Current Organic Chemistry. 2021;25(23):2885-901.
32. Emam JA, Yaya EE, Choudhary MI, Yousuf S, Gebremedhin TM. In Vitro Antioxidant and Anti-inflammatory Activities of Twenty-two Ethiopian Medicinal Plants. Ethiop Pharm J. 2021;37(1):89-94.
33. Ramkumar R, Periyasamy SK. Anti-inflammatory activity of Dodonaea viscosa leaves. IJRAR-International Journal of Research and Analytical Reviews (IJRAR). 2019;6(2):223-5.
34. Revathi N, Dhanaraj TS. A study on in vitro anti-inflammatory activity of silver nanoparticles synthesized from Dodonaea angustifolia leaf extract. Journal of Pharmacognosy and Phytochemistry. 2019;8(4):1878-81.
35. Nayeem N, Siddiqui NA, Imran M, Alsuwayt B. HPTLC analysis and in vitro biological activity of Dodonaea viscosa. Pharmacophore. 2019;10(6):1-8.
36. Simpson BS, Luo X, Wang J, Song Y, Claudie D, Garg S, Smith N, McKinnon R, Semple S. Development and evaluation of a topical anti-inflammatory preparation containing Dodonaea

polyandra extract. Journal of Pharmacy & Pharmaceutical Sciences. 2015;18(4):578-99.
37. Khan K, Rasool S, Khan K, Badshah SL, Ahmad N, Jan MT, Hizbullah SM, Khan I, Ullah A, Muhammad A. Computational evaluation and anti-inflammatory and analgesic activities of nebrodenside a isolated from Dodonaea viscosa. Natural Product Communications. 2019;14(5):1934578X19848157.
38. Salinas-Sánchez DO, Zamilpa A, Pérez S, Herrera-Ruiz M, Tortoriello J, González-Cortazar M, Jiménez-Ferrer E. Effect of hautriwaic acid isolated from Dodonaea viscosa in a model of kaolin/carrageenan-induced monoarthritis. Planta Medica. 2015;81(14):1240-7.
39. Ngabaza T, Johnson MM, Moeno S, Patel M. Identification of 5, 6, 8-Trihydroxy-7-methoxy-2-(4-methoxyphenyl)-4H-chromen-4-one with antimicrobial activity from Dodonaea viscosa var. angustifolia. South African journal of botany. 2017;112:48-53.
40. Priya VT, Balasubramanian N, Shanmugaiah V, Sathishkumar P, Kannan ND, Karunakaran C, Alfarhan A, Antonisamy P. Partially purified lead molecules from Dodonaea viscosa and their antimicrobial efficacy against infectious human pathogens. Journal of Infection and Public Health. 2021;14(12):1822-30.
41. Pérez-Narváez OA, Castillo Hernández S SL, Leos-Rivas C, Pérez-Hernández RA, Chávez-Montes A, Verduzco-Martínez JA, Sánchez-García E. Antibacterial Effect of Ethanolic Extracts of Dodonaea viscosa L. Jacq. and Mammea americana L. against Staphylococci Isolated from Skin Lesions. BioMed Research International. 2023;2023.
42. Amelo W, Nagpal P, Makonnen E. Antiplasmodial activity of solvent fractions of methanolic root extract of Dodonaea angustifolia in Plasmodium berghei infected mice. BMC complementary and alternative medicine. 2014;14:1-7.
43. Mengiste B, Makonnen E, Urga K. Invivo antimalarial activity of Dodonaea Angustifolia seed extracts against Plasmodium berghei in mice model. Momona Ethiopian Journal of Science. 2012;4(1):47-63.
44. Omosa LK, Akala H, Kenanda EO, Ndunda B. Variability of surface exudates of Dodonaea angustifolia Lf, antioxidant and antiplasmodial activities of the compounds. Journal of Natural Sciences Research. 2016;6(10):78-85.
45. Herrera-Calderon O, Rahman MH, Pena-Rojas G, Andia-Ayme V. Dodonaea viscosa Jacq: a medicinal plant with cytotoxic effect on colon cancer cell line (HT-29). J Pure Appl Microbiol. 2020;14(3):1927-34.
46. Zhang LB, Liao HB, Zhu HY, Yu MH, Lei C, Hou AJ. Antiviral clerodane diterpenoids from Dodonaea viscosa. Tetrahedron. 2016;72(49):8036-41.
47. Zhao XT, Lei C, You JQ, Zhao T, Yu MH, Shi XL, Hu X, Hou AJ. Dimeric clerodane diterpenoids and antiviral constituents of Dodonaea viscosa. Bioorganic Chemistry. 2021;112:104916.
48. Shaheen MO, Borsanyiova MA, Mostafa SA, Chawla-Sarkar MA, Bopegamage SH, El-Esnawy NA. In vitro effect of Dodonaea viscosa extracts on the replication of coxackievirus B3 (Nancy) and rotavirus (SA-11). J Microbiol Antimicrob Agents. 2015;1(2):47-54.
49. Muthukumran P, Begumand VH, Kalaiarasan P. Anti-diabetic activity of Dodonaea viscosa (L) leaf extracts. International Journal of PharmTech Research. 2011;3(1):136-9.

HOW TO CITE THIS ARTICLE
Waweru AW, Osoro EK, Omolo JO. A review on the Phytochemistry and Pharmacological Activities of some Species from Genus *Dodonaea* (Sapindaceae Family). J Phytopharmacol 2024; 13(1):70-76. doi: 10.31254/phyto.2024.13110