Bangladesh Pharmaceutical Journal ***24****(1): 76-82, 2021 (January)* **- Review article**

A Short Review on the Bioactive Constituents from Six *Terminalia* Species

Mohammad Musarraf Hussain

Department of Pharmacy, Faculty of Life and Earth Sciences, Jagannath University
Dhaka-1100, Bangladesh

(Received: August 18, 2020; Accepted: December 16, 2020; Published (web): January 28, 2021)

Abstract

Terminalia as a genus has received a great attraction to evaluate and examine the pharmacological potential having their medicinal properties. Different species under *Terminalia* genus have been used as herbal medicine with various formulations in the treatment of abdominal pain, cancer, cough, conjunctivitis, diarrea, heart problem, leproscopy, urinary tract infection, and sexual related diseases. These properties have been reported to express abundant biological characteristics for example antioxidant, antiparasitic, antibacterial, antifungal, antiviral, and anti-inflammatory. This review has constructed to solicitude the phytochemicals from the genus *Terminalia*. A total six species belongs to this genus such as *Terminalia chebula, T. citrina, T. phanerophlebia, T. belerica, T. catappa, and T. arjuna* have been studied and fifty-six phytochemicals with their chemical structures have been reported in this review. *Terminalia chebula* consists of a higher number of phytochemicals as compared to the other species.

Key words: *Terminalia*, Phytochemicals, Tannins, Glucosides, Pyranosides, Triterpenoids, Phenolic compounds.

Introduction

Nature is a significant resource for medicinal plants. The medicinal plants along with elucidated chemical compounds having pharmacological activities are using as traditional medicinal agents in the prevention and management of different diseases for many years (Hussain 2020, 2019a, 2019b, 2018). These medicinal plants having varied curative properties like anti-microbial, anticancer, anti-inflammatory, anti-plasmodial, and anti-oxidant potentials (Hussain *et al.*, 2016, 2011, 2010; Billah *et al.*, 2013; Ismail *et al.*, 2010). *Terminalia* is a second prevalent genus under the family of Combretaceae having 200 species and is distributed in tropical countries especially in Southeast Asia (Fahmy *et al.*, 2015). *T. chebula* is a medium tree, which can go up to 30.0 m in height, with a trunk having diameter up to 1.0 m. This plant also has traditional use as medicine to treat liver and kidney dysfunction. Dried fruit is also used in Ayurveda as cardiotonic, antitussive, diuretic, homeostatic, laxative, and diuretic (Tawaril *et al.*, 2017).

Reported bio-active constituents

A total six medicinal plants from *Terminalia* genus for example *Terminalia chebula, T. citrina, T. phanerophlebia, T. belerica, T. catappa, and T. arjuna*, were reviewed and fifty six (**1-56;** Figures 1-6) phytoconstituents have been reported along with their chemical structures in this article.

Tannins: Several tannins having hepatitis C inhibitory potentials were isolated from *Terminalia chebula*, which are chebumeinin A (**1**) and B (**2**), chebulic acid (**3**), casuarinin (**4**), pentagalloyl glucose (**5**), 5-O-galloylshikimic acid (**6**), ethyl

Corresponding author: Mohammad Musarraf Hussain, Email: m.musarraf.hussain@gmail.com and mmhussain@pharm.jnu.ac.bd

DOI: https://doi.org/10.3329/bpj.v24i1.51638

gallate (**7**), gallic acid (**8**), corilagin (**9**), chebulagic acid (**10**), ellagic acid (**11**), tetra-o-galloyl-β-D-glucose (**12**), chebulinic acid (**13**), and penta-O-galloyl-β-D-glucose (**14**) (Figure 1) (Ajala *et al.*, 2014; Mahajan *et al.*, 2010; Saleem *et al.*, 2002; Lee *et al.*, 2007; Han *et al.*, 2006).

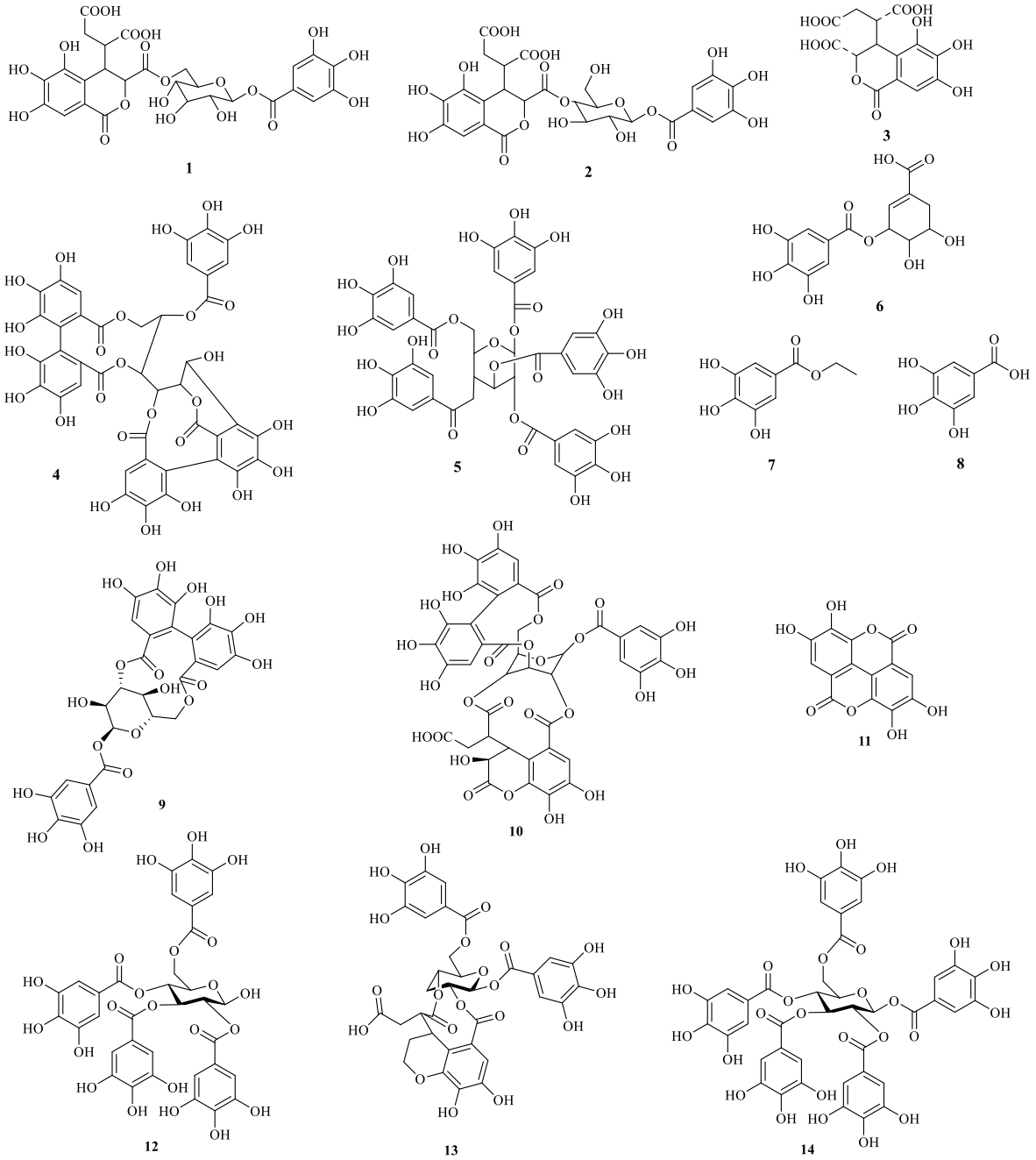


Figure 1. Tannins from *Terminalia chebula*

Glucosides: Six glucosides and one glucosidic ester bearing antiestrogenic and antimicrobial property were elucidated from *Terminalia citrine* and *Terminalia phanerophlebia*; for example, ~~T~~terminaloside-L (**15**), terminaloside-M (**16**), terminaloside-N (**17**), terminaloside-O (**18**),

terminaloside-P (**19**), methyl-3,4,5-trihydroxybenzoate (**20**), and 1,6-di-o-coumaroyl glucopyranoside (**21**). Among all the isolated glucosidic compounds from *Terminalia* genus, compound **21** was reported to be a lead molecule for the discovery of medicinal agents targeting tuberculosis (Figure 2) (Muhit *et al.*, 2016; Madikizela *et al.*, 2014).

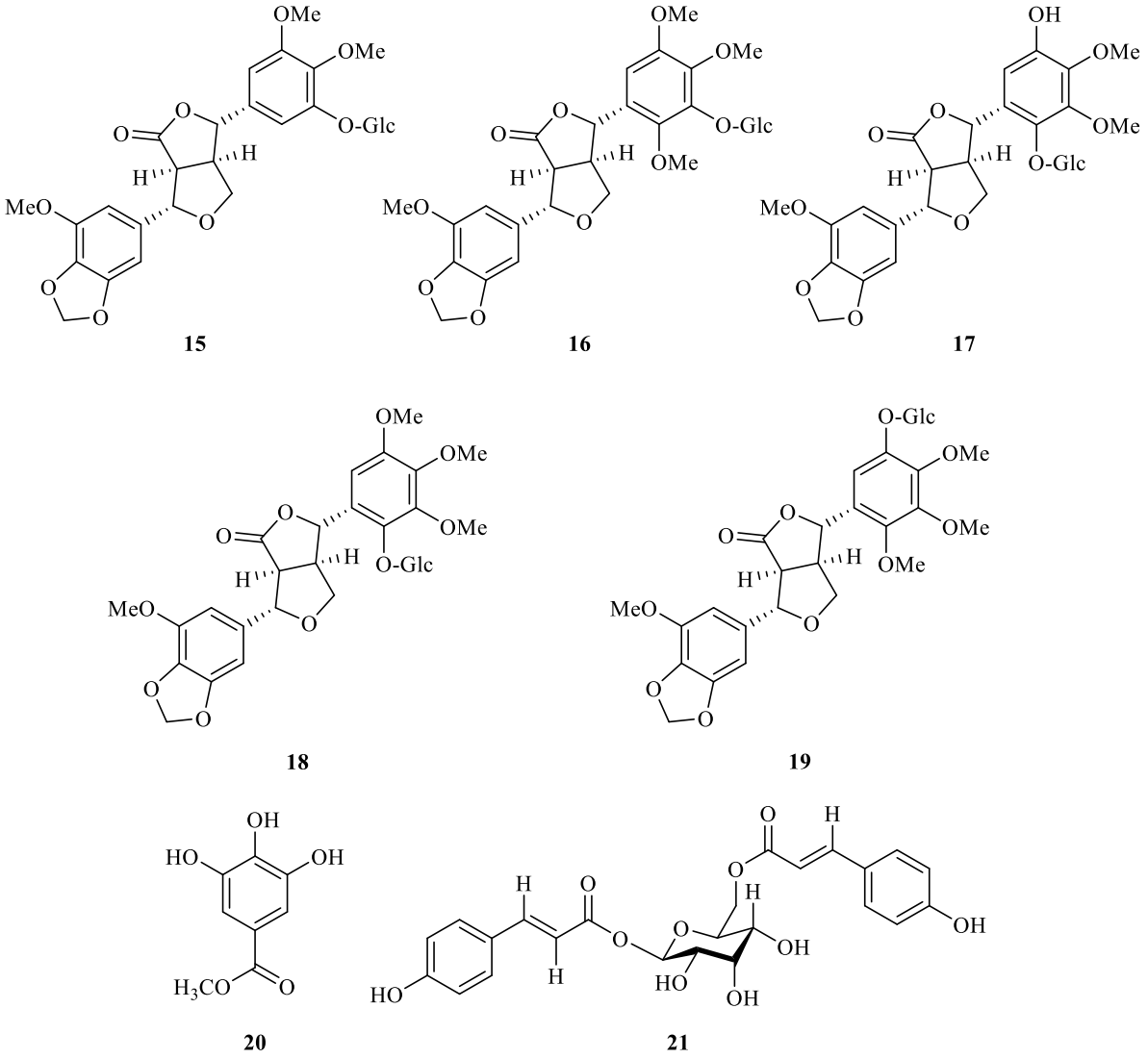


Figure 2. Glucosides from *Terminalia citrina* (**15-19**) and *Terminalia phanerophlebia* (**20, 21**)

Pyranoside: Antiplatelet and antioxidant potency containing one pyranoside, benzoyl-β-D-(4′→10″geranilanoxy)-pyranoside (**22**), has been reported from *Terminalia belerica* (Figure 3) (Ansari *et al.*, 2016).

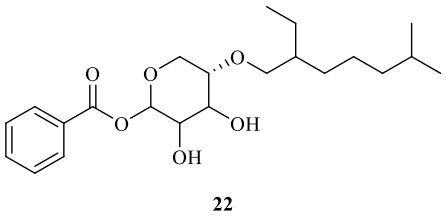
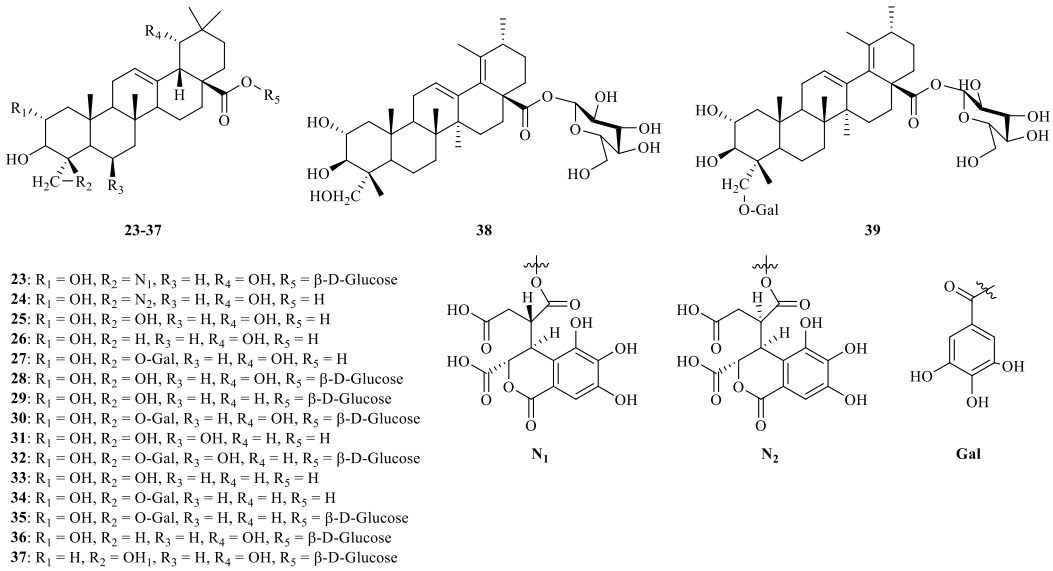


Figure 3. Pyranoside from *Terminalia belerica*

Triterpenoids: The reported triterpenoids from the medicinal plant, *Terminalia chebula* are 28-O-β-D-glycopyranosyl ester (**23**), 23-O-4′-*epi*-neochebuloylarjungenin (**24**), arjungenin (**25**), arjunic acid (**26**), 23-O-galloylarjunic acid (**27**), arjunglucoside I (**28**), arjunglucoside II (**29**), quercotriter-penoside I (**30**), terminolic acid (**31**), 28-O-β-D-glucopyranosyl-23-O-galloylterminoliate (**32**), arjunolic acid (**33**), 23-O-galloylarjunolic acid (**34**), 28-O-β-D-glucopyranosyl-23-O-galloylarjunolate (**35**), arjunetin (**36**), crataegioside (**37**), 28-O-β-D-glucopyranosyl-pinfaenoate (**38**), and 28-O-β-D-glucopyranosyl-23-O-galloylpinfaenoate (**39**) (Figure 4) (Lee *et al.*, 2017).



23: R_1 = OH, R_2 = N_1, R_3 = H, R_4 = OH, R_5 = β-D-Glucose
24: R_1 = OH, R_2 = N_2, R_3 = H, R_4 = OH, R_5 = H
25: R_1 = OH, R_2 = OH, R_3 = H, R_4 = OH, R_5 = H
26: R_1 = OH, R_2 = H, R_3 = H, R_4 = OH, R_5 = H
27: R_1 = OH, R_2 = O-Gal, R_3 = H, R_4 = OH, R_5 = H
28: R_1 = OH, R_2 = OH, R_3 = H, R_4 = OH, R_5 = β-D-Glucose
29: R_1 = OH, R_2 = OH, R_3 = H, R_4 = H, R_5 = β-D-Glucose
30: R_1 = OH, R_2 = O-Gal, R_3 = H, R_4 = OH, R_5 = β-D-Glucose
31: R_1 = OH, R_2 = OH, R_3 = OH, R_4 = H, R_5 = H
32: R_1 = OH, R_2 = O-Gal, R_3 = OH, R_4 = H, R_5 = β-D-Glucose
33: R_1 = OH, R_2 = OH, R_3 = H, R_4 = H, R_5 = H
34: R_1 = OH, R_2 = O-Gal, R_3 = H, R_4 = H, R_5 = H
35: R_1 = OH, R_2 = O-Gal, R_3 = H, R_4 = H, R_5 = β-D-Glucose
36: R_1 = OH, R_2 = H, R_3 = H, R_4 = OH, R_5 = β-D-Glucose
37: R_1 = H, R_2 = OH_1, R_3 = H, R_4 = OH, R_5 = β-D-Glucose

Figure 4. Triterpenoids from *Terminalia chebula*

Acidic compounds: Five acidic and two other compounds (*i.e.*, carbonyl and o-glucosidic compounds) such as 2-pentadecanone (**40**), vanillic acid (or, 4-hydroxy-3-methoxybenzoic acid) (**41**), syringic acid (or, 4-hydroxy-3,5-dimethoxybenzoic acid) (**42**), ferulic acid (or, (E)-3-(4-hydroxy-3-methoxyphenyl)acrylic acid) (**43**), p-coumaric acid (or, (E)-3-(4-hydroxyphenyl)acrylic acid) (**44**), 3,4,4′-tri-O-methyl-ellagic acid (**45**), and β-sitosterol-3-O-β-D-glucoside (**46**) were elucidated from *Terminalia catappa* (Figure 5) (Baratelli *et al.*, 2012; Hussain *et al.*, 2016, 2008).

Miscellaneous compounds

The isolated phytochemicals from *Terminalia arjuna* are triterpenoids, ursane tri-terpene-glucosyl ester, ursane tri-terpene-glycosyl esters and phenolic compounds. Reported compounds under these classes are arjunic acid (**47**), arjunetin (**48**), arjungenin (**49**), 28-O-β-D-glucopyranosyl-2α,3β-dihydroxyurs-12,18-dien-28-oate (**50**), 28-O-β-D-glucopyranosyl-2α,3β,23-trihydroxyurs-12,18-dien-28-oate (**51**), quadranoside viii (**52**), kajiichigoside f1 (**53**), 28-O-β-D-glucopyranosyl-2α,3β,23-trihydroxyurs-12,19-dien-28-oate (**54**), 3-O-methylellagic acid 4′-O-*α*-l-rhamnopyranoside (**55**), and (−)-epicatechin (or, (2R,3R)-2-(3,4-dihydroxyphenyl)chromane-3,5,7-triol) (**56**) (Figure 6) (Varghesea *et al.*, 2015; Wang *et al.*, 2010; Toumy *et al.*, 2003).

Concluding remarks and future perspective

Extracts from the different plants under the genus *Terminalia* is a good source of phytochemical compounds. A number of reports have revealed ethnopharmacological potential from the different medicinal plants (Das *et al.*, 2020). Here, a short survey has been performed based on the literature on the genus *Terminalia* which revealed different

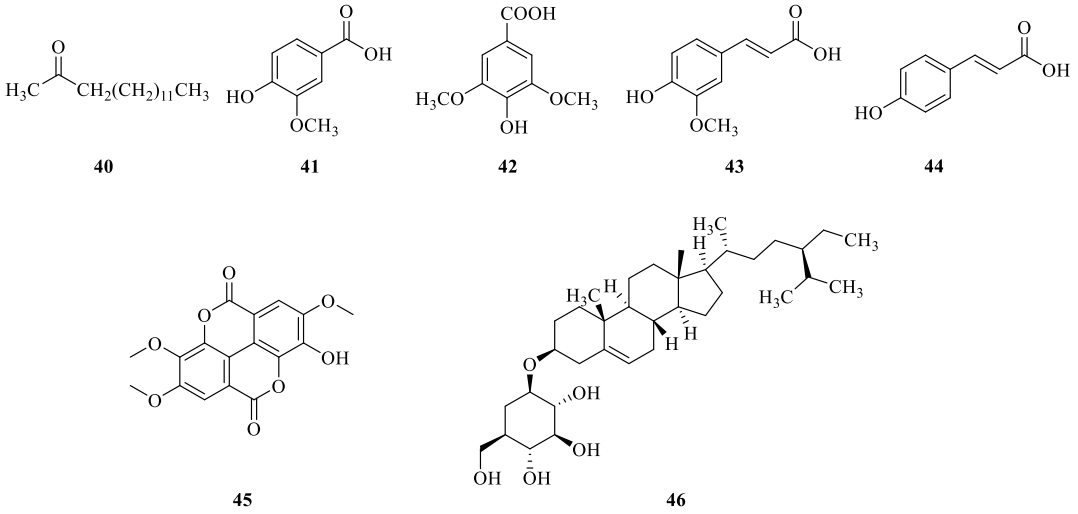


Figure 5. Acidic compounds from *Terminalia catappa*

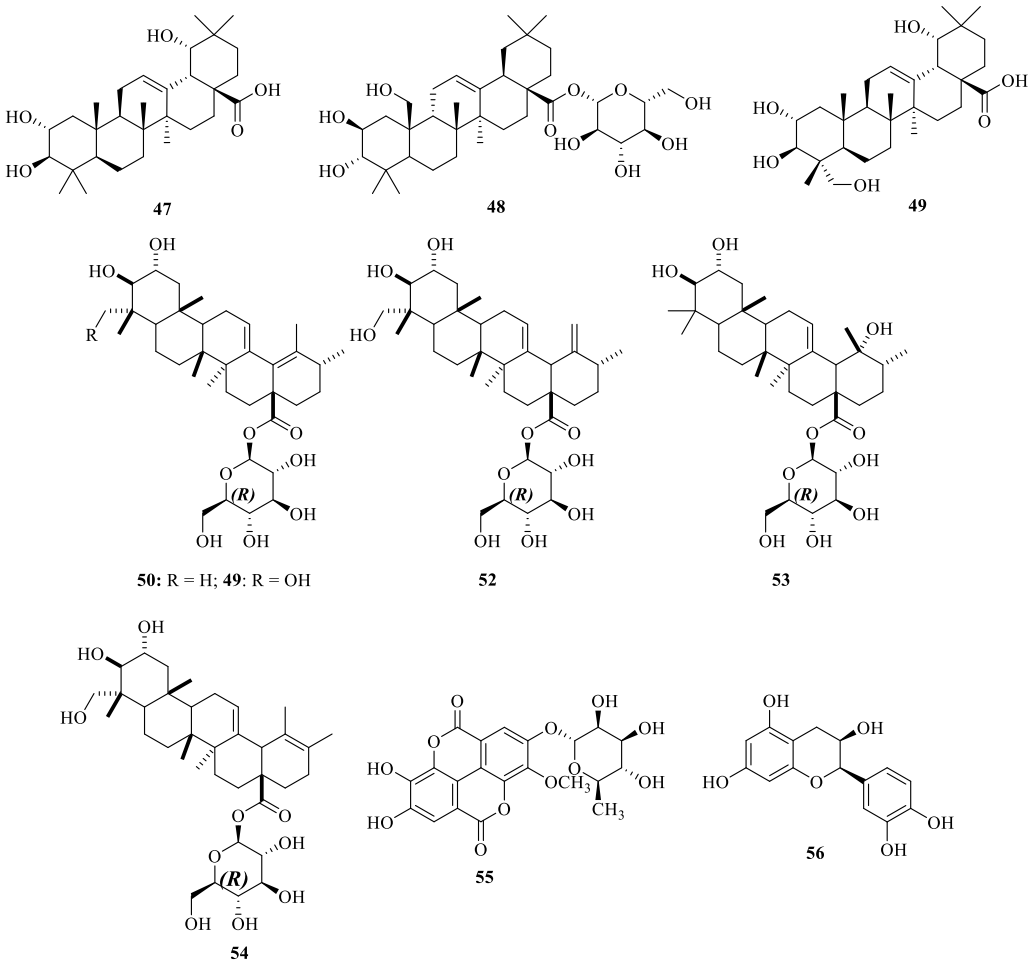


Figure 6. Compounds from *Terminalia arjuna*

phytochemicals such as tannis, glucosides, pyranosides, triterpenoids, and acidic compounds (Fahmy *et al.*, 2015). Six medicinal plants (*Terminalia chebula, T. citrina, T. phanerophlebia, T. belerica, T. catappa, and T. arjuna*) under the genus *Terminalia* have been studied and fifty six compounds were reported having varied and distinctive chemical structure various bioactivity and pharmacological properties. The current review presents a short perceptive of the chemistry of various *Terminalia* species, that can be helpful in the progress and finding of the novel medicinal moieties for the diagnosis and treatment of different health related problems and diseases.

References

Ajala, O.S., Jukov, A., Ma, C.M., 2014. Hepatitis C virus inhibitory hydrolysable tannins from the fruits of *Terminalia chebula*. *Fitoterapia.* **99**, 117-123.

Ansari, V.A., Arif, M., Hussain, M.S., Siddique, H.H., Dixit, R.K. 2016. New 4 -Substituted benzoyl-β-D glycoside from the fruit pulp of *Terminalia belerica* with antiplatelet and antioxidant potency. *Integr. Med. Res.* **5**, 317-323.

Baratelli, T.D.G., Gomes, A.C.C., Wessjohann, L.A., Kuster, R.M., Siams, N.K. 2012. Phytochemical and allelopathic studies of *Terminalia catappa* L. (Combretaceae). *Biochem. Systematics Ecology* **41**, 119-125.

Billah, A.H.M.M., Hussain, M.M., Dastagir, M.G., Ismail, M., Quader, A. 2013. α-Spinasterol from *Amaranthus spinosus* stem. *Bol. Latinoam. Caribe Plant. Med. Aromat.* **12**, 15-17.

Das, G., Kim, D-Y., Fan, C.,Gutie´ rrez-Grijalva, E.P., Heredia, J.B., Nissapatorn, V., Mitsuwan, W., Pereira, M.L., Nawaz, M., Siyadatpanah, A., Norouzi, R., Sawicka, B., Shin, H-S., Patra, J.K. 2020. Plants of the genus *Terminalia*: An insight on its biological potentials, pre-clinical and clinical studies. *Front. Pharmacol.* **11**, 561248.

Fahmy, N.M., Al-Sayed, E., Singab, A.N. 2015. Genus *Terminalia*: A phytochemical and biological review. *Med. Aromat. Plants* **4**, 218.

Han, Q., Song, J., Qiao, C., Wong, L., Xu, H. 2006. Preparative isolation of hydrolysable tannins chebulagic acid and chebulinic acid from *Terminalia chebula* by high-speed counter-current chromatography. *J. Sep. Sci*. **29**, 1653-1657.

Hussain, M.M. 2018. A short review on phytoconstituents from the genera *Albizzia* and *Erythrina*. *Bangladesh Pharm. J*. **21**, 160-172.

Hussain, M.M. 2019a. A mini review on the chemical compounds of the genus *Acacia. Bangladesh Pharm. J*. **22**, 235-242.

Hussain, M.M. 2019b. A comprehensive review on the phytoconstituents from six species of the genus *Amaranthus*. *Bangladesh Pharm. J*. **22**, 117-124.

Hussain, M.M. 2020. A further comprehensive review on the phytoconstituents from the genus *Erythrina*. *Bangladesh Pharm. J*. **23**, 65-77.

Hussain, M.M., Dastagir, M.G., Billah, A.H.M.M., Ismail, M. 2011. Alpinum isoflavone from *Erythrina stricta* Roxb. *Bol. Latinoam. Caribe Plant. Med. Aromat.* **10**, 88-90.

Hussain, M.M., Mughal, M.M.R., Alam, M.M., Dastagir, M.G., Billah, A.H.M.M. Ismail, M. 2010. Antimicrobial activity of *n*-hexane and Ethyl acetate extracts of *Erythrina stricta* Roxb. *Bangladesh J. Microbiol.* **27**, 65-66.

Hussain, M.M., Rahman, M.S., Jabbar, A., Rashid, M. A. 2008. Phytochemical and biological investigation of *Albizzia lebbek* Benth. *Bol. Latinoam. Caribe Plant. Med. Aromat*. **7**, 273-278.

Hussain, M.M., Tahia, F., Rashid, M.A. 2016. Secondary metabolites from some species of *Albizzia*: A review. *Bangladesh Pharm. J.* **19**, 1-8.

Hussain, M.M., Tuhin, M.T.H., Akter, F., Rashid, M.A. 2016. Constituents of *Erythrina*-a potential source of secondary metabolites: A review. *Bangladesh Pharm. J.* **19**, 237-253.

Ismail, M., Hussain, M.M., Dastagir, M.G., Billah, M., Quader, A. 2010. Phytochemical and antimicrobial investigation of *Luffa cylindrical*. *Bol. Latinoam. Caribe Plant. Med. Aromat.* **9**, 327-332.

Lee, D.Y., Yang. H., Kim, H.W., Sung, S.H. 2017. New polyhydroxytriterpenoid derivatives from fruits of *Terminalia chebula* Retz and their α-glucosidase and α-amylase inhibitory activity. *Bioorg. Med. Chem. Lett.* **27**, 34-39.

Lee, H–S., Jung, S–H., Yun, B-S., Lee, K-W. Lee. 2007. Isolation of chebulic acid from *Terminalia chebula* Retz. and its antioxidant effect in isolated rat hepatocytes. *Archives Toxicol*. **81**, 211-218.

Madikizela, B., Aderogba, M.A., Finnie, J.F., Staden, J.V. 2014. Isolation and characterization of antimicrobial compounds from *Terminalia phanerophlebia* Engl. & Diels leaf extracts. *J. Ethnopharmacol*. **156**, 228-234.

Mahajan, A., Pai, N. 2010. Simultaneous isolation and identification of phytoconstituents from *Terminalia chebula* by preparative chromatography. *J. Chem. Pharm. Res*. **2**, 97-103.

Muhit, M.A., Umehara, K., Noguchi, H. 2016. Five furofuranone lignan glucosides from *Terminalia citrina* inhibit in vitro E2-enhanced breast cancer cell proliferation. *Fitoterapia* **113**, 74-79.

Saleem, A., Husheem, M., Härkönen, P., Pihlaja, K. 2002. Inhibition of cancer cell growth by crude extract and the phenolics of *Terminalia chebula* Retz fruit. *J. Ethnopharmacol*. **81**, 327-336.

Tewaril, D., Mocan, A., Parvanov, E.D., Sah, A.N., Nabavi, S.M., Huminiecki, L., Ma, Z. F., Lee, Y.Y., Czuk, J.O.H., Atanasov, A.G. 2017. Ethnopharmacological approaches for therapy of jaundice: Part II. Highly used plant species from *Acanthaceae*, *Euphorbiaceae*, *Asteraceae*, *Combretaceae*, and *Fabaceae* Families. *Frontiers Pharmacol*. **8**, 519.

Toumy, S.A.A.E., Rauwald, H.W. 2003. Two new allagic acid rhamnosides from *Punica granatum* heart wood. *Planta Med*. **69**, 682-684.

Varghesea, A., Savaib, J., Panditac, N., Gaudda, R. 2015. In vitro modulatory effects of *Terminalia arjuna*, arjunic acid, arjunetin, and arjungenin on CYP3A4, CYP2D6 and CYP2C9 enzyme activity in human liver microsomes. *Toxicol. Reports* **2**, 806-816.

Wang, W., Ali, Z., Shen, Y., Li, X–C., Khan, I.A. 2010. Ursane triterpenoids from the bark of *Terminalia arjuna*. *Fitoterapia*. **81**, 480-484.