Chapter 4
Alisma orientalis (Sam.) Juzep. 泽泻 (Zexie, Alismatis Rhizoma)

Min Fu and Ling Wang

4.1 Botanical Identity

Alismatis Rhizoma is the dried tuber of *Alisma orientalis* (Sam.) Juzep. of the family Alismatacea. It grows plentifully in ditches and ponds in Fujian, Jiangxi, and Sichuan provinces of China. It is collected in the winter, sliced, and dried or stir baked with salt water. Alisma is also called winter plantain tuber, Alisma Plantago Aquatica or Alisma orientale.

The word Alisma is said to be a word of Celtic origin meaning "water", a reference to the habitat in which it grows. Early botanists named it after the Plantago because of the similarity of their leaves.

Alismatis Rhizoma is a hairless plant that grows in light (sandy), medium (loamy) and heavy (clay) acid, neutral and basic (alkaline) soils and also in water but not in the shade. It consists of a fibrous root, several basal long stemmed leaves (15–30 cm), and a triangular stem (up to 1 m tall). It has branched inflorescence bearing numerous small flowers with three rounds or slightly jagged, white or pale purple petals. The flowers open in the afternoon. Alisma is in flower from June to August, and the seeds ripen from July to September. The flowers are hermaphrodite (have both male and female organs) and are pollinated by flies (Fig. 4.1).

M. Fu (✉)
McGill University, 3640 University Street, Montreal, QC H3A 2B2, Canada
e-mail: fmess@163.com

L. Wang
College of Pharmacy, Henan University of Traditional Chinese Medicine, Zhengzhou 450008, China
e-mail: 465533397@qq.com

Y. Liu et al. (eds.), *Dietary Chinese Herbs*, DOI 10.1007/978-3-211-99448-1_4

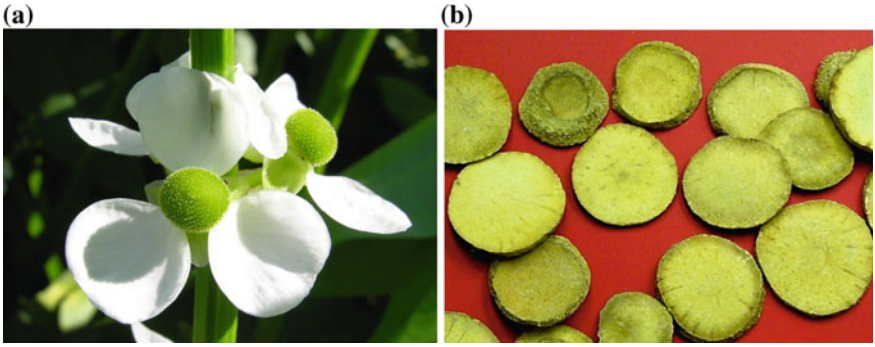

Fig. 4.1 Flowering plant (**a**) and sliced crude drug (**b**) of *A. orientalis*

4.2 Chemical Constituents

4.2.1 Triterpenoids

Triterpenoids are major and representative chemical constituents found from the rhizomes of *A. orientalis*. So far, the kind of compounds isolated from the plant include alisol A (**1**), B (**5**), C (**3**) and their monoacetates alisol A 24-acetate (**2**), alisol B 23-acetate (**6**), and alisol C 23-acetate (**4**), etc. (Fig. 4.2). Compound **2** showed the strongest activity for lowering blood lipid among these triterpenes. Compound **6** was thought to be the most important active component with the most extensive research to date [1–4].

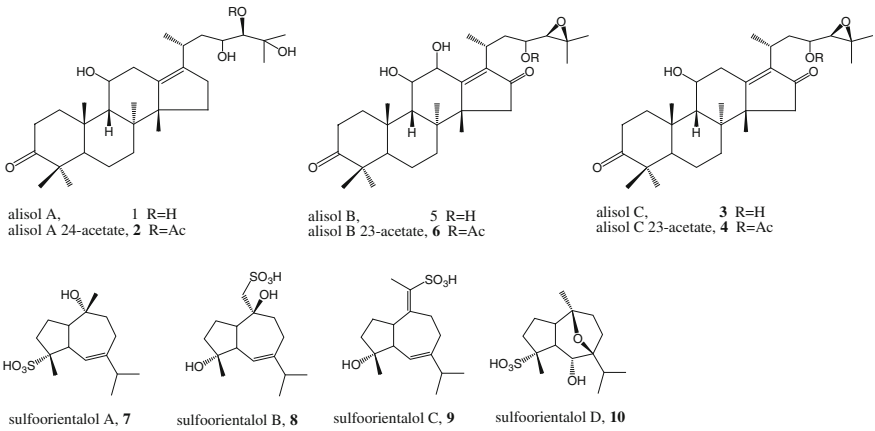

Fig. 4.2 Major triterpenoids and sesquiterpenes form *A. orientalis*

4.2.2 Sesquiterpenes

Some sesquiterpenoids reported from *A. orientalis* include sulfoorientalol A (**7**), B (**8**), C (**9**), and D (**10**), which showed the ability to inhibit the contraction of isolated bladder smooth muscle induced by carbachol [5].

4.3 Pharmacological Studies

Alismatis Rhizoma is an excellent diuretic agent, used widely for dysuria, edema, and different urological disorders, such as nephritis. It also has been used in modern practices to reduce arteriosclerosis and hyperlipemia, to improve the metabolism of fat in the liver, and to treat fatty liver, acute nephritis, swelling during pregnancy and obesity. Alisma is thought to be a good fat-reducing and anti-aging medicinal herb.

4.3.1 Diuretic Effect

Taking this herb orally by healthy people may increase the urine, sodium, and urea output. It has an obvious diuretic effect and is able to increase the excretion of urine, urea and chlorides. Its diuretic action on nephritis patients, with acute or chronic kidney inflammation, is more notable [6, 7].

4.3.2 Inhibition of Kidney Stones

The active constituents of *A. orientalis* can down-regulate the bikunin mRNA expression, decrease the calcium oxalate formation in rat kidney, and inhibit the renal stone formation in rat urolithiasis model [8]. In experiments on hamsters, the water decoction of this herb significantly lowers the renal calcium content and decreases calcium oxalate crystal formation in the renal tubule, thereby inhibiting the formation of kidney stones [9].

4.3.3 Improvement of the Cardiovascular System

This herb has hypotensive, anti-atherosclerosis, blood-sugar-reducing and lipotrophic effects. In experiments on hamsters, it significantly lowers the levels of total cholesterol and LDL-cholesterol in the serum, inhibits blood platelet aggregation

and thrombosis, and enhances fibrinolysin activity [10]. In addition, an alcohol-based extract of the herb increases isolated rabbit heart's coronary artery blood flow volume, has a slight inhibitory effect on miocardia, but does not affect the heartrate. The triterpenes, alisol M 23-acetate and alisol A 23-acetate, were isolated from *A. orientalis* and found against the Farnesoid X receptor (FXR), which is a member of nuclear receptor superfamily and viewed as one of the essential target proteins to develop antidiabetic treatments. *A. orientalis* might exert anti-hyperglycemic effect through the FXR pathway [11].

4.3.4 Enhancing Immunity and Anti-inflammation

17 beta-epoxy alisol A, alisol B 23-acetate and alisol A 24-acetate have shown immunosuppressive functions [12]. Administered to mice at the dosages of 10 and 20 g/kg, the water decoction of this herb slows down carbon clearance, and inhibits 2, 4-chloronitrobenzene-induced contact dermatitis [12, 13].

4.3.5 Lipotropic Effect

The lipid-soluble fraction has distinct anti-cholesterolemic and anti-atherosclerotic effects. It also decreased hepatic lipids in rabbits fed with a high-cholesterol and high-fat diet, indicating that the herb has lipotropic effect. The herb also exhibited a significant therapeutic effect on high fat feed-induced fatty liver due to a low-protein diet and those with liver damage due to carbon tetrachloride [14]. Administration with *A. orientalis* methanol extract 150, 300, and 600 mg/kg markedly decreased the serum and liver lipids; the high level of fasting serum glucose was reduced and insulin resistance was improved. The *A. orientalis* methanol extract treatment is helpful in preventing the oxidative stress by lessening lipid peroxidation and activating antioxidant enzymes [15, 16].

4.3.6 Promoting Weight Loss

Administering raw herb decoction (20 g/kg) to sodium glutamate-fattened hamsters lowers their Lee index, fat indices, and serum nitroglycerine content. Modern research proved that it lowers blood pressure, blood cholesterol and blood sugar. According to these properties, it not only could be used for weight loss and boosting fat loss, but it also may be good for treatment of other disease related with fat, such as diabetes, hypertension or high blood pressure, and high blood cholesterol. Therefore, Alismatis Rhizoma is a valuable remedy for weight loss [17].

4.3.7 Digestive Disorders

Dried stem bases to be, eaten, or grated and taken with water are effective in treating digestive disorders such as heartburn, cramps and stomach flu. The investigation of this herbal medicine also showed improvement in intestinal permeability and protection from alcohol-induced liver injury and intestine damage. Markers of the liver injury, aminotransferase abnormalities and hepatomegaly were improved and morphological changes, such as liver steatosis, mixed inflammation, and collagen deposition were lessened in rats treated with *A. orientalis* methanol extract 150, 300 and 600 mg/kg [15].

4.3.8 Anti-migration Activity

A fluorescence imaging based assay for screening compounds with anti-migration activity indicated one component with anti-migration activity which suggests a new proposed. The new proposed method with good precision, stability and linear range showed to analyze the inhibitory activity of anticancer compounds [18].

4.3.9 Other Pharmacological Activities

The powdered seed is an astringent used in cases of bleeding. This herb can also inhibit *Staphylococcus aureus*, *Diplococcus pneumoniae* and *Mycobacterium tuberculosis* [14]. The whole plant is also shown to promote conception.

Alismatis Rhizoma has been found to exert the effect of hypoglycemic activities and metabolism combined with other herbal medicines [19, 20].

4.4 TCM Applications and Dietary Usage

Alismatis Rhizoma has been thought of as a cure for rabies, though this has not been substantiated. This drug is sweet and tasteless in flavor and has the effects of excreting dampness. It has the effect of inducing diuresis similar to poria and can be used for various syndromes of water and dampness retention. This drug is cold in property and can expel heat in the kidney and urinary bladder, so it is very suitable for expelling heat in the Xia-jiao (lower part of body).

To treat edema, dysuria (difficult or painful discharge of urine), diarrhea, strangury (slow and painful spasmodic discharge of urine), leucorrhea, fluid retention syndromes, etc.:

(a) Edema and other syndromes due to damp-heat in the abdomen: This herb is often used together with such herbs as poria and umbellate pore fungus (*Polyporus umbellatus*), known as Umbellate Pore-fungus Decoction (Zhuling Tang), tuckahoe (*Poria cocos*), Job's tears (Semen Coicis), etc.
(b) Vertigo due to phlegm retention: This herb can be used in combination with large white head atractylodes rhizome (Rhizoma Atractylodis Macrocephalae), known as Oriental Water Plantain Decoction (Zexie Tang).

4.5 Side Effects and Toxicity

Therapeutic doses of *A. orientalis* are safe to use. One case of an allergic skin rash was reported in more than 200 cases of hyperlipidemia patients using the herb. Uncomfortable digestive disorders were also reported in a few cases of long-term use. The intravenous and intraperitoneal LD_{50} values of the methanolic extract of the rhizome in mice were 0.98 and 1.27 g/kg, respectively. No details occurred at an oral dose of 4 g/kg. No toxic effects were observed in rats fed with a diet containing the herb for two and a half month. However, it may have serious side effects or even toxic effects such as hepatotoxicity. (a) Do not use in case of damp cold or spermatorrhea or leucorrhagia as a result of kidney yang deficiency; (b) Do not use the herb in new borns, children, or pregnant or breast feeding women without first consulting a specialist.

References

1. Li (2012) Studies on active components in *Nauclea* officinalis and *Alisma orientalis*. Doctoral Thesis. Zhejiang University
2. Yoshikawa et al (1993) Crude drugs from aquatic plants. I. On the constituents of Alismatis Rhizoma. Chem Pharm Bull 41(11):1948–1954
3. Yoshikawa et al (1999) Sudies on Alismatis Rhizoma. III. Stereostructures of new protostane-type triterpenes, Alisos H, I, J-23-acetate, K-23-acetate, M-23-acetate, and N-23-acetate, from the dride rhizome of *Alisma Orientale*. Chem Pharm Bull 47(5):524–528
4. Chen et al (2001) Effect of alisol B acetate, a plant triterpene, on apoptosis in vascular smooth muscle cells and lymphocytes. Eur J Pharmacol 419(2–3):127–138
5. Yoshikawa et al (1993) Sulfoorientalols A, B, C, and D, four new biologically active sesquiterpenes from Alismatis Rhizoma. Chem Pharm Bull 41(6):1194–1196
6. Feng et al (2014) Diuretic and anti-diuretic activities of the ethanol and aqueous extracts of Alismatis rhizoma. J Ethnopharmacol 154(2):386–390
7. Satoh et al (1991) The effects of crude drugs using diuretic on horse kidney (Na++ K+)-adenosine triphosphatase. Yakugaku Zasshi 111(2):138–145
8. Cao et al (2004) The effects of the active constituents of *Alisma orientalis* on renal stone formation and bikunin expression in rat urolithiasis model. Zhonghua Xue Yixue Zazhi 84 (15):1276–1279

9. Cao et al (2003) An experimental study of effect of different extracts of *Alisma orientalis* on urinary calcium oxalate stones formation in rats. Chin J Chin Mater Med 28(11):1072–1075
10. Yang et al (1998) Effects of rhizome alismatis extract on blood glucose in normal and diabetes. Pharmacol Clin Chin Mater Medica 14:29–30
11. Lin et al (2012) Triterpenes from *Alisma orientalis* act as farnesoid X receptor agonists. Bioorg Med Chem Lett 22(14):4787–4792
12. Zhang et al (2009) Chemical constituents of *Alisma orientalis* and their immunosuppressive function. Chin J Chin Mater Med 34(8):994–998
13. Yin et al (2001) Advances in studies on immunoregulation of *Alisma orientalis* and its active constituents. Chin Tradit Herbal Drugs 32:1132–1133
14. Zhou et al (1997) Review on the chemistry and pharmacology property of Rhizoma Alismatis. Zhong Cao Yao (Chin Tradit and Herbal Drugs) 28:125–127
15. Hong et al (2006) Protective effects of the *Alisma orientalis* extract on the experimental nonalcoholic fatty liver disease. J Pharm Pharmacol 58(10):1391–1398
16. Xie et al (2012) Emerging approaches of traditional Chinese medicine formulas for the treatment of hyperlipidemia. J Ethnopharmacol 140(2):345–367
17. Zhou et al (1995) Effect of wu lin powder and its ingredients on atrial natriuretic factor level in mice. J Chin Integr Med 15(1):36–37
18. Fong et al (2007) Reversal of multidrug resistance in cancer cells by Rhizoma Alismatis extract. Phytomedicine 14(2–3):160–165
19. Fu et al (2011) Analysis of major herbs in Chinese herbal formula Jianpi Huoxue Decoction for improving intestinal permeability based on uniform design). Zhongxiyi Jiehe Xuebao 9(11):1234–1241
20. Li et al (2012) Study on the hypoglycemic activities and metabolism of alcohol extract of Alismatis Rhizoma. Fitoterapia 83(6):1046–1053