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Review

Nutriology, pharmacology and cardiovascular effects of common wild vegetables

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Summary. The wild vegetables are praised for their nutritional, health care and even medical values. Preliminary wild vegetable dishes, health care products have been developed and popular with people. However, the systematic analyses of the common wild vegetables are scanty, and in particular, the toxicological studies are neglected in some extent during the utilization of these plants. In this article, the nutritional, health care and even medical values of several common wild vegetables are reviewed. The results suggested that they are more nutritional than the common cultivated vegetables, and that the cardiovascular effects are usually attributable to their anti-oxidant properties. With regard to the dietary safety, toxicological studies have to be continued as well.

Key words: cardiovascular agents, edible plants, health care surveys

Introduction

There are about 600 species of wild vegetables in China, and 200 of them are usually picked for food. Wild vegetables more often grow in the wild environment of fresh air, rich water, and fertile soils, and thus making them with high nutritional values (1). Wild vegetables are characterized by its naturally pure and nutrient-rich properties and become a hot spot for further exploitations and development due to their potential social and economic benefits (2). Wild vegetables contain essential proteins, sugars, inorganic salts and dietary fibers, and therefore with nutritional values much higher than the cultivated vegetables. In some species, proteins, carotenes, vitamins, minerals and amino acids as well as other contents of individual wild vegetables can be several to even a hundred times higher than in the cultivated vegetables. Especially the anti-bacterial effects attributable to the large numbers of active groups that certain wild vegetables have are unmatched by the cultivated ones, thereby killing pathogenic bacteria and viruses, eliminating toxins, and being adjutants for the treatment of certain infective diseases (1). However, the detailed descriptions of the common wild vegetables are scanty. In this article, nutritional and pharmaceutical characteristics of the common wild vegetables in Northern China are described.

Ixeris chinensis

Morphological Features

Ixeris chinensis (Latin name: *Ixeris chinensis (Thunb) Nakai*) is a perennial herb of *Ixeris Cass.*, *Compositae*. It is bitter in taste and cold in nature. It contains milk. The plant is 10-40 cm high. The blades are glabrous. The stems are erect, glabrous, and branching in the upper part. The basal leaves are obovate lanceolate, or a spoon-shaped, 5-10 cm long and 2-4 cm wide. The apexes are blunt. The edges are in plume splitting; whereas some-

times piano-shaped pinnately splitting margin can be seen. Meanwhile, there are irregular sharp serrations on the edges. The cauline leaves are sessile, and are auricular shaped at base. The capitulum can be about 5 mm long, and merge into verticillasters in most occasions. The corollas are 6-8 mm long, tongue-shaped, yellow. The flower tongues are 4-6 mm long with 5 teeth. The achenes are in dark brown when mature. The pappi are white (Fig. 1A). The flowering period is from July to September. Often do they grow in mountain slopes, forest margins and shrubs as well as roadsides. It is very widely distributed throughout China except for Ningxia, Qinghai, Xinjiang, Tibet, Guangdong and Hainan. It is also distributed in the Soviet Union, Mongolia, Korea and Japan. Its tender roots, stems and leaves are edible, and country folks pick up the seedling and fresh leaves for food. The whole plant (crude drug name: *Patrinia*), rhizomes and roots are for medicinal use, for clearing away *heat* and toxins, evacuating pus for detumescence, activating blood circulation and removing blood stasis.

Nutriology

Ixeris chinensis has a high nutritional value. It contains proteins 1.8 g, sugars 4.0 g, food fibers 5.8 g, calcium 120 mg, phosphate 52 mg and trace elements, such as zinc, copper, iron and manganese, *etc.*, and vitamins B_1, B_2 and C, carotenes and nicotinic acids per 100 g fresh *Ixeris chinensis* plants. Besides, it also contains some chemical substances, such as mannitol, dandelion, hexacosanol, choline, tartaric acid and limonin, *etc*. The contents of vitamin C and carotenes are very rich in *Ixeris chinensis*, 2.1 and 2.3-folds of those in spinach. The nutritional contents of the young seedlings are even more abundant with proteins 1.8 g, fats 0.5 g, food fibers 5.4 g, sugars 4.6 g, carotenes 540 g, vitamin B_1 0.09 mg, vitamin B_2 0.11 mg, vitamin C 19 mg, vitamin E 2.93 mg, vitamin PP 0.6 mg, potassium 180 mg, calcium 66 mg, iron 9.4 mg, zinc 0.86 mg, and phosphate 41 mg per 100 g young seedlings. It also contains 17 kinds of amino acids, with arginine, histidine, and glutamic acid being the most amino acids contained, accounting for 43% of the total amount of all amino acids (3,4).

The tender roots, stems and leaves harvested in Spring can be delicious when they are eaten as raw, with sauce, fried, or made into soup, stuffing, or porridge. The roots can also be pickled for food. There are some dishes of *Ixeris chinensis*, such as *Ixeris chinensis* with sauce, fried pork slices with *Ixeris chinensis* and fried pork livers with *Ixeris chinensis*, *etc*. (5).

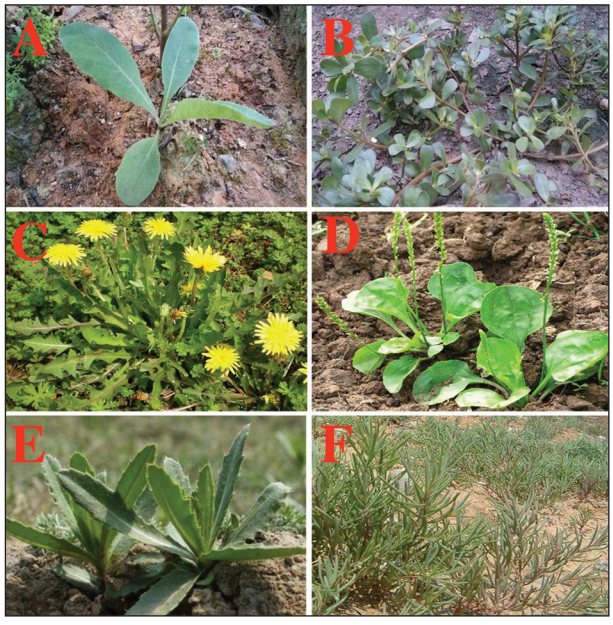

Figure 1. Morphological features of the common wild vegetables: (A) *Ixeris chinensis*; (B) purslane; (C) dandelion; (D) plantain; (E) *Cirsii Herba*; and (F) *Suaeda salsa.*

Product development

Newly developed food products of *Ixeris chinensis* include tea, beverage, can, mesh, and lyophilized powder, *etc*. (3).

Pharmocology

Modern medical research revealed that *Ixeris chinensis* has a strong inhibitory effect on *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Escherichia coli*, an inhibitory effect on leukemia cells, and causes obvious damage to sarcoma cells. The triterpenoids, sterol, sesquiterpene, and flavonoids that *Ixeris chinensis* contains ensure multiple pharmacological activities, like antitumor, anti-allergy, anti-leukemia, and hepato- and cerebroprotective effects (6).

Experimental studies demonstrated that the extract of *Ixeris chinensis* could ameliorate carbon tetrachloride-induced degeneration and necrosis of liver cells in mice, by way of a significant decrease of aspartate aminotransferase and malondialdehyde (MDA) (7,8).

The extract of *Ixeris chinensis* could result in significantly decreased contents of nitric oxide, interleukin-1, tumor necrosis factor-α and a decreased activity of nitric oxide synthase of the exudates from the inflamed rat paws (9).

Further studies revealed that the alcohol extract of *Ixeris chinensis* could obviously prolong the thrombosis time and decrease blood viscosity and extent of auricular swelling induced by dimethylbenzene (10). The extract of *Ixeris chinensis* (5, 10 and 20 g/kg) could lengthen evidently the bleeding time and coagulation time of rabbit and mice compared to those of the control group (11).

Cardiovascular effects

Ixeris chinensis could decrease the content of MDA of homogenates of rat liver, heart, kidney and brain *in vitro*. *Ixeris chinensis* could decrease evidently MDA in all rat tissues *in vivo* (12). *Ixeris chinensis* flavonoids could remarkably decrease brain capillary permeability and the content of MDA, increase the activity of superoxide dismutase (SOD) in the brain tissue of cerebral ischemia and anoxia mice (13). In the rat myocardial ischemia-reperfusion model, management with total flavonoids of *Ixeris chinensis* was associated with a significant lower serum lactate dehydrogenase (LDH), MDA and myeloperoxidase levels in comparison to those of the control (14). Extract of *Ixeris chinensis* roots, either large, medium, or small doses, remarkably increased the urine contents of the rat and mice, and remarkably increased the urine content of rabbit, and significantly enhanced the natrium and chlorine ion concentrations in the urine of rats; whereas functions of *Ixeris chinensis* leaves were very weak. At a dosage of 50 mg/kg of extract of the stem and leaf of *Ixeris chinensis* could hoist briefly blood pressure; however, at a dose of ≥100 mg/kg, it declined briefly blood pressure (15).

Purslane

Morphological features

Purslane (Latin name: *Portulaca oleracea L.*) is an annual herb of *Portulacaceae*, *Portulaca L.* It is cold in property, sweet and sour in flavor. The whole plant is glabrous. The stem is usually in a supine position, growing crawling on the ground. The branches are pale green or reddish. The leaves are in an arrangement of an alternate phyllotaxis. The blades are flat, fleshy, dentate-like, dark green on top, and pale green or dark red at bottom. The petioles are thick and short. The flowers are sessile, and blooms in full at noon. The bracts are leaflike, and the sepals are green and helmet-shaped. The petals are yellow and obovate. The anthers of the stamens are yellow. The ovaries are glabrous. The capsules are ovoid. The seeds are tiny, skewing sphere shaped, dark brown and lusterous (Fig. 1B). The flowering period is from May to August, and the fruit period, July to September. The plant likes to grow in the fertile soils, with drought and waterlogging tolerance and strong ability to grow. It is widely distributed in the whole world, but mainly produced in South America.

Nutriology

Purslane contains various nutrients, including moisture 92 g, protein 2.3 g, fat 0.5 g, carbohydrates 3.0 g, calcium 85 mg, phosphate 56 mg, iron 1.5 mg, β-carrot 2.23 mg, thiamine 0.03 mg, riboflavin 0.11 mg, niacin 0.7 mg, and ascorbic acid 23 mg per hectogram of plants. Trace element contents, such as zinc, iron, manganese and selenium are several and even ten times higher than other species of wild vegetables. The contents of vitamins B_1 and B_2 are slightly higher, and carotene and vitamin C were significantly higher than those of the ordinary vegetables; wherein β-carrot is 10 times, and vitamin E is 56 times of those in leeks. Purslane contains all 18 kinds of amino acids, and the eight essential amino acids that purslane contains accounted for 44.95% of the total amounts of amino acids (16).

Product development

Purslane is excellent for both medication and food. There are also diverse meals of purslane, both fresh and dry. It can be with sauce, fried, or made into soup, or stuffings. Products like purslane juice, purslane instant granules, and quick-frozen purslane have been developed and exported to Japan (16).

Pharmacology

Purslane contains a lot of α-linolenic acids, a kind of ω-3 fatty acid, 10 times of that of spinach (16).

α-linolenic acids can effectively reduce the saturated fatty acids. Purslane is also rich in vitamin E, vitamin C, carotene and glutathione. Long-term consumption of purslane can also prevent platelet aggregation, coronary spasm and thrombosis, thereby effectively preventing from arteriosclerosis, coronary heart disease, myocardial infarction and other cardiovascular diseases (17). It also contains norepinephrine and glucose, bihydroxyethylamine, and malic acid, *etc*. These nutrients show very important biological functions in improving the body's immunity (16).

The active ingredients of purslane are alkaloids, flavonoids, terpenes, and organic acids. Flavonoids are mainly quercetin, kaempferol, myricetin, apigenin and luteolin. Modern research shows that purslane lipid-lowering and anti-atherosclerotic, anti-inflammatory, anti-virus, anti-aging, anti-oxidant, anti-tumor, immunity-enhancing, and skeletal muscle relaxation effects (18,19). As a hyper-potassium diet, purslane is a certain hypotensive agent, with effects of prevention and treatment of hypertension (20).

Zhang et al. (20) developed sour and hot purslane, purslane beverages and other products. The developed medical products included oral liquid, capsules and anti-inflammatory cream (21,22).

n-3 fatty acids can promote the formation of vasodilator and anti-platelet aggregation effects of prostacyclin, inhibit of platelet arachidonic acid convert to a strong vasoconstrictor and platelet aggregation thromboxane A_2, strengthen vascular expansion and decrease platelet aggregation. n-3 fatty acids by blocking the synthesis of thromboxane, reduce the production of leukotriene B_4, prevent the proliferation of the damaged vascular walls, and increase fibrinolytic activity (22). Both fresh purslane juice and extract of Chinese medical herb purslane reduced significantly the serum total cholesterol, triglycerides, low-density lipoprotein cholesterol, lipid hyperoxidation contents both in serum and liver and arteriosclerosis index, increased high-density lipoprotein cholesterol and SOD activities in blood and liver in rats fed with a high fat and cholesterol diets (23). Rabbit hyperlipid model was given purslane dry power 8-12 g daily and it could remarkably restrain or lower total cholesterol, triglycerides, MDA, whole blood and plasma viscosities; but raise highdensity lipoprotein-cholesterol in a dose-dependent manner. Ultrastructral observations illustrated that purslane could decrease lipid deposition of the aortic intima and inhibit the formation of atherosclerotic plaque (24).

Cardiovascular effects

Patients with coronary heart disease complicated with hyperviscosity were treated with compound purslane, two bags, three times a day (10 g/bag, equal to 15 g of raw drug). After 6 weeks levels of total cholesterol and triglycerides were decreased in compound purslane group patients, level of high-density lipoprotein was increased obviously; plasma lipid peroxidation was decreased, and SOD activity was increased, contents of endothelins and thromboxane B_2 and thromboxane B_2/prostaglandin 1α ratio were decreased obviously, calcitonin-gene-related peptide (CGRP) and prostaglandin 1α increased, showing that an obvious effect on regulating lipid, anti-oxidition and protecting vessel endothelial cell in the patients with coronary heart disease (25). Purslane polysaccharide had strong scavenging effect on superoxide radical with an IC50 of 4.29 μg/mL, and on hydroxyl radical with an IC50 of 1.97 μg/mL, but had mild effect on 1,1-diphenyl-2-picryl hydrazyl (DPPH). Purslane polysaccharide showed a significant protective effect on lipid peroxodation of rat-liver homogenate but had little inhabitation effect on hemolysis of rat erythrocytes induced by hydrogen peroxide (26). Studies on the effects of total flavonoids of *Portulaca oleracea L.* on cardiac function and carotid blood pressure in anesthetized rats showed that flavonoids can enhance cardiac function and increase blood pressure in a dose-dependent manner, but have little effect on heart rate (27).

Pretreatment of myocytes with total flavone of portulaca resulted in reducstion of LDH, creatine kinase and MDA release in ischemia-reperfusion neonatal rats, Ca^{2+} concentration in cells of total flavone of portulaca (20 mg/L) was close to that of normal control. When the myocytes were pretreated with 5, 10, and 20 mg/L total flavone of portulaca, cellular calcium concentration decreased significantly. These effects were in a dose-dependent manner (28). Pretreatment with total flavone of portulaca 10, 30 and 100 mg/L for hypoxia/reoxygenation injury of H9c2 myocytes indicated decreased creatine kinase, LDH and MDA, and increased SOD (29).

The water extract of the herb enhanced the activities of SOD, and Ca^{2+}-ATPase, and decreased MDA content in senile mouse model (30).

Wistar rats were given compound purslane, which was found to decrease total cholesterol, apolipoprotein B, platelet aggregation rate, microviscosity of the erythrocyte membrane and erythrocyte rigidity index and to increase apolipoprotein A1, glutathione peroxidase and lecithin cholesterol acyltransferase (31).

Chinese medicinal formulae containing high dose of *Portulaca oleracea L.* (45-60 g), one dose daily for three days as an adjunct to the treatment of chronic heart failure showed it might relieve the heart failure symptoms (32).

Dandelion

Morphological features

Dandelion (Latin name: *Taraxacum mongolicum Hand.-Mazz.*) is a perennial herb of the composite family, *Taraxacum Weber*. Dandelion is sweet in taste, neutral in nature, and non-toxic. The plant is 10-25 cm high, containing white milk. The roots are deep and long, single or branching with yellow brown skin. The root leaves are aligned in a form of rosette, narrowly lanceolate, irregularly pinnately divided margin with triangular lobes. There are several teeth in the entire margin. The apexes are slightly blunt or pointed, and they taper into a handle at the base. The petioles and main veins are often reddish purple. The upper part of the scapose is purple red in color densely covered with white villous arachnoid furs. The capitulum is involucre campanulate. The achenes are dark brown. The long pappuses are white (Fig. 1C). The flow and fruit periods are from April to October. They grow on the roadsides, fields, and hillsides. They distribute in in most parts of China, and in North Korea, Mongolia, and Russia as well.

Nutriology

The edible parts of the dandelion plant accountfor 84%. Per 100 g edible parts contain protein 4.8 g, fat 1.1 g, sugar 5.0 g, crude fiber 2.1 g, calcium 216.0 mg, phosphorus 93.0 mg, iron 10.2 mg, carotene 7.35 mg, vitamin B_1 0.03 mg, vitamin B_2 0.39 mg, vitamin C 47.0 mg, and niacin 1.9 mg. Dandelion dishes include dandelion fried with shredded pork, garlic dandelion, dandelion rice porridge, dandelion jujube soup, and dandelion bean soup. In addition, deep processing of the dandelion has lead to the development of a series of products like dandelion tea, dandelion drinks and a variety of health food products for sale (33).

In recent years, dandelion has been cultivated taken as vegetable and medicinal plant. Some people make dandelion into small soft packages of canned food, not only as regular health vegetable, but also for the off-season vegetables. Japan has produced dandelion candy and dandelion coffee. According to Japanese experts, the dandelion can be made into energy drinks, both nutritional and immunity-enhancing, but also with physiological adjustment, rehabilitation, and control of aging. In Japan, dandelion is also made into health food, such as miso soup and wine. Drugs processed with dandelion may obtain quite good effects. The dandelion dishes are:

1) Dandelion salad: The Spring leaves of dandelion, made into salad mixed with spices, is tasty just like lettuce.
2) Fried dandelion: The dandelion roots are debittered by boiling, sliced and fried in oil.
3) Dandelion coffee: In Autumn, to dig the dandelion roots, wash, slice and dry them. Put a bit of the slices into coffee for drink.
4) Dandelion pastry: Crushed powders of leaves, stems and roots of dandelion are made into pastry and bread, *etc*.
5) Pickled vegetables of dandelion pollen: A little dandelion pollen is added to the pickled vegetable and it taste bitter. This product has a unique flavor, and it increases appetite.
6) Dandelion sauce: To take 200 dandelion inflorescences, add 1 kg of water and an appropriate amount of lemon, and cook for one hour.
7) Dandelion wine: Put the dried dandelion root slices 50-100 g into 0.5 kg ordinary wine or white wine. It is ready to drink after soaking for three days. It may have the effects of detoxification, cancer prevention and so on.
8) Crude dandelion drink: To squeeze the fresh dandelion juice, supplemented with other ingredients, and made into drink, which becomes very popular with the Japanese (34).

Product development

Dandelion is rich in resources with low prices. The development of dandelion products is to meet the demands of natural and pollution-free products.

Dandelion beverage has detoxification, anti-bacterial and anti-inflammatory properties. It is a one-set edible and medicinal drinks. Dandelion is crushed and extracted in water and made into dandelion juice. To add sugar, citric acid and other ingredients, and then to stir, filter and sterilize. In addition, fruits like hawthorn, green beans, pineapple, and prickly pear have been investigated for complex beverage with dandelion for the development of new products.

With reference to its anti-bacterial and anti-inflammatory effects, the development of dandelion toothpaste has been proposed at relieving the common oral diseases. The dandelion toothpaste obtained by boiling along with the herbs of clearing away *heat* and removing *fire*, such as *Alpinia oxyphylla Miq*., and *Houttuynia cordata* may have the effect of abolishing bad breath. Gao et al. (35) developed dandelion pox dispel cream, which has the functions of anti-inflammatory, skin care and balance the oil secretion. Dandelion has the effects of clearing away the *heat* and promoting diuresis, removing toxicity for detumescence. For multiple folliculitis, eczema and other skin infections, it shows a good effect. Used in cosmetics, dandelion can play a skin-cleaning role by avoiding human pathogen invasions. The chlorogenic acid, flavonoids, SOD enzymes in dandelion have strong anti-oxidant and of tyrosine kinase-inhibiting effects, thereby delaying skin aging. Therefore, the development of dandelion skin care products is a new trend of dandelion products (36).

Pharmacology

Broad-spectrum antimicrobial effect: Dandelion protects against *Staphylococcus aureus*, *Staphylococcus epidermidis*, hemolytic *streptococcus* and *Catarrhal cocci*, showing a significant antimicrobial effect. Recent experiments confirmed that combined dandelion and trimethoprim has a synergistically anti-bacterial activity.

Hepatoprotective and choleretic effects: Dandelion injection or ethanol extract of dandelion via duodenal administration increased bile of the anesthetized rats by more than 40%. A repeated test after gallbladder removal showed same results, disclosing a direct hepatocystic effect of dandelion. Dandelion polysaccharide did not show an obvious inhibition effect on liver cancer, but effectively antagonized cyclophosphamide-induced micronuclei mutation (37).

Anti-gastric injury: Dandelion or the compound prescription decoctum of *Rhizoma Chuanxiong*, *Radix Codonopsis* and dandelion could significantly reduce the stress-induced gastric mucosal lesions and decrease the incidence of ulcer and ulcer index in rats. The compound prescription decoctum also showed a protective effect to varying degrees of mucosa-damaged ulcer induced by stress method, pylorus ligation and absolute ethanol (38).

The extracted dandelion polysaccharides have the role of reducing blood sugar (39).

Dandelion (4 g/kg/day), feeding for mice, raised the of antibody production levels and the phagocytic rate of the macrophages in the animal, supporting that dandelion could enhance and regulate the immune function of the body by improving the immune suppression status (40).

Cardiovascular effects

In the experiment of cardiomyocyte injury of primary monolayer culture of neonatal rat, 300 μg/mL dandelion, similar to *Radix Ginseng*, could better protect oxygen-glucose deprivated myocardial cells, stablilize the cellular membrane structures, and maintain the mitochondrial and sarcoplasmic reticulum structures close to normal levels, and increase SDH activity, reduce LDH activity, and reduce LDH leakage and restore the intracellular glycogen contents to normal levels (41).

The cardioprotective effect of dandelion on mice with viral myocarditis displayed that the total flavonoids of dandelion either low, medium or high doses (25, 50 and 100 mg/kg) significantly decreased the apoptotic rate in comparison to the control group (42).

Yang et al. (43) investigated the anti-oxidant effects of different components of dandelion polysaccharides (DPs) 1 and 2. The results showed that the ability to scavenge free radical of DP1 and DP2 were powerful, and that of DP2 was stronger than that of DP1. But the ability to scavange superoxide anion free radicals of DP1 was slightly stronger than DP2.

Ge et al. (44) detected the anti-free radical effects of polysaccharides from dandelion roots, and found that the polysaccharide content was 63.31% in the dandelion roots and the IC50 against hydroxy, oxygen and 1,1-diphenyl-2-picryl hydrazyl (DPPH) radicals were 0.047 mg/mL, 0.01 mg/mL, and 0.154 mg/mL, respectively, proving the strong scavenging activity of polysaccharides from dandelion roots.

In an experiment on rat, dandelion leaf tea did not show significant influences on serum triglycerides, total cholesterol and high-density lipoprotein (45).

Plantain

Morphological features

Plantain (Latin name: *Plantago asitica Linn.*) is an annual or biennial herb, of *Plantaginaceae*, *Plantago L.* It is sweet in taste and cold in nature. The taproot is long with many lateral roots. Many are with fewer succulents. The rhizomes are short. The basal leaves are in a form of rosettes, supine, oblique, or vertical. The leaf blades are papery. They are elliptic, elliptic-lanceolate, or ovate-lanceolate, 3-12 cm long and 1-3.5 cm wide. The apexes are acute or slightly blunt. The edges have sinuolate blunt teeth, irregularly notched or toothed. The bases are wide wedged tapering to narrow wedged down to the petioles. There are 5-7 leaf veins, slightly concave on top, and apparent protuberance on back. Both surfaces sparsely grow white pubescences. The petioles are 2-6 cm long. The bases expand into a sheath-like structure (Fig. 1D). It grows in the grassland, river, ditch, meadow, and roadsides. It is distributed throughout China, but more in the north. The plant also grow in North Korea, Russia (Far East), Japan, Nepal, Malaysia, and Indonesia.

Nutriology

Mainly the leaves and buds of plantain are taken for food. Per 100 g leaves or buds contain carbohydrates 10.0 g, protein 4.0 g, fat 1.0 g, crude fiber 3.3 g, calcium 309 mg, phosphorus 175 mg, iron 25.3 mg, carotene 5.85 mg, vitamin C 23 mg as well as other minerals and vitamins. They also contain a variety of pharmaceutical ingredients, with diuretic, swelling reduction, antidiarrheal, *heat*-clearing away, sterilizing, eyesight-improving, and *phlegm*-dispelling effects.

Plantain is rich with soluble dietary fibers accounting for up to 24.63% (dry weight accounted for), which are more than in other raw materials with a high dietary fiber content.

Pharmacology

Ursolic acid is a major active ingredient of plantain. Ursolic acid has synergistic hypnotic effects of pentobarbital and antiepileptic effects of pentylenetetrazol; it has anti-bacterial, anti-ulcer, antitussive properties. In particular, ursolic acid has strong anti-tumor activity.

Plantain contains plantagins, which are flavonoids, a kind of natural phenolic compound and one of the main active ingredients of medicinal plants. The general extraction rate of total flavonoids from plantain was 2.8%-3.5%, and the microwave extraction rate was 5.21%. Aucubin, an iridoid glycoside, that plantain contains, has strong anti-bacterial and diuretic effects. It can inhibit the replication of hepatitis B virus DNA. Plantasan is a multi-component polysaccharide. It can cause irritation of the intestinal mucosa, so enhancing peristalsis (46).

Product development

Plantain products that have been developed include nutritional yoghurt (47), compound beverage with Longjing Tea and Plantain herb (48) and with *Portulaca oleracea L.* and plantain (49).

Cardiovascular effects

Small doses of plantaginis could slow the heart rates, and increase blood pressure; whereas high doses could cause a heart attack, and a reduced blood pressure in rabbits (50). Alcohol extract of plantain could reduce the blood pressure of the anesthetized dogs and cats, and inhibit isolated rabbit and frog hearts. Plantain may regulate lipid metabolism and lower serum cholesterol. Plantain (30-60 g) is firstly soaked in cold water for 1 hour, then cooked in high heat for twice, twice water decoctions are divided into three doses, one dose per day for consecutively one month. This was evidenced as an effective therapy for hypertensive patients (51).

Cirsii Herba

Morphological features

Cirsii Herba (Latin name: *Herba cephalanoplosis segeti*) is a perennial herb, the whole plant of *cephalanoplos segetum (bunge) kitam*, belong to *Asteraceae (compositae)*, the composite family. It is sweet, bitter and cold in nature. It has a long root, and often is the underground part greater than the aerial part. The stems are erect. The young stems are covered by white silk-like hairs, angled, 30-80 cm high. At base, it is 3-5 mm in diameter. The upper part has branches. The inflorescence branches are glabrous or with thin hairs. The leaves are alternate, and the basal leaves wither and fall when the flowers blooms. The leaves of the lower and middle parts are oval or elliptic-lanceolate, 7-10 cm long and 1.5-2.2 cm wide. It is green on the surfaces, and light green on back. There are various densities of white silk-like hairs on both sides, mucronate or obtuse on top, and narrow or obtuse at base. The serrates are present nearly entirely or sparsely at the edges of the leaves. There is no petiole (Fig. 1E).

It is distributed in plains, hills and mountains. There is cultivated *Cirsii Herba* for medicinal purposes. Except for Tibet, Yunnan, Guangdong and Guangxi, it is distributed almost in the entire country. In Eastern Europe, Eastern Russia, West Siberia and the Far East, Mongolia, North Korea and Japan, it also has a wide distribution. The type specimen was collected from Poland.

Nutriology

Main nutritional ingredients of *Cirsii Herba* are water 89.84 g, carbohydrate 2.96 g, crude fat 0.52 g, protein 3.22 g, crude ash 1.71 g, crude fiber 1.75 g per 100 g plant. In addition, it contains trace elements, vitamins and amino acids. The tender stems and leaves are edible. After scalded in boiling water, it can be stir-fried, make soup or mix with other staple food for eating. It can also be preserved, or made into sautéed bean curd with *Cirsii Herba*, steamed dumplings stuffed with *Cirsii Herba* (52). The diet therapeutic prescriptions of *Cirsii Herba* are: 30-60 g of fresh plants, water frying slag, with proper amount of sugar added, 2 times a day for the treatment of infectious hepatitis; Fresh *Cirsii Herba*, honeysuckle 60 g, decotrated in water and effective for lung abscess; and proper amount of fresh *Cirsii Herba*, a little vinegar, crushed into juice, and apply it to the affected parts. It is also effective for mumps (52).

In late Summer and early Autumn, the harvested whole plant with flowers is rich in rutin, Mongolia flower glycosides, locust glycosides, protocatechuic acid, chlorogenic acid, caffeic acid, tyramine and potassium chloride and other ingredients (53). *Cirsii Herb* leaves can be used for edible wild plants, but also medicinal (52).

Pharmacology

The main chemical components of *Cirsii Herba* are organic acids (protocatechuic acid, caffeic acid and chlorogenic acid), triterpenoids (β-sitosterol, stigmasterol, pseudo-acetyl dandelion sterol and dandelion sterols), flavonoids (rutin, acacetin and buddleoside), and other ingredients (tyramine, three dodecanol and potassium chloride) (54).

Anti-tuberculosis: Ethanol infusion of *Cirsii Herba* 1:30000 shows effective inhibition for *Mycobacterium tuberculosis*, and the inhibitory concentration of water decoction is 300 times greater than this.

Hemostatic effect: The water decoction and ether extract could shorten the clotting time of mice. *Cirsii Herba* also has a significant role in promoting blood clotting. The hemostatic effects of *Cirsii Herba* are mainly by way of local vasoconstriction and inhibition of fibrinolysis. The active ingredients for hemostasis are chlorogenic acid and caffeic acid. The tincture of *Cirsii Herba* plays an inhibitory role for the isolated rabbit intestine, but a stimulating effect on rabbit uterus, either pregnant or non-pregnant, either *in vitro* or *in vivo*; whereas an inhibitory effect on the *in vivo* uterus of cat and *in vitro* uterus of rat (55).

Cardiovascular effects

To study the effects of *Cirsii Herba* extracts with acid water on myocardium in Bama miniature pigs, Chen et al. (56) used high, medium and low doses of *Cirsii Herba* extracts (2.0, 1.0 and 0.5 mL/kg, respectively) by intraperitoneal injection once a day, for 7 consecutive days. Compared with normal control group, the electrocardiogram of low dose group was similar to the normal control, but the S-T segment

of electrocardiogram in medium dose group raised slightly, and the electrocardiogram in high dose group showed typical myocardial ischemia. The indexes of serum myocardial enzymes of low dose group showed no statistically significant difference compared with normal control, but the profiles of LDH and creatine kinase isoenzyme (CK-MB) in medium dose group were higher than those of the normal control, and those of LDH, CK-MB, creatine kinase and aspartate amino transferase in high dose group were higher than those of normal control, and the differences were statistically significant. Wang (57) noted in rat experiments that flavonoids extract could reduce blood sugar and glycosylated serum protein levels, lower triglycerides, cholesterol and low-density lipoprotein levels, and increase glycogen content, thereby improving lipid metabolism of the body. The flavonoids extract could also promote insulin secretion and hepatic glycogen synthesis, increase glutathione peroxidase and hydrogen peroxide content, enhance SOD activity, and reduce serum MDA level and mRNA expressions of cytochrome C.

Cirsii Herba can function as a heart stimulant, elevate blood pressure, and enhance cardiac and vascular contractions. Decoction and alcohol extract of *Cirsii Herba* afford isolated rabbit hearts and guinea pig atrial muscle contractile forces and frequency enhancement. Propranolol can block this action. Decoction can enhance the contraction of rabbit aortic strips. This effect could be antagonized by phentolamine, indicating that it has an adrenergic receptor agonist activity, and the active ingredients tyramine extracted and separated from *Cirsii Herba* has a blood pressure-boosting effect in rats significantly (55). The blood pressure-boosting substances contained in each gram of *Cirsii Herba* are equivalent to 14 μg of noradrenalin, blood pressure-boosting effect can be enhanced by cocaine and ephedrine, and be antagonized by ergotoxine, *etc*. Its decoction or tincture, intravenous injection at a dose of 70 mg/kg, could increase blood pressure of the anesthetic dogs and rabbits, similar to the effect of adrenaline. Meanwhile, the volume of the kidney and the spleen decreased. These preparations could produce the similar effect of adrenaline on isolated frog heart and rabbit heart. The blood vessels of the rabbit ears and the lower limbs of the rats were significantly contracted. The production of these effects may be due to catecholamine (58). Compared with the normal control, the blood pressures in treatment groups were decreased markedly and blood pressure tracing curve decreased markedly, but regained after 2-3 minutes, while the heart rate stepped down (59).

Zhang (53) reported that a 68-year-old male patient with primary hypertension was managed with *Cirsii Herba* 200 g, decocted in water, and divided into two portions to take for twice a day. The patient's blood pressure was well controlled. Fresh *Cirsii Herba* 150 g three times daily or 200 g twice daily in association with daily amlodipine 5 mg or enalapril 10 mg, or pure fresh *Cirsii Herba* 500 g decocted in water for dose taken, blood pressure was well controlled without abnormalities of other organs. *Cirsii Herba* assisted long-acting calcium channel blockers amlodipine, in the case of not increasing the dosage of the drug, the antihypertensive effect was enhanced. Coordinated use with angiotensin converting enzyme inhibitor enalapril, the blood-lowering effect of *Cirsii Herba* offsets the time difference, reducing the influences of blood pressure variability on target organs. The antihypertensive doses of *Cirsii Herba* that the patients taken significantly surpassed those regulated in The "Chinese Pharmacopoeia" version 2000 with 15-30 g for raw *Cirsii Herba* and with 50-100 g for fresh *Cirsii Herba*; whereas long-tern use did not show any toxic and side effects. Antihypertensive treatment in patients with primary hypertension with *Cirsii Herba*, the patient's vascular endothelial function might be also improved. Whether *Cirsii Herba* possesses the effects of protecting vascular endothelium, anticoagulation, reducing blood viscosity and other mechanisms is worthy of further study. The chemical compositions of *Cirsii Herba* are complex. Whether the active sites have the functions of inhibiting the plasma renin activity, angiotensin converting enzyme activity and antagonizing angiotensin II receptor remains to be clarified.

Suaeda salsa

Morphological features

Suaeda salsa (Latin name: *Suaeda heteroptera Kitagawa*), is an annual herb of *Suaeda Forsk. Ex. Scop.*,

Chenopodiaceae. It is slightly salty in taste and slightly cold in nature. It is 20-80 cm high, green or purple. The stems are erect, cylindrical, brown, with micro strip edges, glabrous. The branches are more concentrated in the upper part of the stem, slender, loose open or obliquely upward climbing. The leaves are strip-shaped or semi-cylindrical, typically 1-2.5 cm long and 1-2 mm wide. The apexes are acute or slightly obtuse, sessile. The leaves of the upper branches are shorter. The flowers are glomerules, containing 3-5 flowers, with axillary inflorescence. On the branches are arranged in intermittent spikes. The small bracts are oval, with almost entire edges. The flowers are bisexual, sometimes with female. The perianths are hemispheric, and the bottom surfaces are flat. The lobes are ovate, slightly fleshy, with membranous margins. The apexes are obtuse; It is slightly thickened on back when with fruits, and sometimes, at the base of the triangle, there are extending or narrowly winged projections. The anthers are ovate or oblong, 0.3-0.4 mm long. There are two stigmas, with nipples, usually tinted with dark brown, and the styles are inconspicuous. The utricles are wrapped in the perianthes. The peels are membranous. When the fruits are ripe, they often break and reveal the seeds. The seeds are hemitropous, lenticular, or crooked oval shaped, 0.8-1.5 mm in diameter, black and shiny. The periphery edges are dull. There are conspicuous dot textures on the surface (Fig. 1F). The flower and fruit periods are from July to October. It is distributed in Europe and Asia. In China, it is distributed in Hebei, Qinghai, Shanxi, Zhejiang, Ningxia, Inner Mongolia, Shaanxi, Xinjiang, Jiangsu, Shandong, and Gansu, *etc*., growing in the areas at an altitude of 100 to 3,800 meters. Usually, it grows in saline-alkali soils, beaches and lakes. Currently it has not been introduced by artificial cultivation.

Nutriology

Its leaves and young stem sections can be taken as vegetables. The taste is tender and soft without any other peculiar flavors. Local residents always have a habit of plunking and used for food, and no poisoning events occurred (60).

Suaeda heteroptera Kitagawa has a slightly salty taste and a slightly cold nature. The nutritive value of *Suaeda heteroptera Kitagawa* is very high, with nutritional ingredients per 100 g seedling of carotenes 1.75 mg, vitamin B_1 0.1 mg, vitamin B_2 0.1 mg, vitamin C 78 mg and abundant mineral supplementations, such as potassium, calcium and magnesium, *etc*. In addition, it also contains rich dietary fibers. Therefore, it helps stimulating the gastrointestinal peristalsis to aid digestion, and preventing from rectal carcinoma, diabetes mellitus, gallbladder stones and hemorrhoids. *Suaeda salsa* contains a variety of ingredients, which meet the needs of the human body. Its dietary fibers can stimulate gastrointestinal motility and help digestion. It can prevent rectal cancer, diabetes, gallstones, hemorrhoids and so on (61).

Analysis of the nutritional ingredients of *Suaeda salsa* showed samples per 100 g containing protein 4.1 g, vitamin C 52 mg, β-carotene 3.78 mg, vitamin E 0.23 mg, vitamin K_1 0.15 mg. It is also rich in B vitamins (B_1, B_2, B_3, B_6 and folic acid), crude fiber, minerals and amino acids (62).

Seeds contain abundant nutrient ingredients with more oils. It was determined that the seeds were composed of crude protein 21.8%, crude fat 21.94%, corase fiber 13.86%, crude ash 7.06% and salinity 5.2%. Oils abstracted from the seeds contain unsaturated fatty acid 90.56%, of which linoleic acids accounting for 74.06%, oleic acid 11.80%, linolenic acid 4.6%. They also contain vitamin E and trance element selenium. These nutrient elements play an important role in prevention of tumorigenesis, dereasing blood lipids, antiatherosclerosis and anti-aging (63).

Leaves and seeds of *Suaeda salsa* contain 18 kinds of amino acids. Essential amino acids of the leaves accounted for 46.8% and those of the seeds accounted for 37.6%. Contents of essential amino acids of fresh leaves and tender caudex of *Suaeda salsa* were much higher than those of common vegetables; those of the seeds, except for leucine, were lower than those of maize and millet, and methionine content was lower than those of the millet, all other amino acids were higher than those of the staple food (64).

Suaeda salsa are naturally growing, nor harassing pest. Hot and sour salad of *Suaeda salsa* shall be palatable, very fresh. In Spring and Summer, people usually take *Suaeda salsa* leaves for dishes, by making salad, *Suaeda salsa* steamed bread by blending with flour, or stuffing dumplings. The taste is all right in spite of

some slight bitter salty taste. In Autumn, *Suaeda salsa* plants are mature and produce seeds, which are stroked down, washed, dried, mixed with food, and are made into steamed bread or cake, and in this way, the food is more delicious that those made of *Suaeda salsa* leaves. Therefore, there are various food products of *Suaeda salsa*, for example, *Suaeda salsa* Pork Bun, *Suaeda salsa* pancake, *Suaeda salsa* steamed bread; *Suaeda salsa* seed steamed bread, in addition to cold dish of *Suaeda salsa* in sauce.

Product development

There are also some patent products: *Suaeda salsa* fish meatball (raw materials: fish meat 40-65 portions, *Suaeda salsa* 15-25 portions, *Cassava* modified starch 8-20 portions, and cornstarch 8-20 portions, *etc*.), with a peculiar taste and more abundant nutritional value (65), canned *Suaeda salsa* (66), dried *Suaeda salsa* (67) and *Suaeda salsa* pastry (68).

Pharmacology & Cardiovascular effects

Experimental studies revealed that *Suaeda heteroptera Kitagawa* seed oil could significantly decrease the serum lipid peroxidation contents and increase the activities of erythrocyte SOD and glutathione peroxidase of the experimental rabbit. It demonstrated that *Suaeda heteroptera Kitagawa* seed oil might have some effects of delaying aging and preventing and curing senile diseases (69).

Experimental rabbits were fed by colleseed oil, serum palmitic acid was siginificantly decreased, linoleic acid, vitamin E and selenium were significantly increased, cholesterol, triglyceride and low-density lipoprotein were decreased and high-density lipoprotein was increased. All these results showed that colleseed oil could protect against atherosclerosis (70).

An experimental study showed that adenosine diphosphate- and collagen-induced rabbit platelet aggregation was remarkably attenuated by *Suaeda salsa* rapeseed oil. It was considered that this effect was due to the unsaturated fatty acids and vitamin E that the seeds contain (71).

The metabolic responses included the increased amino acids and decreased succinate, fructose, glucose, fumarate and ferulate in above-ground part of *Suaeda salsa* exposed to mercury. The expression levels of myo-inositol-1-phosphatesynthase (INPS), choline monooxygenase (CMO), betaine aldehyde dehydrogenase (BADH), catalase and glutathione peroxidase were elevated in above-ground part of *Suaeda salsa* after combined mercury and salinity exposure. Increased activities of anti-oxidant enzymes including SOD, peroxidase and catalase were uniquely observed in salinity-treated samples (72). *Suaeda salsa*, a pioneer halophyte in intertidal zone of the Bohai coast, was proved to have cadmium-tolerant capacity. It suggested that cadmium exposure exerted an oxidative stress on *Suaeda salsa*, disturbed natrium homeostasis across membranes and interfered with the metabolism of inositol (73).

Discussion

Wild vegetables are rich in nutritional ingredients, including proteins, fats, carbohydrates, vitamins and mineral substances, in particular more abundant plant fibers. Many wild vegetables have much higher contents of nutritional ingredients than common vegetables (74).

Nutritional component analyses on 7 kinds of common edible wild vegetables including *Taraxacum mongolicum Hand nutrition dandelion –Mazz.* in Hebei Province, showed that edible portions of 7 kinds of wild herbs were of the great differences concerning nutritional components, but they were rich in crude protein, crude ash, crude fiber, rich in a large number of mineral elements potassium, calcium and megnesium, containing essential trace elements iron, copper, manganese and zinc. However, lead was detected in all 7 edible wild vegetables. Except for wild garlic (*Longstamen Onion Bulb*), lead contents in the remaining 6 were all above standards 1.65-4.4 times. In addition to wild garlic, cadmium was deteted in the other six kinds of edible wild vegetables, and the content of cadmium exceeded the standard 1.72 and 2 times, respectively in shepherd's-purse and salsola collina (75). They suggested that the toxic materials should be in relation to the pollution of the environment.

Nutritional components of 5 kinds of wild vegetables including *Cirsium setosum* and *Patrinia villosa* revealed that *Patrinia villosa* had the maximal contents

of crude protein and vitamin C; and *Cirsium setosum* had second most contents of ash and crude fiber out of the five wild vegetables investigated (76).

Wild herbs contain many effective ingredients including alkaloids, flavonoids, quinones, anthracene, glycosides, terpenes, *etc.*, and therefore showing health care function (77). Component-effect relations have been evaluated in terms of cardiovascular effects of some edible natural products (78).

People tend to ignore the toxicity and non edible nature of wild plants. Some wild plants combine poisonous plants, edible plants or medicinal plants in one. For example, amaranth and alfalfa contain solar allergic substances, and some people may be ill by sun exposure after taking these plants for food. Some wild vegetables are toxic in the whole plants, such as milk vetch, *etc.*; while others are toxic in some parts of the plants, as in the root of fern (79).

Some wild vegetables containing harmful substances, such as Nitrates, toxic alkaloids, saponins, glycosides, toxic proteins, *etc.*, long-term or excessive consumptions may cause serious adverse effects on the human body. Nitrates have potential teratogenicity carcinogenicity; toxic alkaloids mainly damage the nervous system, peripheral vagal nerve and sensory nerve poisoning usually show abnormal excitation and subsequent inhibition, and can directly affect the cardiac function, and degeneration and necrosis of other organs, and central nervous system poisoning, and respiratory depression can cause respiratory paralysis; toxic saponins have a stimulating effect on the part of the heart, and can inhibit the respiration, damage the heart and the kidney, and may incur a hemolytic effect; the toxic protein can affect the gastrointestinal tract as a strong stimulation and corrosion agent, and cause a wide range of bleeding (80,81).

Toxicology studies demonstrated that *Sauropus androgynus* caused an increased sperm deformity rate in mice, an inhibition of the growth of SD rats, and organ damages involving spleen, heart, testis, liver, and kidney, *etc.*, probably relating to its enrichment of cadmium, 4 times more than the national standard. The cadmium content of *Gynura divaricata* is also over the national standard, and toxicological studies suggest that it may have cumulative toxicity. They are not suitable for long-term consumption as vegetables (82). Heavy metal content investigations of 5 kinds of wild vegetables of Guizhou found that purslane, lamb's-quarters and water fennel were in excess of the standards of different levels, indicating that heavy metal security of wild vegetables should cause for concern and wild vegetables of easy accumulation of heavy metals may warrant reassessments for food safety and toxicology studies (74).

Wild vegetables need to go through some processing before consumption after harvest as do for cultivated vegetables. Whichever method of processing, its main purpose is to poison and to smell and to maintain its nutritional ingredients as possible. Preparation methods of wild vegetables are mainly raw food, salad, and fried, steamed, fresh soup, pickled, and dried vegetables and other produce (77).

At present safety evaluation undertaken for wild vegetables are confined with fewer species evaluations, and lack of complete analyses. With increasing intake of wild vegetables, subchronic and chronic toxicity studies should be strengthened, providing security reference for the toxic accumulation of wild vegetables. Screening of types and varieties of non-toxic wild vegetables and strengthening the research of the special nutritional ingredients and health care functions and development of new products are our next step.

Conclusions

The common wild vegetables have considerable nutritional values compatible to the cultivated vegetables. Besides, they also have health care and medical benefits. The cardiovascular effects are usually attributable to their anti-oxidant properties. They deserve sustained efforts for developing health care products. However, toxicological studies have to be continued as well.

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