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A Comprehensive Review on the Phytoconstituents from Six Species of the Genus *Amaranthus*

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Abstract

The objective of this review is to consider the phytoconstituents from six species under the genus *Amaranthus* (*A. retroflexus*, *A. spinosus*, *A. viridis*, *A. caudatus*, *A. hypocondriacus* and *A. tricolor*). A total of sixty five (**1-65**) phytoconstituents with chemical structures have been reported in this study. *A. retroflexus* consists of high number of reported phytoconstituents.

Key words: *Amaranthus*, Sesquiterpenes, Glucosides, Prenylpropanoids, Phenolics, Triterpnoids, Saponins, Fatty acids, Flavonoids.

Introduction

Environment is a major source of medicinal plants and these plants are using as conformist moieties for the treatment of a variety of diseases from numerous years (Hussain 2018, Hussain *et al*. 2016a, 2016b).These medicinal plants are carrying out curative characteristics (anti-inflammatory, anti-cancer, anti-microbial, anti-oxidant, and anti-plasmodial action) and used as traditional medicine for the treatment of various diseases (Hussain *et al*., 2011, 2010, 2008; Billa *et al*., 2013, Ismail *et al*., 2010). *Amaranthus* is a combination genus of perennial plant (annual and short lived). A small number of *Amaranthus* species have been cultivated as ornamental plants, pseudocereals, and leafy vegetables. A total 60 species are belonging under this genus. *Amaranthus retroflexus* (Family: Amaranthaceae) is an erect and annual flowering herb native to tropical continents with height in 3 m and leaves 15 cm. *A. spinosus* (Spiny amaranth, Family: Amaranthaceae) is a plant used for jaundice and diuretic as traditional medicine. *A. viridis* (Green amaranth) is also an annual herb having light green stem with height 60-80 cm. *A. caudatus* is a flowering plant (Height: 3-8 ft) and can grow everywhere. *A. hypochondriacus* is an ornamental plant endemic to Mexico and used as a source of food. *A. tricolor* (Family: Amaranthaceae) is an annual flowering plant (Height: 2-3 ft) having rich purple flowers native to Bangladesh and used as a leafy vegetables.

Phytoconstituents: A total six species under the genus *Amaranthus* have been studied in this review and sixty five (**1-65**) molecules were reported as phytoconstituents (Figures 1-10). The reviewed medicinal plants are *Amaranthus retroflexus*, *A. spinosus*, *A. viridis*, *A. caudatus*, *A. hypocondriacus*, and *A. tricolor*.

Sesquiterpenes: Four sesquiterpenes having anti-oxidant properties were isolated from the medicinal plant *A. retroflexus* for example Amarantholidols A (**1**), Amarantholidols B (**2**), Amarantholidols C (**3**) and Amarantholidols D (**4**) (Figure 1) (Pacificao *et al*. 2008).

Glucosides: A bunch of sesquiterpenes glucosides such as Amarantholidoside I (**5**), Amarantholidoside II (**6**), Amarantholidoside II (**7**), Amarantholidoside IV (**8**), Amarantholidoside V (**9**), Amarantholidoside VI (**10**), Amarantholidoside VII (**11**) have been reported from the *A. retroflexus* (Figure 2) (Fiorentino *et al*., 2006).

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Prenylpropanoids: A few prenylpropanoids were also isolated with chemical structures solved from the species *A. retroflexus* under this genus like Ferulic acid (**12**), Umbelliferone (**13**), Apigenin (**14**), Boropinic acid (**15**), 4-Geranyloxyferulic acid (**16**), 7-Isopentenyloxycoumarin (**17**), Auraptene (**18**), and Umbelliprenin (**19**) (Figure 3) (Fiorito *et al*., 2017; Touati *et al*., 2009; Okuyama *et al*., 2016).

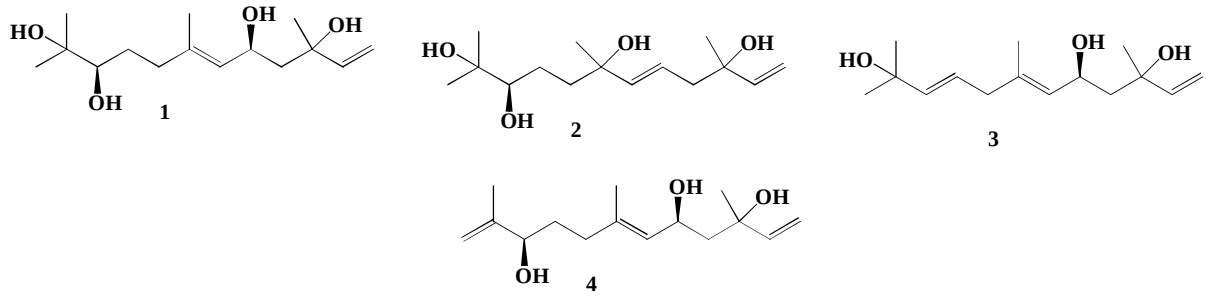


Figure 1. Sesquiterpenes from *A. retroflexus.*

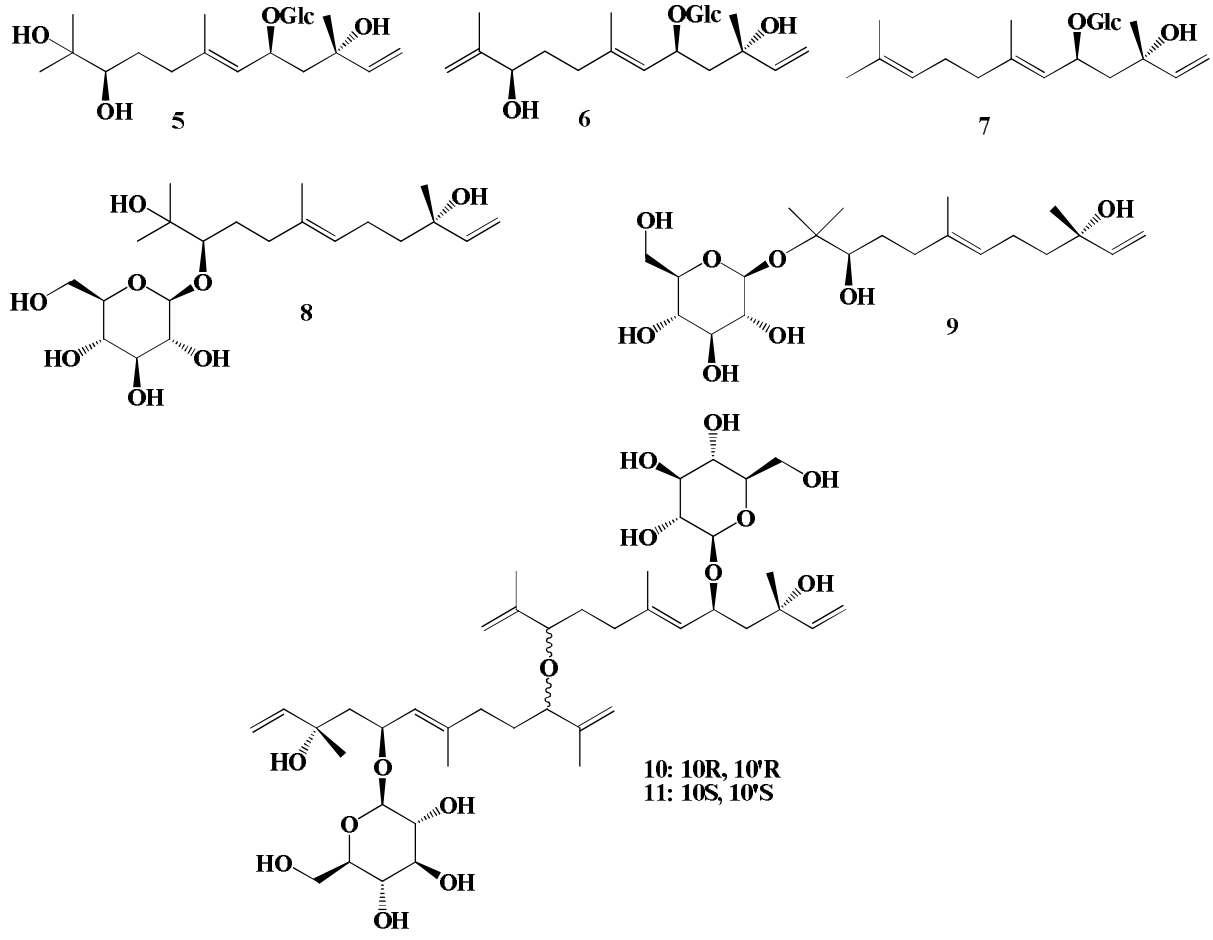


Figure 2. Glucosides from *A.retroflexus.*

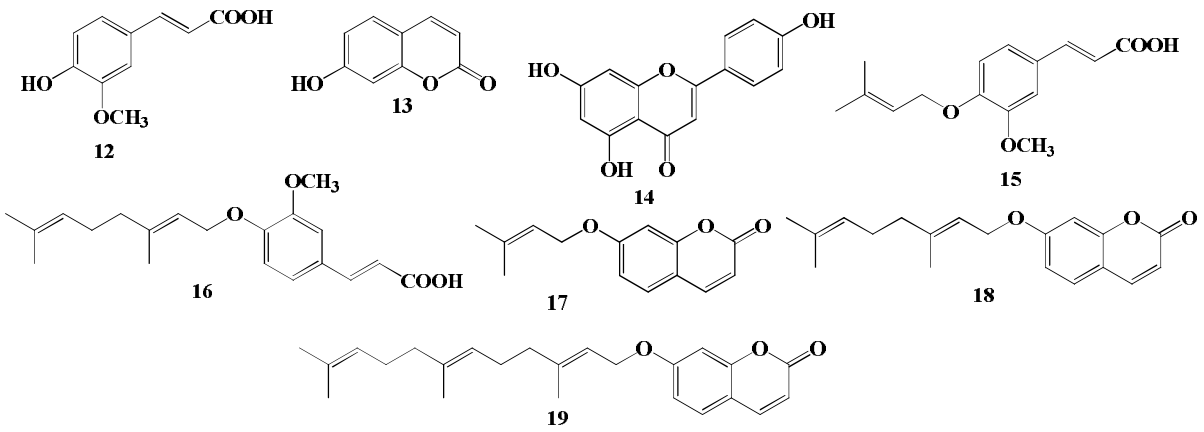


Figure 3. Prenylpropanoids from *A. retroflexus.*

Phenolic compounds: Two phenolic compounds such as Amaranthine (**20**) and Isoamaranthine (**21**) bearing anti-malarial activities are known from the medicinal plant *A. spinosus* (Figure 4) (Hilou *et al*. 2006; Stintzing *et al*. 2004).

Steroidal molecules: A group of steroidal molecules consist of anti-microbial functions have been found from *A. viridis* for example, Triacontanol (**22**), Palmitic acid (**23**), Spinasterol (**24**), Cycloeucalenol (**25**), Cholesterol (**26**), Oleanolic acid (**27**), 3,4-seco-olean-12-en-4-ol-3,28-dicarboxylic acid (**28**), Squalene (**29**), Trilonolein (**30**), Polyprenol (**31**), and Phytol (**32**) (Figure 5) (Hue *et al*., 2017, Ragasa *et al*., 2015; Naeem *et al*., 2012; Filho *et al*., 2007; Hoa *et al*., 2014; Xia *et al*., 2011; Rao *et al*., 1998; Basyuni *et al*., 2017; Santos *et al*., 2013).

Triterpnoids saponins and glycosides: A lot of triterpnoid saponins and glycosides for example 3-*O*-α-L-Arabinopyrano-syl-(1→2)-[β-D-glucopyranosyl-1→6]-β-D-2β,3β,6β,23-tetrahydroxy-olean-12-en-28-oic acid-28-*O*-β-D-glucopyranoside (**33**), 3-*O*-β-D-Arabinopyranosyl-(1→6)-β-D-glucopyranosyl-2β,3β,6β,23-tetrahy-droxyolean-12-en-28-oic acid-28-*O*-β-D-glucopyranoside (**34**), 3-*O*-β-D-Glucopyranosyl-2β,3β-dihydroxy-30-noroleane-12,20(29)-diene-23,28-dioic acid 28-*O*-β-D-glucopyranosyl ester (**35**), 2β,3β-Dihydroxy-30-noroleane-12,20(29)-diene-23,28-dioic acid 28-*O*-β-D-glucopyranosyl ester (**36**), Oleanolic acid 3-O-β-D-glucopyranosyl-28-O-β-D-glucopyranoside (**37**), 2β-Hydroxyoleanolic acid 3-*O*-β-D-glucopyranosyl-28-*O*-β-D-glucopyranoside (**38**),3-*O*-β-D-glucopyranosyl-2β,3β-dihydroxyolean-12-ene-23,28-dioic acid 28-*O*-β-D-glucopyranosyl ester (**39**), 3,4,5-Trihydroxydehydro-α-ionol-9-*O*-α-L-rhamnopyranosyl-(1→6)-β-D-glucopyanoside (**40**), 3,4,5-Trihydroxydehydro-α-ionol-9-*O*-β-D-glucopyanoside (**41**), and 3-Oxo-4-hydroxy-β-ionyl-9-*O*-β-D-glucopyranoside (**42**) are known to occur in *A. caudatus* (Figure 6) (Rastrelli *et al*. 1998).

Saponins: A few phytochemicals such as saponins were separated from *A. hypochondriacus* such as 3-*O*-α-L-Rhamnopyranosyl-(1→3)-β-D-glucuronopyranosyl-2β,3β-dihydroxyolean-12-ene-28-oic acid 28-*O*-β-D-glucopyranosyl ester (**43**), 3-*O*-α-L-Rhamnopyranosyl-(1→3)-β-D-glucuronopyranosyl-2β,3β-dihydroxyolean-12-ene-23-al-28-oic acid 28-*O*-β-D-glucopyranosyl ester (**44**), 3-*O*-α-L-Rhamnopyranosyl-(1→3)-β-D-glucuronopyranosyl-2β,3β-dihydroxy-30-norolean-12,20(29)-dien-28-oic-acid 28-*O*-β-D-glucopyranosyl ester (**45**), 3-*O*-α-L-Rhamnopyranosyl-(1→3)-β-D-glucuronopyranosyl-2β,3β-dihydroxy-30-norolean-12, 20(29)-dien-23-al-28-oic acid 28-*O*-β-D-glucopyranosyl ester (**46**), 2β-hydroxyoleanolic acid (**47**), Aterogenic acid (**48**), Prosapogenin (**49**), Thladioside H1 (**50**), Mixture of methyl-glucoside and prosapogenin (**51**) and Ciwujianoside Cl (**52**) (Figure 7) (Kohda *et al*., 1991).

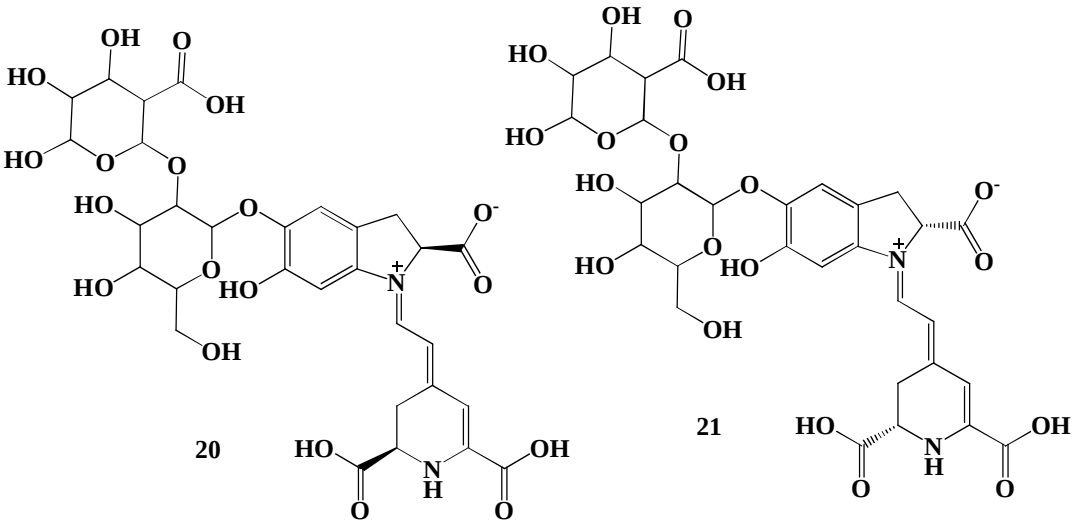


Figure 4. Phenolic compounds from *A. spinosus.*

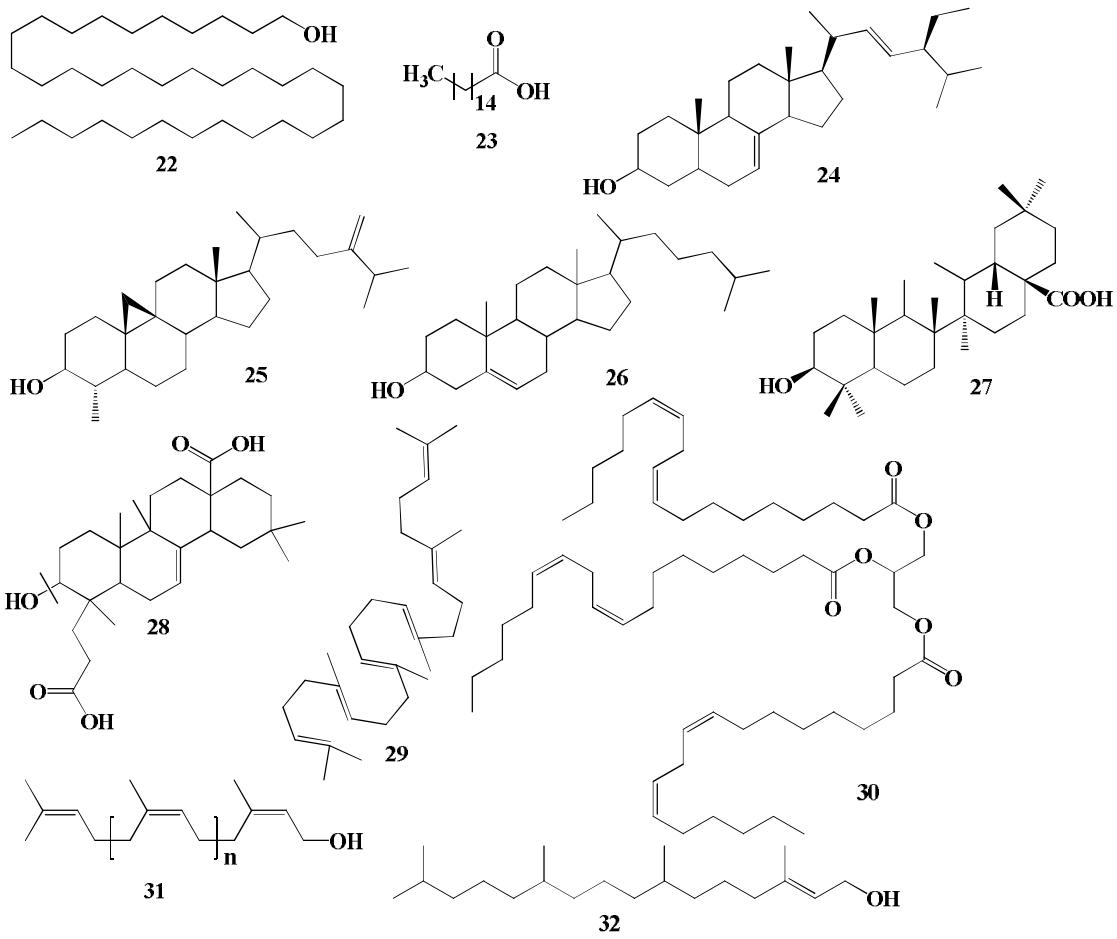
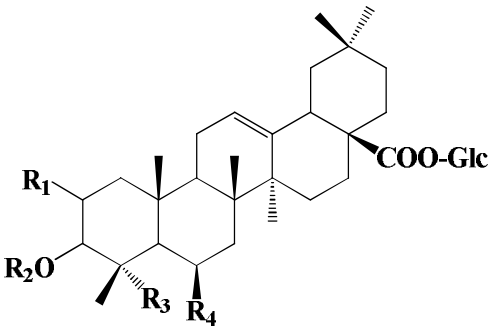
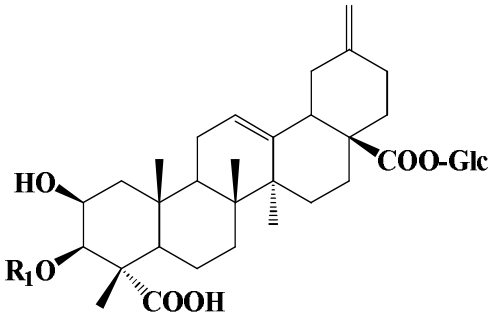


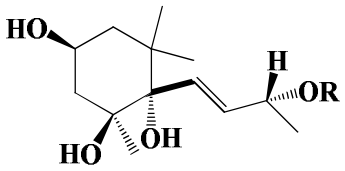
Figure 5. Steroidal compounds from *A. viridis.*

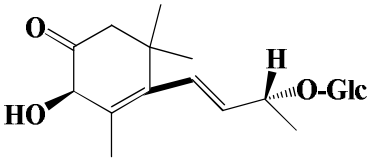




33: R_1 **= OH,** R_2 **= Glc-Ara-Glc,** R_3 **=** CH_2OH**,** R_4 **= OH**
34: R_1 **= OH,** R_2 **= Glc-Glc,** R_3 **=** CH_2OH**,** R_4 **= OH**
37: R_1 **= H,** R_2 **= Glc,** R_3 **=** CH_3**,** R_4 **= H**
38: R_1 **= OH,** R_2 **= Glc,** R_3 **=** CH_3**,** R_4 **= H**
39: R_1 **= OH,** R_2 **= Glc-Glc,** R_3 **= COOH,** R_4 **= H**

35: R_1 **= Glc**
36: R_1 **= H**

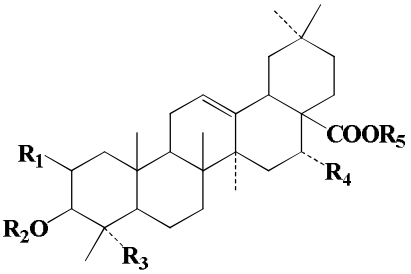


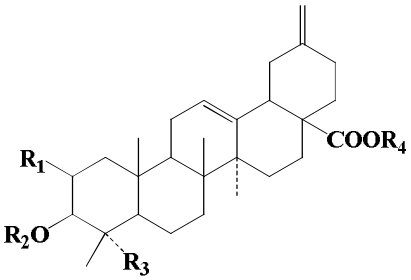


40: R = Glc-Rha
41: R = Glc

42

Figure 6. Triterpnoids saponins and glycosides from *A. caudatus.*





43: R_1 **= OH,** R_2 **= GlcUA-Rha,** R_3 **=** CH_3**,** R_4 **= H,** R_5 **= Glc**
44: R_1 **= OH,** R_2 **= GlcUA-Rha,** R_3 **= CHO,** R_4 **= H,** R_5 **= Glc**
47: R_1 **= OH,** R_2 **= H,** R_3 **=** CH_3**,** R_4 **= H,** R_5 **= H**
48: R_1 **= OH,** R_2 **= H,** R_3 **=** CH_3**,** R_4 **= OH,** R_5 **=** CH_3
49: R_1 **= OH,** R_2 **= GlcUA-Rha,** R_3 **=** CH_3**,** R_4 **= H,** R_5 **= H**
50: R_1 **= H,** R_2 **= GlcUA-Glc,** R_3 **= CHO,** R_4 **= H,** R_5 **= Xyl-Rha-Xyl-Xyl**
51: R_1 **= OH,** R_2 **= GlcUA-Rha,** R_3 **= CHO,** R_4 **= H,** R_5 **= H**

45: R_1 **= OH,** R_2 **= GlcUA-Rha,** R_3 **=** CH_3**,** R_4 **= Glc**
46: R_1 **= OH,** R_2 **= GlcUA-Rha,** R_3 **= CHO,** R_4 **= Glc**
52: R_1 **= H,** R_2 **= Ara,** R_3 **=** CH_3**,** R_4 **= Glc-Glc-Rha**

GlcUA: Beta-D-Glucuronopyranosyl
Rha: Alpha-L-Rhamnopyranosyl
Glc: Beta-D-Glucopyranosyl
Ara: Alpha-L-Arabinopyranosyl
Xyl: Beta-D-Xylopyranosyl

Figure 7. Saponins from *A. hypochondriacus.*

Fatty acids: Four fatty acids for example Linolenic acid (**53**), Lignoceric acid (**54**), Arachidic acid (**55**), and 24-Methylenecycloartenol (**56**) with were also isolated from, *A. tricolor* under this genus (Figure 8) (Fernando *et al.*, 1984; Otto *et al.* 2014).

Flavonoids: Four flavonoidal phytoconstituents like Gallic acid (**57**), Caffeic acid (**58**), Rutin (**59**), and Quercetin (**60**) were also isolated from *A. caudatus* (Figure 9) (Paranthaman *et al.*, 2012; Reckziegel *et al*., 2016; Zhao *et al.*, 2014).

Miscellaneous compounds: A few other compounds have also been isolated from *A. spinosus* such as Caffeoylquinic acid (**61**), Coumaroylquinic acid (**62**), Feruloylquinic acid (**63**), Quercetin 3-*O*-rutinoside (**64**), and Quercetin 3-*O*-glucoside (**65**) (Figure 10) (Stintzing *et al.*, 2004; Iwashina *et al.*, 2012).

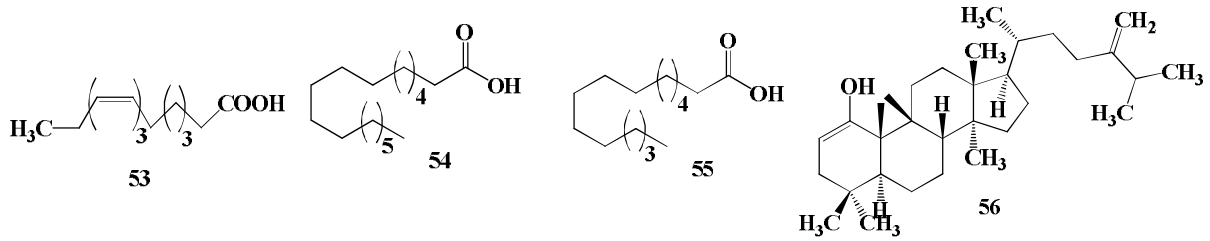


Figure 8. Fatty acids from *A. tricolor.*

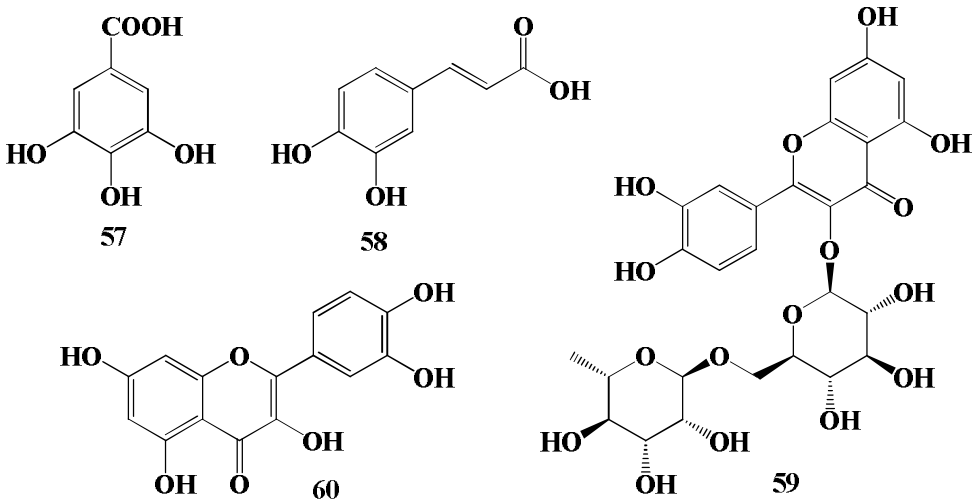


Figure 9. Flavonoids from *A. caudatus.*

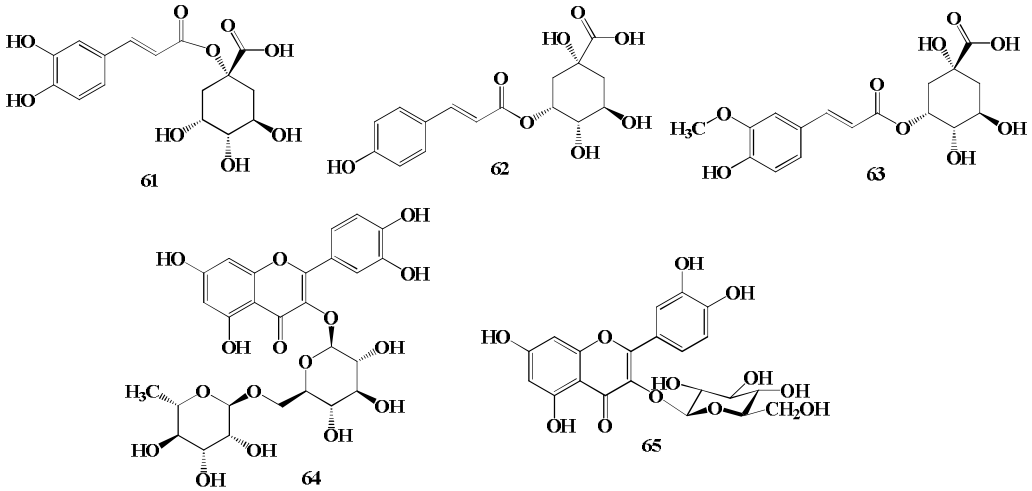


Figure 10. Miscellaneous compounds from *A. spinosus.*

Conclusion

Phytoconstituents from six species under the genus *Amaranthus* have been studied. Different molecules with structurally distinctive characteristics have been reported from these medicinal plants.

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