

5.1.2. *Alisma plantago-aquatica* L., Sp. Pl., ed. 1, 342 (1753); Boulos, Fl. Egypt 4: 2 (2005).

Constituents

The rhizomes of *Alisma plantago-aquatica* contain starch (5% in July and 45% in November), glucose, fructose, galactose, arabinose, sucrose, raffinose, and stachyose (Stich, 1957). The starch granules are small ($\leq 5\mu\text{m}$) and gave similar X-ray patterns to sweet potato starch, showed low swelling power and solubility at 70-80°C and low viscosity (Fujimoto *et al.*, 1983). The leaves of *Alisma plantago-aquatica* var. *orientalis* contain less than 10 mg% ascorbic acid (vitamin C) (Shinka and Hiraoka, 1947). The average relative abundance of leaf monosaccharides of grass plant community containing *Alisma plantago-aquatica* were arabinose 12%, xylose 13%, mannose 5%, galactose 12% and glucose 54% (Dungait *et al.*, 2008). The plant was reported to accumulate high concentration of iodine among halophytes growing in USSR (6.10 mg/kg dry mass) (Fedotov *et al.*, 1975).

The following protostane triterpenoids have been isolated from the rhizomes of *Alisma plantago-aquatica* L.: alisol A (**24**), alisol A 24- acetate, alisol B (**25**), alisol B 11- acetate, alisol B 23- acetate, 16 β -methoxyalisol B monoacetate, 16 β -hydroxyalisol B monoacetate, alisol C monoacetate, 11-deoxyalisol C, alisol D (**26**) (Fukuyama *et al.*, 1988), and alisol G (Miyamoto and Murata, 1970; Geng *et al.*, 1988a; Fukuyama *et al.*, 1988; Zhang *et al.*, 2003; Chau *et al.*, 2007; Liu *et al.*, 2007c; Adams *et al.*, 2011). Two sesquiterpenes, alismol and alismoxide have been identified from the rhizomes of *Alisma plantago-aquatica* L. var. *orientalis* (Oshima *et al.*, 1983). The lipid fraction of the rhizomes of *Alisma plantago-aquatica* var. *orientalis* yielded the following protostane triterpenes: alisol A, alisol B, alisol A monoacetate, alisol B monoacetate, epialisol A, alisol C and alisol C monoacetate (Murata *et al.*, 1968; Kamiya *et al.*, 1970; Murata and Miyamoto, 1970; Kim *et al.*, 2007).

An acylated sitosterol glucoside (sitosterol 3-O-6-stearyl- β -D-glucopyranoside) was isolated from the rhizomes of *Alisma plantago-aquatica* (Geng *et al.*, 1988b). Prinoresinol, octadeca-9,12-dienoic acid and octadeca-9,12-dienoic acid methyl ester were identified from *Alisma plantago-aquatica* L. var. *orientalis* Samueleson (Phan *et al.*, 2006).

Alisma plantago has been reported to contain a lipid containing P, choline and unsaturated fatty acid in its molecule and differed from lecithin, choline, methionine, citrovorum factor, vitamin B₁₂ or biotin (Kobayashi, 1960a).

The contents of 24-acetyl alisol A and the 23-acetyl alisol B as well as the yield of *Alisma plantago-aquatica* significantly increased in plants applied with different concentrations of S-3307. The optimal concentration of S-3307 was 80 mg/kg⁻¹ reached the best result when applied 36 days after seedlings (Liao *et al.*, 2008).

The contents of six trace elements in *Alisma plantago-aquatica* were reported (Zhang *et al.*, 2010). The plant was found efficient for removal of heavy metals (Zn, Cu and Pb) from storm water (Fritioff and Greger, 2003).

Baranenko *et al.* (1999) studied lipid peroxidation (LP) intensity and antioxidant activity

(AA) of *Alisma plantago-aquatica* L. leaves, which grew in natural environment, under the different water availability. The highest LP intensity and AA was established for the terrestrial plants in comparison with air-water ones. It was remarked that changes in levels of LP and AA depends upon the year of material collection.

Alisma plantago, growing in soil, in one case in air and in the other in water had total ash, 10.7, 31.2; P, 0.38, 0.90; K, 4.12; 5.95; Ca, 1.16, 5.73; and Mg, 0.26, 0.26 respectively (Combes *et al.*, 1952). Liu *et al.* (2007b) studied the quality change of *Alisma plantago-aquatica* (through comparing the changes of 24-acetyl alisol A and 23-acetyl alisol B and other corresponding components as well) at various growing-seedling stages, transplanting stages, and collecting stages. Total quality of the plant was the best when grow-seedling was on 25th June, transplanting on 10th September, and collecting on 22nd December in the same year.

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