
Cibotium barometz

Scientific Name

Cibotium barometz (L.) J. Sm.

Synonyms

Aspidium barometz (L.) Willd., *Dicksonia barometz* (L.) Link, *Nephrodium barometz* (L.) Sweet, *Polypodium barometz* L.

Family

Cibotiaceae

Common/English Names

Chain Fern, Chain Fern Rhizome, Cibot Rhizome, Cibota, Cibotium, Golden Chicken Fern (Plate 2), Golden Hair Dog Fern, Golden Moss, Golden Lamb, Lamb of Tartary, Scythian Lamb, Tartarian Lamb, Vegetable lamb of Tartary, Wooly Fern.

Vernacular Names

Chinese: Guo Ji, Jin Mao Guo Ji, Huang Gou Tou;
Dutch: Goudharige Hondsvaren;
French: Agneau De Scythie, Cibotie, Pitchawar;

Hawaiian: Pulu-Pulu;

Indonesian: Paku Simpai;

Italian: Felci Arboree;

Japanese: Hitsuji Shida, Taka-Warbi, Shishiba (Okinawa);

Malaysia: Paku Kidang, Penawar Jambi, Bulu Pusi, Bulu Empusi;

Philippines: Salagisog (Bikol), Tinampa (Igorot), Borabor, Borabor Ta Paku, Sabong To Borabor (Iloko);

Thailand: La Ong Faifaa (Central), Kut Phi Pa (Northern), Kut Suea, Pho Si (Pattani), Khon Kai Noi (Loei), Taet Ling (Trat), Ninla Pho Si (Songkhla, Yala), Wankai Noi (General), Hatsa Daeng (Nakhon Ratchasima);

Vietnamese: Cau Tich, Kim Mao (Vietnamese Chinese), Cut Bang (Tay), Co Cut Pa (Thai Ethnic), Nhai Cu Vang (Dao Ethnic), Dang Pam (K'ho Ethnic), Long Cu Ly, Cu Lan, Long Khi

Origin/Distribution

Wild distribution of the species had been reported in southern parts of China, northeast India, western Malay Peninsula, Indonesia (from Java to Sumatra), Myanmar, Thailand, Vietnam, Laos, Cambodia (Qin and Dong 2003; Zhang et al. 2008; Nguyen et al. 2009a; Zhang



Plate 1 *Cibotium barometz* plant habit

and Nishida 2013), Taiwan (Van Steenis and Holttum 1959) and Philippines (Nguyen et al. 2009a).

Agroecology

This fern species has a relatively widespread distribution, occurring in the valley, edges of the forest, along stream-banks in the lowlands, wet mountainous ravines from 100 to 1500 m elevation in tropical and sub-tropical zones in China, Indochina and southeast Asia (WHO 1990; NIMM 1999; Qin and Dong 2003). The plant is hygrophilous and shade enduring when young. It is well adapted to warm and humid conditions. Optimum average temperature varies between 20 and 23 °C, the rainfall ranges from 1800 to 2600 mm every year. It thrives on red-brown ferralitic and acid soils but will tolerate marginally alkaline soils.

Edible Plant Parts and Uses

The rhizome starch is used for making cakes and liquor in China (Cui 1998; Dai et al. 2003; Cao et al. 2007; Yun et al. 2009a, b; Liu et al. 2012).

Botany

A large tree fern reaching height of 1–3 m high (Plate 1) with massive, prostrate to erect caudex (trunk), the young tops and base covered with dense, stiff, golden-brown, long hairs (Plate 4). Fronds in a tuft at the apex of the trunk, 1–2 m long, bipinnately compound, ovate to elliptical in outline, up to 2 × 1 m, under side glaucous, upper side darker green (Plate 3), with stipes thick, up to 1 m long or more, triangular in transverse section at base, densely bearing caducous adpressed hairs, stipe and rachis green, turning purplish beneath with age; base of stipe with a mass of long (1–1.5 cm) hairs, upper part of stipe and rachis covered with small, appressed flaccid hairs becoming glabrescent; pinnae many, alternating, pinnate pinnatifid, in outline oblong to lanceolate, apex acuminate; pinnules numerous, often with a few pairs of tertiary leaflets at the base, deeply pinnatifid throughout, very shortly stalked or sub-sessile at distal parts of pinnae, pinnule-segments slight falcate, apiculate, margins crenulate to serrulate-serrate. Sori 1–5 pairs on pinnule-segments; indusia bivalvate, outer indusia round, inner ones more or less oblong; outer valve of indusium usually large; paraphyses dark

Plate 2 *Cibotium barometz*
plant label



reddish brown, long and numerous. Spores pale yellowish, with equatorial ridge.

Nutritive/Medicinal Properties

Rhizome Phytochemicals

Pterosin R (Murakami et al. 1980), pterosin Z (Zhao et al. 2011) and ptaquiloside (Potter and Baird 2000) were found in *C. barometz*. Yang et al. (2010) reported *C. barometz* to contain volatile oils, pterosins, aromatic compounds, water-soluble phenolic compounds, flavonoids, amino acids, inorganic elements, volatile oils, pterosins, aromatic compounds, water-soluble phenolic compounds, flavonoids, amino acids, inorganic elements. Xu et al. (2012a) reported *C. barometz* processed products (drying, cutting, roasting, boiled, etc.) to contain phenolic compounds, volatile oil, sterols, saccharides, glucosides, amino acids, mineral elements and phospholipids.

Pterosin R (Murakami et al. 1980), pterosin Z (Zhao et al. 2011) and ptaquiloside (Potter and Baird 2000) were found in *C. barometz*. Twelve constituents, mainly organic acids, were isolated from *C. barometz* rhizome volatile oil with palmitic acid and linoleic acid as the major acids (Jia et al. 1996). The contents of protocatechuic acid and caffeic acid in all the samples of *C. barometz* rhizomes collected from various areas were above 0.020 and 0.029 %, respectively, and the

highest content was found in the processed products (Yuan et al. 2000). Twenty-five compounds were identified in the essential oil from *C. barometz* rhizome; the main constituents were oleic acid, linoleic acid, palmitic acid, pentadecanoic acid, 7,10,13-hexadecatrienoic acid methyl ester, linolenic acid methyl ester with relative content over 10 %, respectively (Xu et al. 2000). The content of phosphatidylcholine was 0.198 % in *C. barometz* (Xu et al. 2001). Zhang and Wang (2001) found the following compounds in the rhizomes, onitin, protocatechuic acid, β -sitosterol, daucosterol and 2-furancarboxaldehyde-5-hydroxymethyl. Nine compounds were isolated and identified from the rhizomes: palmitic acid, β -sitosterol, 1-mono-palmitin, daucosterol, caffeic acid, protocatechuic acid, protocatechuic aldehyde, *n*-butyl- β -D-fructopyranoside and D-glucose (Cheng et al. 2003). Twelve compounds palmitic acid, palmitic acid methyl ester, linoleic acid, oleic acid, stearic acid ethyl ester, 4'-hydroxyacetanilide, sucrose, C₂₇ saturated fatty acid, protocatechualdehyde, β -sitosterol, vanillin and 3,4,5,7-tetrahydroxyflavone were isolated from *C. barometz* rhizome (Xu et al. 2004). *C. barometz* rhizomes were reported to contain flavonoids, kaempferol and onychin (Xu et al. 2004; Hu and Yu 2006).

Ye et al. (2006) reported *C. barometz* to have flavonoids, and to be rich in the trace elements such as Fe, Ca, Zn, Mg, Ni, Mn, Cu. Wu et al. (2007) found the following compounds in the

Plate 3 Close-up of frond**Plate 4** Golden-brown hairy caudex top with frond removed

rhizomes: β -sitosterol, daucosterol, onitin, alternariol, (3*R*)-des-*O*-methyl lasiodiplodin, protocatechuic acid. Ryu and Lee (2008) found protocatechuic acid, caffeic acid and shinbarometin (2-*O*-(9*Z*,12*Z*-octadecadienoyl)-3-*O*-[α -D-galactopyranosyl-(1'' \rightarrow 6')-*O*- β -D-galactopyranosyl]glycerol) in the rhizomes. Eight compounds including two new furan derivatives, cibotiumbarosides A and B, corchoionoside C and a new glycolipid, cibotiglycerol were isolated from a methanol extract of *Cibotium barometz* rhizomes (Nguyen et al. 2009b). Three

unusual sesquiterpenes having 1-indanone nucleus (1, 3 and 4) and an unusual orthoester spiropyranosyl derivative of protocatechuic acid (2) were isolated from *Cibotium barometz* rhizomes (Wu and Yang 2009).

Xie et al. (2011) reported 5-hydroxymethyl furfural, protocatechuic acid and protocatechuic aldehyde in raw material and processed products of *C. barometz*.

The content of total phenolic acid in *C. barometz* rhizome from different areas in China varied from 3.72–6.16 %, and it was 3.09–5.09 %

in its processed products (Ju et al. 2012). Ten compounds were purified from 70 % alcohol extract of *C. barometz* and their structure were identified as 1-*O*-caffeoyl-D-glucopyranose; 6-*O*-caffeoyl-D-glucopyranose; 3-*O*-caffeoyl-D-glucopyranose; 3-hydroxymethyl-2(5*H*)-furanone; β -miroside; cibotiumbaroside A; protocatechuic acid; glucose; mannose; Corchoionoside C and kojic acid (Xu et al. 2012b). Xu et al. (2013b) isolated two hydrolyzable tannins, 4-*O*-caffeoyl- α -D-glucopyranose and 4-*O*-caffeoyl- β -D-glucopyranose, from the rhizomes. The content of tannins in the rhizomes were found to decrease after different processing (Jia et al. 2001). Six compounds isolated from *C. barometz* were identified as 6-*O*-protocatechuoyl-D-glucopyranose; 3-*O*-caffeoyl-D-glucopyranose; 1-*O*-caffeoyl- β -D-glucopyranose; caffeic acid; protocatechuic acid and *p*-hydroxybenzoic acid (Xu et al. 2013c). Compound 1 was a novel phenolic glucoside named cibotiumbaroside D.

Xu et al. (2012a, b) reported the following pharmacological effects of *C. barometz* and its processed products: analgesic, haemostatic, anti-inflammatory, anti-bone loss, antioxidative, anti-platelet, hepatoprotective, antihyperlipidemic and central nervous system (CNS). Earlier, Yang et al. (2010) reported the following pharmacological effects of *C. barometz*: antiosteoporotic, anti-inflammatory, haemostatic, analgesic and anti-rheumatic. Maillard reaction was found to be involved in the processing of *C. barometz* rhizome, which may be contributed to the variation in chemicals and activity between raw and processed *C. barometz* (Xu and Jia 2011).

Antioxidant Activity

The chloroform and *n*-butanol fractions of the ethanol rhizome extract exhibited significant 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity (Ryu and Lee 2008). Baked processed products of *C. barometz* exhibited stronger antioxidative activity than the raw material (Xu et al. 2011). The methanol extract of *C. barometz* rhizome exhibited effective antioxidant activity in a dose-dependent manner with IC₅₀

values of 44.2, 19.84, 137.66, 22.94, 289.73, 53.52 μ g/mL for DPPH \bullet , ABTS \bullet^+ , super anion $\bullet\text{O}_2^-$, hydroxyl $\bullet\text{OH}$ scavenging assays, Fe³⁺ reducing power, Cu²⁺ reducing power assays, respectively (Mai et al. 2012). Its total phenolic content was 50.88 mg CAE (caffeic acid equivalent)/g and the caffeic acid content (the major contributing compound) was 1.82 mg/g. Three rhizome compounds 1-*O*-caffeoyl-D-glucopyranose, 3-*O*-caffeoyl-D-glucopyranose compound 3 and cibotiumbaroside A showed significant DPPH antioxidant activity, and the scavenging activity of 1-*O*-caffeoyl-D-glucopyranose was similar to that of vitamin C (Xu et al. 2012b).

Lai et al. (2009) reported *C. barometz* leaf extract to have antioxidative (1,1-diphenyl-2-picrylhydrazyl (DPPH), ferric ion reducing power (FRP), β -carotene bleaching (BCB) and ferrous ion chelating (FIC)) and antibacterial activity in vitro. The IC₅₀ value for DPPH radical scavenging assay was 0.25 mg/mL and 1542 mg ascorbic acid/100 g and ferric reducing power was 804 mg GAE/100 g and its total phenolic content was 1589 mg GAE/100 g. The order of the fern extracts in these antioxidative activities was similar to that for TPC, i.e., *Blechnum orientale* \geq *Drynariolinearis* $>$ *C. barometz* $>$ *Asplenium aureum* $>$ *Asplenium nidus*. The antioxidative activity in terms of its ability to inhibit lipid peroxidation as measured by beta carotene bleaching assay showed that at the highest concentration, the BCB antioxidative activity decreased in the order D. linearis (99 %) $>$ B. orientale (73 %) = C. barometz (69 %) $>$ A. aureum (51 %) = A. nidus (47 %). All ferns showed very low ferrous ion chelating activity (<22 %), except for A. aureum (58 % at a concentration of 6.7 mg/mL).

Antioosteoporotic Activity

Cibotium barometz was found to have high inducing ability on alkaline phosphatase activity in human foetal osteoblast (Lee et al. 2003). Several compounds isolated from the rhizome including cibotiumbaroside B and cibotiglycerol showed inhibition of the bone-destroying osteoclast for-

mation with no effect on bone marrow-derived macrophage (BMM) cell viability (Nguyen et al. 2009b). Yu et al. (2011) found the *n*-butanol extract of *C. barometz* processed products had the most significant effect on cell proliferation of osteoblasts in the rat and in-vitro culture. *Cibotium barometz* rhizome extract prevented total bone mineral density decrease in the femur induced by ovariectomy in female rats, which was accompanied by a significant decrease in skeletal remodelling, as was evidenced by the decreased levels of the bone turnover markers, such as osteocalcin (OC), alkaline phosphatase (ALP), deoxypyridinoline (DPD) and urinary Ca and P excretions (Zhao et al. 2011). The treatment could also enhance the bone strength and prevent the deterioration of trabecular microarchitecture. The results indicated that *C. barometz* extract might be a potential alternative medicine for the prevention and treatment of postmenopausal osteoporosis.

Various *n*-butanol extract fractions from different processed products of *C. barometz* showed a significant proliferative effect on osteoblasts in the order of the wined>the heated>the salted>the sand-heated and wined system>the alcohol-processed>the steamed>the crude material (Xu et al. 2013a). The q test showed no significant difference among sand-heated, alcohol-processed and steamed *C. barometz*; no significant difference between heated and salted *C. barometz*. Various control substances also showed a certain proliferative effect on osteoblasts in the order of the mixed control>protocatechuic aldehyde>protocatechuic acid>kojic acid. The q test showed no significant difference between protocatechuic aldehyde and protocatechuic acid. All of *n*-butanol extract fractions from different processed products of *C. barometz* showed a significant effect on osteoblast proliferation, of which wined *C. barometz* showed the best effect. All of phenolic compounds such as protocatechuic aldehyde, protocatechuic acid and kojic acid showed a significant proliferative effect on osteoblasts. Raw rhizome slices of *C. barometz* steamed with rice wine and its index constituents like protocatechuic acid and protocatechuic aldehyde were found to promote prolif-

eration and differentiation of primary rat osteoblasts cultured in-vitro (Xu et al. 2014b). *Cibotium barometz* was reported to be active in preventing post-menopausal osteoporosis in ovariectomized rat (Rufus et al. 2013). Among the different processed rhizomes of *C. barometz* namely raw, sand-baked, wined, steamed and salted, sand-baked and wined processed rhizomes were better than the steamed, salted and raw rhizomes in inhibiting retinoic acid-induced osteoporosis in male rats evidenced by their effects on s-(TRAP) tartrate-resistant acid phosphatase and total scores of OPG (osteoprotegerin), Ca, P, interleukins IL-6, IL-1 and TNF-alpha (Xu et al. 2014a).

Antiviral Activity

Six herbal extracts, including two from *C. barometz* rhizome (designated as CBE and CBM), were found to be potent inhibitors of severe acute respiratory syndrome associated coronavirus (SARS-CoV) at concentrations between 25 and 200 µg/mL (Wen et al. 2011). Among the extracts, CBM also showed significant inhibition of SARS-CoV 3CL protease activity with IC₅₀ value of 39 µg/mL.

Antibacterial Activity

The ranking of the antibacterial activity based on the number of test bacteria inhibited of fern leaf extracts was *Asplenium nidus* (4)>*Drynaria linearis* (3)=*Blechnum orientale* (3)>*C. barometz* (2) (Lai et al. 2009). *C. barometz* leaf extract was inhibitory in-vitro to *Staphylococcus aureus* and *Bacillus cereus*.

Anticancer Activity

Many traditional applications or phytotherapeutic concepts propose to inhibit the proliferation of prostate cancer cells. Fractions from *Cibotium barometz* exhibited hormonal influences on LNCaP and PC-3 prostate cancer cells (Bobach

et al. 2014). The differential behaviour of the two prostate cancer cell lines allowed the discrimination between potential androgenic or antiandrogenic activities and effects on the oestrogen or glucocorticoid receptor.

Hepatoprotective Activity

Onychin exhibited antioxidation and protective effect from liver damage induced by lipid peroxide in mice (Yang et al. 2002). It significantly decreased the level of lipid peroxide malondialdehyde in the liver homogenate.

Antityrosinase Activity

C. barometz leaf extract showed moderate antityrosinase activity (35 % inhibition), equivalent to 102 mg of quercetin/g and 11 mg of kojic acid/g.

Pharmacokinetic Studies

Three unusual sesquiterpenes having 1-indanone nucleus (1, 3 and 4) and an unusual orthoester spiropyranosyl derivative of protocatechuic acid (2) were isolated from *Cibotium barometz* rhizomes (Wu and Yang 2009). Compound 1 was well-absorbed, and 2 and 3 were poorly absorbed compounds in the human intestine. Using human Caco-2 cell monolayer model, the permeation rates of 1, 3 and 4 increased linearly as a function of time up to 180 min and with the concentration within the test range of 25–200 μ M.

Traditional Medicinal Uses

Cibotium barometz has been traditionally used as anti-inflammatory and anodyne (Wu and Yang 2009). Its rhizomes and roots were reported to be collected for medicinal uses, including use as blood coagulant and treatment of ulcers, rheumatism, typhoid and coughs (Puri 1970; May 1978; Nguyen et al. 2009a, b; Wu et al. 2007). This fern has been reported to be used in traditional medi-

cine to treat fainting, wounds, ulcers, cough, rheumatism and used as kidney and liver tonic (May 1978; Piggott 1988). According to Nguyen et al. (2009a, b), Zhang et al. (2008), the rhizome of *C. barometz* is believed to replenish the liver and the kidney, strengthen the tendons, muscles and bones and relieve rheumatic conditions. It is widely used to cure rheumatism, limb-ache, lumbago, neuralgia and pollakiuria in aged humans, leucorrhoea, sciatica, micturition, enuresis and body-ache in pregnant women. The golden hair covering the rhizome is used for styptic for poulticing the wounds and cuts in the limbs to stop bleeding in Peninsular Malaysia and China (Burkill 1966) (Plate 2). In Vietnam, rhizomes are used to treat rheumatism, lumbago, neuralgia, sciatica, enuresis and body aches in pregnant women (WHO 1990; NIMM 1999).

According to Stuart (2014), the rhizome is considered as anodyne, anti-inflammatory, anti-rheumatic, tonic, styptic. In Chinese medicine, the rhizome is used to tonify *yang*; used as anti-rheumatic, for strengthening the bones and muscles, and to replenish the liver, kidneys and the male generative organs. It is recommended as an ‘old man’s remedy’. The roots are also used for the treatment of lumbar pain, numbness, hemiplegia, leucorrhoea, spermatorrhoea, tumours and bleeding in women. In Philippines, the rhizomes are used as topical for wounds and ulcers, and as haemostatic poultice for wounds, osteodynia, leucorrhoea, dysuria and polyuria. *C. barometz* is one of 30 components in a Chinese herb pill used in regimen of therapy – herb therapy, foot massage, leg traction and exercise – for femoral head necrosis (Stuart 2014).

Other Uses

C. barometz is reported to be used in southeast Asia for medicinal purposes and as food and fibre (Lemmens et al. 1989). The hairs that cover the rhizome were reported to be used for stuffing cushions (Chandra 1970; Van Steenis and Holtum 1959) or as packing material (May 1978). The fibres of the stem have been used by the Annamites for weaving into hats, etc. in

Indochina (Burkill 1966). Oldfield (1995) noted that tree ferns were used in the horticultural market as pot plants as well as for landscaping, and to act as substrate material for orchids. In general, all *Cibotium* species have also ornamental value and, e.g. crowns with croziers are cut for table decoration. In China, a diluted solution of plant parts is used to control aphids and spider mites.

Comments

Dried rhizome of this fern is in demand as medicine. It is known to be in trade and to be collected from the wild in China and Vietnam. Nguyen et al. (2009a) reported that the species was listed as Threatened in the 1996 Red Data Book of Vietnam.

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