Dioscorea villosa L.
Wild yam

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WILD YAM Dioscorea villosa L.

1. Taxonomy
Dioscorea villosa L.
Dioscorea is a widely distributed genus with well over 600 species worldwide.
Family: Dioscoreaceae
Common names: Wild yam, colic root, rheumatism root
Other North American species include D. floridana Bartlett and D. mexicana Scheidw. D. batatas Decne. - a native of China - is occasionally found escaped from cultivation. D. quaternata was previously described as a separate species (Gleason & Cronquist 1991), however it is now regarded as synonymous with D. villosa (The Plant List, 2010).

N. Wild Yam.—O. The rhizome of Dioscorea villosa; Dioscoreaceae.—H. United States.—D. The shape and size of the drug are well represented in Fig. 165; crooked, branched, somewhat flattened, with few rootlets; very hard and tough, but breaks with an abrupt, somewhat fibrous fracture; pale-brown externally and white within, with yellowish wood-bundles; odorless, and taste insipidly mucilaginous but developing a slight acridity after chewing for a little while.—C. An acid principle resembling saponin, resin, etc.—U. Said to be anti-spasmodic and anti-rheumatic; also useful in bilious colic, cholera morbus, etc. Dose: 0.5 to 2 grams.
2. Botanical description and distribution

*D. villosa* is a deciduous perennial herbaceous twiner that grows counterclockwise over small and medium-size shrubs. The upper leaves are alternate, heart-shaped and shiny with long petioles, entire margins, prominent veins and acuminated apices. The lowermost leaves are usually arranged in whorls. The plants are dioecious. Small staminate (male) flowers are white and perfumed, and arranged in panicles, while carpelate (female) plants produce small solitary flowers at the leaf nodes. The fruit is a membraneous 3-valved capsule with one or two chocolate-colored winged seeds in each locule (Albrecht, 2006). The long, cylindrical seldom branched rhizomes grow to 5-10 mm in diameter, with numerous tough, slender roots attached underneath.

Distribution: Eastern USA, most common in the central and southern regions, wet woodlands from Connecticut-Tennessee, Texas-Minnesota. It prefers moist open woods, thickets and roadsides (Gleason & Cronquist, 1991).

Part Used
Dried rhizome and roots
Note: In alignment with the traditional literature, this monograph may use the term “root” to imply both root and rhizome.

3. Traditional uses

Traditional uses in Appalachia

*D. villosa* is found all over the Appalachian region, and is a popular herbal remedy for pains associated with rheumatism and arthritis, colic and intestinal cramps, proving itself a reliable antispasmodic and anti-inflammatory (Howell, 2006). Of all remedies, it is the most effective in the treatment of bilious colic, as well as being a useful treatment for rheumatism (Crellin & Philpott, 1990).

Other traditional uses

Native American use
*D. villosa* was most commonly used by Native Americans to help relieve labor pains at the time of delivery (Moerman, 1998). Otherwise it was not widely used, possible as the rhizome is quite hard and unpalatable as food (Cech, 2000), unlike some other species of yam.

Folklore & Home
Warren (1859) encouraged the home use of *D. villosa* for nausea and spasms during pregnancy, as well as for the treatment of bilious colic. Gunn (1859) recommended making a decoction of one ounce of powder in one quart of boiling water to be taken every half hour in doses of “one half to a tea cup full” until intestinal cramping is relieved. He also suggests using the tincture in doses of one half to a full teaspoon, however it is implied that this is an uncommon form of use. Salter (1877) encouraged the liquid extract in doses of one teaspoon every five minutes until
relaxation [of intestines] is perfect. Meader (1861) recommended the tincture of *D. villosa* as an expectorant.

**Physiomedical**
Physiomedicalist W. Cook (1869) used a warm infusion of the root of *D. villosa* as a relaxant to ease nervous excitement and muscular tension, relieving gas and pains of the bowels. He also used the root as a remedy for female reproductive troubles such as “painful menstruation, neuralgia of the womb, vomiting during gestation and the painful knottings of the uterus incident to the latter stages of pregnancy…as well as labor pains and after pains” (Cook, 1869).

**Eclectic**
Eclectic physician John Fyfe (1909) considered *D. villosa* an excellent remedy for all manner of gut conditions, from the intestines to the liver to the gallbladder, claiming that it relieved “hepatic congestion”. He stated *D. villosa* was “directly curative” of colicky conditions, as well as useful in the treatment of gallstones and in nausea accompanying pregnancy. Ellingwood (1919) also accounted for a broad range of uses of *D. villosa* including treatment of both bilious colic and female reproductive disorders. He described it as an anodyne, claiming *D. villosa* relieved spasms and pains almost immediately, and suggested that if no relief was felt within two hours that use should be discontinued. Regarding its use as a female reproductive tonic he explained, “In neuralgic dysmenorrhea, in ovarian neuralgia, in cramp like pains in the uterus at any time and in sever after pains it often acts satisfactory, quickly relieving the muscular spasm”. Moore (1930) reiterated Ellingwood’s claims that *D. villosa* acted as a reproductive remedy saying that it was an excellent treatment for afterpains and spasmodic dysmenorrhea (Moore, 1930).

**Regulars**
Dr. Paine (1874) related accounts of fellow practitioners and their successes and/or failures in using specific drugs. According to Paine, Henry Summers, a practicing family physician, was extremely successful in using *D. villosa* to address the symptoms of bilious colic and “any other portions affected by the nervous system”. The initial treatment was given to a forty-year-old woman “laboring under a severe form of affection for three days…” (Paine 1874). The second dose relieved the violence of the paroxysm and in two hours the vomiting and pain had been entirely controlled although there was gastric and enteric inflammation for several days.” Paine also stated the extract preparation was successful in treating various forms of neuralgia, spine, brain, and uterine complaints (Paine, 1874).

### 4. Scientific Research

**Phytochemistry**

**Steroidal saponins**
During the 1930s Japanese investigators first discovered the saponin disogenin from an oriental yam (*D. tokoro*) (Fujii & Matsukawa, 1936). Subsequently Russell Marker and co-workers from Pennsylvania State College conducted extensive investigations into the chemistry and biosynthesis of steroidal compounds from natural sources, in the process several saponins were
isolated and identified from North American species of the Liliaceae and Dioscoraceae families (Marker, Turner, Shabica, et al., 1940), including diosgenin from *D. villosa* (Marker, Turner, & Ulshafer, 1940). Marker also described methods for conversion of diosgenin into testosterone and other steroids (Marker, 1940), ultimately leading to synthesis of cortisol and contraceptives. A major screening program revealed that well over 100 species of the *Dioscorea* genus contained the sapogenin diosgenin (Martin, 1969). Since then dozens of glycosides based on the steroidal aglycone structure of diosgenin have been identified, and these are classified as either furanospiral or spirostanol depending on whether the ‘f-ring’ is open or closed (Sautour, Mitaine-Offer, & Lacaille-Dubois, 2007). All these saponins are hydrolyzed *in vivo* by intestinal bacteria, thus releasing the active constituent diosgenin.

![Dioscin structure](image)

**Figure 2.** Structure of dioscin, a spirostanel saponin. Figure reproduced from *The Constituents of Medicinal Plants* (Pengelly, 2004).

Sautour and co-workers have reported six saponins for *D. villosa*: protodioscin, ME protodioscin, parrisaponin, dioscin, progenin III (= prosapogenin A of dioscin) and progenin II (Sautour, Miyamoto, & Lacaille-Dubois, 2006; Sautour et al., 2007). Using H, C and 2D NMR spectroscopy Hayes et al. (2007) identified four major and three minor steroidal saponins in quantitative terms. The major saponins (none of which were reported by Santora et al.) included two furanostanol types - methyl parvifloside and protodeltonin - as well as two spirostanol types – deltonin and glucosidodeltonin. The furostanol saponins were the most common constituent in autumn harvested samples whereas the spirostanol saponins were predominant in summer harvested material. The minor saponins (which were reported by Sautour) were methylprotodioscin, disoscin and prosapogenin A of diosgenin (Hayes et al 2007). Morgan (2011) notes that some commercial extracts are standardized to diosgenin rather than dioscin, and that such extracts may be derived from other species (eg Chinese yam, *D. oppositifolia* L.) which may lack the full chemical profile of *D. villosa*.

Another spirostanol saponin, not previously identified in *Dioscorea* spp., was recently isolated using preparative HPLC (Hu, Lin, Liu, & Yang, 2007).

**Table 1.** Classification of major diosgenin based saponins in *D. villosa*

<table>
<thead>
<tr>
<th>SPIROSTANOL</th>
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<tbody>
<tr>
<td>Dioscin</td>
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</table>
Parrisaponin

Prosapogenin A of dioscin (progenin III)

progenin II

Deltonin

Glucosidodeltonin (Zingiberensis I)

**FURANOSTANOL**

Protodioscin

Methyl protodioscin

Methyl parvifloside

Methyl protodeltonin

**Flavonoids**

Two flavan-3-ol glycosides have been isolated from *D. villosa* (Sautour, Miyamoto, Lacaille-Dubois, 2006)

**Other constituents**

Other constituents identified include phytosterols (sitosterol, stigmasterol, taraxerol), the alkaloid dioscorine, tannins, starch, vitamins b and c, beta carotene and minerals (Braun & Cohen, 2010).

**Pharmacology**

**Hormonal effects**

Most of the biomedical research associated with the species is based on the activity of dioscin and diosgenin. Despite the fact that the molecule can be converted to hormones such as progesterone and dehydroepiandrosterone (DHEA) by several enzymatic steps in the laboratory, there is conflicting evidence as to whether diosgenin has prostergenic activity in itself, and attempts to market it as such have been dubbed by some “the wild yam scam” (Foster & Johnson, 2006). However, estrogentic action on the mammary epithelium of ovariectomized mice has been reported (Aradhana, Rao, & Kale, 1992), while other studies have provided mixed results (Zava, Dollbaum, & Blen, 1998). In one study diosgenin was able to protect the kidneys of rats from morphological changes associated with ovariectomy, posited as occurring due to conversion of diosgenin to progesterone *in vivo* (Tucci & Benghuzzi, 2003). However any direct hormonal effect that can be attributed to *D. villosa* is in fact estrogentic (Morgan, 2011).
When postmenopausal women were given diosgenin-containing edible yam (D. alata) as 30% of their diet for 30 days they had increases in serum estrogens and decreases in serum androgen levels (Wu, Liu, Chung, Jou, & Wang, 2005). A couple of recent studies focusing on osteoporosis and bone formation have investigated the possible interrelationship between diosgenin and steroid hormones.

Osteogenesis
Studies based on ovariectomized rat models compared treatments between diosgenin and DHEA and found they behaved in a similar fashion (Scott, Higdon, et al., 2000). In ovariectomy-induced osteoporosis, diosgenin along with DHEA and estrogen were all found to reduce bone loss in the rats (Higdon, Scott, et al., 2001). In an *in vitro* study, diosgenin upregulated the growth-factor VEGF-A, and promoted angiogenesis through activation of the protein HIF-1 via estrogen-dependent signaling pathways (Yen et al., 2005). Subsequently the osteogenic (as distinct from “estrogenic”) effect of diosgenin has been linked to enhancement of Type 1 collagen, alkaline phosphatase and other bone marker proteins in osteoblastic cells (Alcantara et al., 2011)

Antiproliferative effects
Numerous studies have demonstrated some cytotoxic activity by diosgenin and its glycosides (Hu, Lin, Liu, & Yang, 2007; Sautour et al., 2007). In cell culture studies diosgenin demonstrated antiproliferative effects through cell cycle arrest, apoptosis induction via mechanisms that appear to involve nuclear factor-κB (NF-κB) induction and prostaglandin E₂ synthesis (Moalic et al., 2001). Subsequent studies showed that diosgenin inhibited osteoclastogenesis through inhibition of NF-κB regulated gene expression, while potentiating apoptosis induced both by tumor necrosis factor (TNF) and two chemotherapy drugs (Shishodia & Aggarwal, 2005). Diosgenin also inhibited growth of human colon carcinoma cells in dose dependent manner, via a mechanism involving suppression of HMG-CoA reductase enzyme associated with cholesterol biosynthesis (Raju & Bird, 2007). In a recent anti-cancer screening program using malignant neuroblastoma cells, *D. villosa* extract was found to have the strongest tumoricidal activity of 374 herbal extracts tested (Mazzio & Soliman, 2009).

Heptatoprotective and Cardiovascular Effects
An *in vivo* study on rat models showed that supplementation with 0.5% diosgenin while on a high cholesterol diet provided a hepatoprotective effect on the high oxidative stress of the diet, and also an elevated HDL cholesterol level by 1.5 times compared with the control group (Son et al., 2007). A significantly lower liver cholesterol level was observed with a 7 fold increase in biliary cholesterol secretion, suggesting that diosgenin may be a promising treatment for reducing the progression of atherosclerosis and cardiovascular disease (Son et al., 2007).

Antifungal effects
Steroidal saponins are considered to be an important source of antifungal agents, and numerous glycosides of diosgenin – including three spirostane saponins found in *D. villosa* – actively inhibit *Candida albicans* and other human pathogenic yeasts *in vitro* (Sautour et al., 2007).

Anti-inflammatory activity
Few studies are available, however there is evidence of lipoxygenase inhibition *in vitro* (Nappez, Liagre, & Beneytout, 1995) and some reported regulation of cyclooxygenase expression (Moalic et al., 2001).
Clinical studies
In a double blind cross-over study of 23 women with ‘troublesome’ menopausal symptoms, there was no difference in symptoms between the group using a wild yam cream based on *D. villosa* and the placebo group following three months of treatment (Komesaroff, Black, Cable, & Sudhir, 2009).

5. Modern Phytotherapy
Modern therapeutic use of *D. villosa* reflects pharmacological research and traditional indications. Naturopathic uses include spasmodic conditions of the gastrointestinal tract and associated colicky pain as well as the spasmodic pain of dysmenorrhea (Kuts-Cheraux, 1953). Volume two of the British Herbal Compendium (2006) lists similar indications but also emphasizes an anti-inflammatory action beneficial in acute phases of rheumatoid arthritis as well as musculoskeletal disorders in general. Some respected practitioners suggest there is a hormonal effect that can be helpful in promoting conception and modulating perimenopausal symptoms (Mills & Bone, 2000). Other practitioners dispute any significant hormonal activity (Romm, 2010). Modern midwives continue to use it for the nausea and vomiting of pregnancy as well as threatened miscarriage and for ineffective, hypertonic uterine contractions during labor (Romm, 2010).

Table 2: Modern phytotherapeutic uses of *D. villosa*

<table>
<thead>
<tr>
<th>ACTIONS</th>
<th>THERAPEUTIC INDICATIONS</th>
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<tbody>
<tr>
<td>Spasmolytic</td>
<td>Bilious colic, cholecystitis, spasmodic griping pain in stomach and bowels</td>
</tr>
<tr>
<td>Nervine</td>
<td>Spasmodic dysmenorrhea, uterine cramps, ovarian neuralgia, salpingitis</td>
</tr>
<tr>
<td>Anti-inflammatory</td>
<td>Dyspepsia, morning sickness, chronic flatulence, diverticulitis</td>
</tr>
<tr>
<td>Mild diaphoretic</td>
<td>Acute phase of rheumatoid arthritis, gout, neuralgia</td>
</tr>
<tr>
<td>Cholagogue</td>
<td>Menopausal symptoms, false labour pains</td>
</tr>
<tr>
<td></td>
<td>Leg cramps, intermittent claudication</td>
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</tbody>
</table>
Specific Indications
Bilious colic, acute phase of rheumatoid arthritis (British Herbal Medicine Association, 1983)

Combinations: with *Echinacea angustifolia* DC. and *Hydrastis canadensis* L. in salpingitis
With *Sambucus nigra* L. and *Althaea officinalis* L. for appendicitis and diverticulitis (British Herbal Medicine Association, 1983)

Preparations and dosage
Decoction of dried root, 2-4g three times daily
Tincture: 2-10 mL three times daily
Fluid extract (1:1) 2-4mL/ three times daily (British Herbal Medicine Association, 1983)

Toxicity and contrindications
The Botanical Safety Handbook lists *D.villosa* as Class 1: “Herbs that can be used safely when used appropriately” (McGuffin, Hobbs, Upton, & Goldberg, 1997).

*D. villosa* is deemed to be safe for use in cosmetic studies based on short-term toxicity, dermal irritation, sensitization and genotoxicity tests (Braun & Cohen, 2010).

Based on a single report on a product based on *D. opposita* found in the Australian Drug Reactions Advisory Committee (ADRAC) database, a study was conducted to determine whether giving rats *D. villosa* extracts for four weeks (0.79 g/kg/d) posed a potential risk to renal and hepatic health (Wojcikowski, Wohlmuth, Johnson, & Gobe, 2008). Although the study revealed an increase in collagen formation, growth factors and other markers of renal fibrosis, along with pro-inflammatory markers in the liver, there were no signs of acute renal or hepatotoxicity. Based on these findings the authors recommended that *D. villosa* not be taken for extended periods of time or when pre-existing kidney damage exists (Wojcikowski et al., 2008).

*D. villosa* is regulated in the USA as a dietary supplement.

6. Sustainability considerations
Currently found in over two-thirds of the United States (USDA, 2011), *D. villosa* is listed as "at risk" by the United Plant Savers (2011) due to habitat loss and over-harvesting. While there are many different species from the US, Canada, Puerto Rico and South America the phytochemical properties and percentage composition varies widely, however most do contain diosgenin (Burnham, 2006; Chu, & Figueiredo-Ribeiro, 1991). Therefore, brokers and direct buyers are more concerned with diosgenin levels than the specificity of the species (Greenfield & Davis, 2004). Because some medicinal species of *Dioscorea* are fairly abundant, the sustainability of other less abundant or rare species may be jeopardized as a result of indiscriminate collecting practices. The impact on the most abundant species is initially buffered, but will gradually increase as other species decline.

*D. quaternata*, previously called *D. villosa v. glabra*, may have been used as a substitute for *D.
villosa since the 1850s (Cech, 2000), however this is no longer considered to be a separate species (The Plant List, 2010). *D. hirticaulis*, another synonym for *D. villosa*, is listed as rare and vulnerable globally and historic in Maryland while *D. villosa* is considered globally secure and is not listed as endangered, threatened or rare. Note: *D. bulbifera* is a non-native to the Southern coastal states and is considered a noxious weed.

**Harvesting & Collection regulations**
There are no known restrictions for collecting or harvesting wild yam at this time.

**Market data - harvesting impact, tonnage surveys**
According to Greenfield & Davis (2004) demand currently exceeds supply; increased applications as dietary supplements in European, North and South American markets may continue to increase marketability. Albrecht (2006) felt that overall, specific demand for *D. villosa* was relatively low, a claim supported by Greenfield & Davis (2004), who noted that general brokers are more concerned about the diosgenin levels than the specificity of the species. Rather than increasing production of *Dioscorea* plants, industry has been researching ways to increase diosgenin production in vitro or by chemically converting steroids from other plants such as fenugreek (*Trigonella* spp.) (Nagata & Ebizuka, 2002). While this may impact the mass market nutraceuticals, there will still be a demand for *D. villosa* roots for organic or value-added companies. Of the major companies selling wild yam products in North America and Europe, at least 21% had products containing *D. villosa* alone; 35% had a combination of mixed supplements and stand-alone products (Greenfield & Davis, 2004).

Buyers purchasing wild yam roots look for diosgenin levels over 5%, but because wild yam deteriorates rapidly after harvesting, collection has primarily been limited to low-volume collectors who are capable of supplying small amounts of roots in a fresh state (Greenfield & Davis, 2004).

Once collected, any unused roots must be discarded due to deterioration of the bioactive components, which becomes an economic factor for the grower and collector (Greenfield & Davis, 2004).

**Cultivation**

**Habitat**
Soil requirements for *D. villosa* cover a fairly wide range of pH and soil environments from part shade to high light, from hardwood forest to sandy or heavy clay (Filyaw, 2006; PFAF, 2010; Harding, 1908). The two requirements for growing or cultivating wild yam are moist soils with good drainage and sunlight to light shade (PFAF, 2010; Burnham, 2006). Mayapples (*Podophyllum peltatum*) and black cohosh (*Actaea racemosa*) are often found growing with *D. villosa* (Greenfield & Davis, 2004).

If open fields are used, structures to provide light shade and support for the climbing vines (Cech, 2002) should be provided. Greenfield and Davis (2004) suggest that shade be seven feet tall and open to the prevailing winds.
Propagation
Wild yam has been propagated easily by both seed and root division (Atkinson, n.d.). Field plants should be spaced about 12-18" apart (Greenfield & Davis, 2004; Cech 2002).

Seed propagation
Both male and female plants must be grown if seed is desired (PFAF, 2010). Filyaw (2006) suggests that night insects might be responsible for pollination. Seeds are ripe around September (Filyaw, 2006), these should be collected and separated from the capsules anytime after the first frost (Atkinson, 2010). For wild, woods or garden cultivation Atkinson (2010) suggests that seed can be scattered over the bare ground and sprinkled with garden soil but should be protected with screening or chicken wire to protect from squirrels or seed eating animals. If seeds are to be stored, do not let them dry out (Greenfield & Davis, 2004).

For field or controlled propagation, seed should be sown inside in early spring (March-April) and barely cover, germination takes 1-3 weeks (Fern, 2010). Greenfield and Davis (2004) and Albrecht (2004) both suggest at least 4 weeks cold stratification, which may not be needed if seed is gathered in early winter. For greenhouse or seedbed propagation, prick the seedlings as soon as they have their first true leaves and maintain them the first year, then plant them out the following spring (Fern, 2010).

Vegetative propagation
Fern (2010) suggests that wild yam can be propagated by basal cuttings during the summer or by root division once the plants have gone dormant. Root cuttings may produce more than one shoot, which can be cut about 2-3 inches below the shoot keeping fibrous roots attached and planted separately (Cech, 2002; Fern, 2010), the remaining tuber may be used in medicine. Propagation from rhizome division can produce harvestable roots in 2-3 years (Greenfield & Davis, 2004). Note, some sources suggest using bulbils formed in the leaf axils of wild yam for propagation, however, D. villosa does not produce bulbils (Albrecht, 2004) a fact which can be used for identification.

Harvest
According to Greenfield and Davis (2004) plants should be at least four years old before harvesting. Roots are harvested in the fall, after the aerial parts die back, for optimum concentration of the medically active ingredients (Atkinson, n.d.). Harvested roots should be cleaned and washed using a mesh and hose; moldy or discolored areas should be removed and roots can be cut into smaller pieces for drying (Cech, 2002; Greenfield & Davis, 2004; Albrecht, 2006). Dry these at 70 degrees F for one day, then at 110 degrees F. for two or more days, until they snap when broken (Cech, 2002; Greenfield & Davis, 2004). Dried roots can be stored in moisture and light proof bags for up to one year after which they begin to lose their medicinal value.

Pests
Besides being browsed by wildlife, some plants have been recorded with leaf spot, but overall there are few reported problems with cultivated D. villosa (Greenfield & Davis, 2004).
7. **Summary – some possibilities moving forward**

A significant body of experimental data relating to the biological effects of diosgenin has been acquired over the last 60-70 years, much of which is not specific to *D. villosa*. While these findings may help validate some traditional uses associated with the species, comprehensive investigations into the activity of *D. villosa* extracts via the oral route are long overdue. Further safety data is required to pave the way for future clinical studies. Clinical investigators would be well served to include one or more certified herbal practitioners in their research teams. This would help direct the focus away from trendy products such as the “natural progesterone” creams towards specific clinical applications, as expounded in the Traditional Use and Modern Phytotherapy sections of this monograph.

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Appendix I. Voucher specimen lodged at the Claude E. Phillips Herbarium, Delaware State University. Specimen collected at Ohio Botanic Sanctuary, via Rutledge, OH. May 2011.