7.4.8. ***Amaranthus retroflexus*** L., Sp. Pl., ed. 1, 991 (1753); Boulos, Fl. Egypt 1: 132 (1999).

Common pigweed, red root pigweed

Proximate Composition, Proteins and Amino acids

The proximate composition of the common pigweed (*Amaranthus retroflexus*) was reported as follows: moisture, 8.6-11.28; lipids, 7.92-8.46; ash, 4.46; protein (N x 6.25), 19.13; starch, 33.39 (by diastase), 40.96 (by acid conversion method); reducing sugars, trace; sugars after inversion calculated as sucrose, 2.15; and crude fiber, 10.92 % (Harding and Egge, 1918). Baird and Lane (1947) reported that total ascorbic acid was highest in green leaves and decreased after flowering (780 and 450 mg/100 g dry weight respectively). On the other hand, Aliotta and Pollio (1981) started that it contained 145.73-195.78 mg/100 g vitamin C. The green leaves were found rich in carotene (Grlić, 1954).With polyacrylgel electrophoresis, the protein-bands patterns of *Amaranthus retroflexus*, *Celosia argentea* and *Celosia cristata* were used to differentiate the 3 species which are morphologically similar. *Amaranthus retroflexus* showed the most numerous protein bands (Song and Shi, 1986). The aerial parts of *Amaranthus retroflexus* contain at least 16 amino acids, including essential amino acids valine, leucine, isoleucine, threonine, methionine, lysine, phenylalanine, histidine, and arginine (Burd and Kislichenko, 2006). A 30-residue antimicrobial peptide with six cysteine residues was isolated from the seeds (Lipkin *et al*., 2005).

Digestibility values for redroot pigweed (*Amaranthus retroflexus*) seeds were 2.884 k cal digestible energy/g dry matter and 54.6 % crude protein digestibility, as determined with rats (Harrold *et al*, 1980).

Carbohydrates

Starch from *Amaranthus retroflexus* consists of a small amount of fine spherical granules and large amounts of starch chunks. The chunks were irregular in shape, not birefringent, stained well and uniformly with iodine, and resisted attack by common proteolytic enzymes. The protein content was 1% and ash, fat, and P contents were very low. Swelling was most rapid between 66 and 76^{o}C and increased but little thereafter. Solubility was 60% and swelling power 80% of the corn starch control (Goering, 1967). The properties of starch granules of *Amaranthus retroflexus* has been reported (Rao and Goering, 1970). The study of non structural carbohydrates (TNC), revealed that the main TNC in the leaves was starch. Reducing sugars were the predominant component in the stems. The most starch accumulated in leaves of the upper third of the plant; the most reducing sugars accumulated in the middle strata of the stem (Orwick and Schreiber, 1979). The amylose content of *Amaranthus retroflexus* is 34.3% (Wu and Corke, 1999). Other data of starch are shown in Tables 18 and 49. Glucose and maltose were identified in the herb (Bech, 1966).

Lipids and Volatile Constituents

Christensen and Miller (1941) reported that the seeds oil (7%) contains stearic, 1.7; palmitic, 16.9; oleic, 46; and linoleic 25 % acids. According to Stoller and Weber (1970), the fatty acids of the seed oil (6.4 %) are $C_{16:0}$, 11.8; $C_{16:1}$, 2; $C_{18:0}$, 3.4; $C_{18:1}$, 22.7; $C_{18:2}$, 58.3; and $C_{18:3}$, 1.8 %. The leaves contain high amount of linoleic acid (Conforti *et al*., 2011).

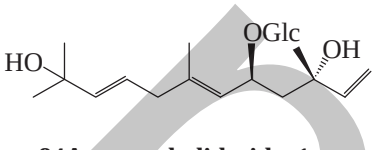
The study of the volatile constituents, released by aqueous *Amaranthus retroflexus* plant tuissue suspensions revealed that large amounts of hexanal were released immediately after preparation of blended suspensions, along with lesser amounts of other 5- and 6-oxygenatated compounds. With time, the hexanal content dropped considerably, leaving *trans*-2-hexenal as the major released volatile. Headspace examination of a vacuum steam distillate prepared from a freshly prepared tissue suspension revealed no significant composition changes with time, but major quantitative differences were noted on comparison with the tissue suspension headspace profile. The common alcohols *cis*-3-hexen-1-ol, 1-hexanol, and *trans*-2-hexen-1-ol predominated in the steam distillate profile (Flath *et al*., 1984). Several volatile organic compounds emitted from the residues of the aerial portions of *Amaranthus cruentus, Amaranthus hybridus, Amaranthus retroflexus, Amaranthus hypochondriacus, Amaranthus palmeri* and *Amaranthus spinosus* were identified and were found to possess inhibitory activity for seed germination as mentioned below (Connick *et al*., 1989). These compounds (which were the most bioactive) include 3-methyl-1-butanol, 3-hexen-1-ol, 2-heptanol, pentanal, 2-methylbutanal, 3-methyl-butanal, ethyl propionate, ethyl butyrate, ethyl isobutyrate, ethyl 2-methylbutyrate, 2-pentanone, 3-pentanone, 3-methyl-2-butanone, 2-heptanone and 2-nonaone.

Sesquiterpenes and Other Constituents

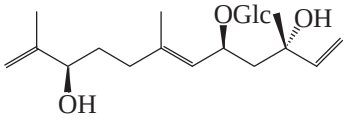
Seven sesquiterpenes with nerolidol skeleton (amarantholidols and amarantholidosides) have been isolated from *Amaranthus retroflexus* (one of the major weeds of the world). The compounds have been identified as: amarantholidols A-D and amarantholidosides I- III (**84-86**) (D'Abrosca *et al*., 2006). Four others *viz*.. amarantholidosids IV-VII (**87-88**) have been also isolated from the plant. The latter two compounds VI and VII are dimeric diasterioisomers (Fiorentino *et al*., 2006; D'Abrosca *et al*., 2006). Four sesquiterpene

glycosides were also identified from the plant. Two of the glycosides are characterized by an aglycone and differed from the site of glucosylation. The other two are dimeric diastereoisomers (**89**-**90**) (Fiorentino *et al*., 2006). The sterols identified in *Amaranthus retxoflexus* are shown in Tables 1, 2 and 56.

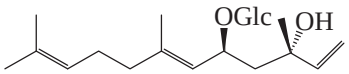
The herb of *Amaranthus retroflexus* contains rutin and another flavonoid (Bech, 1966; Kalinova and Dodakova, 2009). Fifteen phenolic acids were detected in the herb and fruits of the plant (Table 21). Choline, betaine and trigonelline were detected in roots, stems, leaves and flowering organs of the plant. At the time of flowering, choline occurs in roots, and choline and betaine in leaves and flowers (Susplugas *et al*., 1970). Glycinebetaine and trigonelline were identified in *Amaranthus retroflexus* (Table 35).



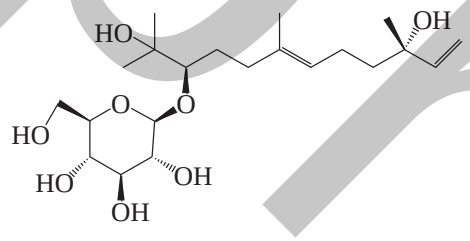
84Amarantholidoside 1



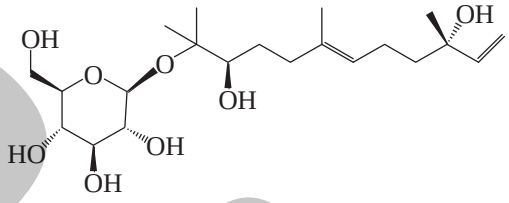
85 Amarantholidoside 11



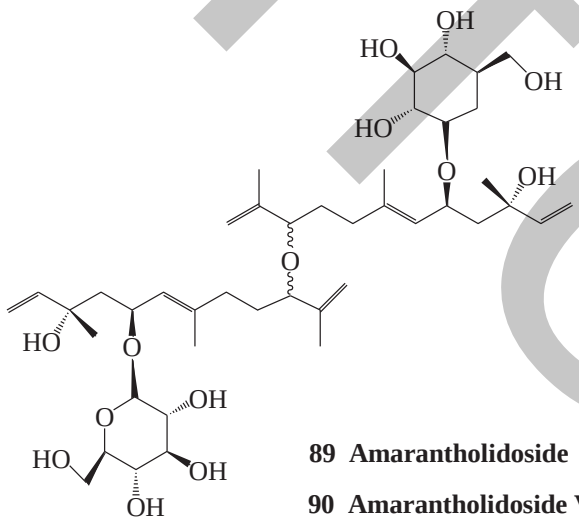
86 Amarantholidoside 111



87 Amarantholidoside IV



88 Amarantholidoside V



89 Amarantholidoside V1

90 Amarantholidoside V11

Amaranthus retroflexus contains partially toxic levels of nitrates (Brakenridge, 1956; Sund and Wright, 1959; Schink, 1961; Carlisle *et al*., 1980). The plant has been reported to contain > 1000 ppm nitrate (Sund and Wright, 1959). According to Brakenridge (1956), the plant contains approximately 6 % nitrate (as KNO_3, dry basis). Young plants contained more nitrate than fully grown plants. Nitrates are reduced to nitrites by bacteria, and not by plant enzymes. Complete reduction of 2.6 g/kg and resorption of the nitrite in a 30-kg hog causes fatal methemoglobinemia; 25 % reduction of nitrate in 1 kg of feed containing 6-7 g/kg of

KNO_3 may be dangerous (Schink, 1961). Leaves contained 12.61-30.75 % oxalic acid, 3-fold more than stems or inflorescence. Nitrate content was highly variable and ranged from 0.04 to 1.48 % (Marshall *et al*., 1967).

Amaranthus retroflexus is Fe accumulator (Chehregani *et al*., 2009) and is appropriate for phytoextraction of Cd (Motesharezadeh *et al*., 2010) and depleted uranium (Sevostianova *et al*., 2010). It can grow on petroleum contamined soil (Mohsenzade *et al*., 2009, 2010).