

ARJUNA

Terminalia arjuna (Roxb. ex DC) Wright & Arn.

Family

Combretaceae

Parts Used

Bark

Description

Arjuna is a very large, evergreen tree which can grow to approximately 20 metres high. It is found in abundance throughout India, Sri Lanka (known as kumbuk), Burma (phauk kyant pin) and Mauritius. In Sri Lanka it grows to an enormous size in the beds of tanks and rivers in the dry regions and is, generally speaking, the most noticeable feature of such scenery. Specimens in the south of Sri Lanka have been recorded in 1800 with trunks seven metres in circumference. A recognised Colombo tree

measured in 1879 was 14 metres in circumference around the base. Its superficial, shallow root system spreads radially along stream banks. This has led to it playing a role in phytoremediation of drinking water in Sri Lanka. It can remove and neutralise pollutants from a contaminated well via its root system therefore purifying the water. It has a huge, often buttressed, trunk and horizontally spreading branches. The large, spreading crown produces drooping branches. The bark is smooth, pinkish or greenish white from outside and flakes off in large, curved and rather flat pieces once a year like a snake skin. The size of each piece may vary up to 15cm or more in length, 10cm in width and three to 10mm in thickness. It has greenish-white, strong, honey scented flowers which are stalkless and found in clusters or in axillary spikes. They flower in autumn and the plant bears a smooth, winged, woody fruit in winter.^{1,2,3,4,5,6}



Traditional Use

Arjuna is a popular Indian medicinal plant, its bark being used as a cardiogenic agent from time immemorial. This renowned heart tonic is used extensively in cardiac debility and is best known for its special properties of strengthening the muscles of the heart and subsequent improved pumping activity of the heart. Its blood coagulating properties are extremely useful in arresting bleeding. The generic name *Terminalia* is derived from the Latin 'terminus' or 'terminalis' (ending), referring to the habit of its leaves being crowded at the tips of the shoots. The name arjuna means 'white' or 'bright', probably denoting its creamy-white flowers or the shining quality of its bark. Both Caraka and Susruta (principal contributors to Ayurvedic texts pre-200 CE (Common Era (previously AD)) mentioned arjuna in their Samhitas (foundational Ayurvedic texts) but surprisingly did not indicate its use for heart diseases. It was Acarya Vagbhata (an influential classical writer of Ayurveda in the 7th Century) who for the first time indicated arjuna was used for treating heart disease. Subsequently it was endorsed by Cakradatta (who composed another landmark publication) and Bhavamisra (another Ayurvedic scholar). In ancient texts like Caraka Samhita, arjuna is categorised under *pramehaghna* (antidiabetic) and *raktastambhaka* (styptic). Later on it was incorporated into *hrdroganasaka* (ameliorating heart disease).⁷

The astringent (*rasa*) bark is remarkable for the immense amount of lime it contains, and traditionally was largely burnt as a source of lime for chewing with betel (a mild stimulant from the pepper and kava family), the copious ash almost entirely consisting of pure calcium carbonate.⁸

A decoction of the bark is used to wash ulcers and is taken internally for liver congestion and as an antidote to poisons, especially snakebite and scorpion stings. The juice of the leaves is a remedy for earache. For fractures, with excessive bruising, the powdered bark is given internally with milk. In Sri Lanka preparations of the bark are administered for diseases of the heart and lungs, and for fractures and bruising.^{9,10} Arjuna bark, ground to a paste with water and applied externally on the site of fractures helps in their early healing. It is also recommended in traumatic injuries associated with swelling. The dressing of the wounds and ulcers with a decoction

of arjuna bark hastens the healing and cleansing.¹¹ Traditional healers from Kancheepuram district, Tamil Nadu boil the bark powder with water, and inhale it to cure headache and to kill worms in teeth. They also use fruit paste topically on wounds.¹² Fresh bark powder is used for treating heart ailments by the Malabar tribe, Kerala.¹³ Tribals living in Sundargarh District, Orissa use dried bark powder along with rice washed water to treat blood in urine, and tribes living in Malkangiri district chew the fresh bark and swallow the juice as an antacid.¹⁴

In a book on the classical use of Ayurvedic plants, milk processed with arjuna (*ksirapaka*) should be used in cardiac disorders. Arjuna with ghee, milk or jaggery water is used to treat heart disease, chronic fever and to attain longevity. Arjuna was also used in combination with other Ayurvedic herbs for cough remedies. In diarrhoea associated with blood arjuna mixed with honey and taken with milk is used to check the haemorrhage.¹⁵ Twenty grams of stem bark of arjuna in 50mL of water is boiled to half, filtered, mixed in 50mL of goat milk and given internally, once a day for a week, to control palpitation and high-blood pressure. Five grams of finely powdered stem bark of arjuna is administered twice a day for 3 days to relieve pain in lower limbs.¹⁶

The bark, leaves and fruits of arjuna have also been traditionally been used for urinary discharge, strangury (painful passage of small quantities of urine), leucoderma (white patches on the skin), anaemia, sweating, asthma and tumours. Arjuna is also used traditionally in the treatment of red and swollen mouth, tongue and gums, dysentery, skin eruptions, pains, fatigue, diabetes, bronchitis and obesity. It effectively controls menstrual disorders such as menorrhagia and leucorrhoea caused by a laxity of the uterus. Arjunarista, a medicinal wine prepared from arjuna bark, *dhataki* (*Woodfordia fruticosa*) and *manuka* – black raisins is the most popular formulation used to treat cardiac debility, convalescent patients, bleeding piles, diarrhoea and leucorrhoea in the dosage 2 to 4 teaspoons twice a day.^{17,18,19}

Constituents

Arjuna contains triterpenoids, including arjunin, arjunic acid, arjunolic acid, arjungenin, and terminic acid. The bark also contains glycosides, including arjunetin, arjunoside I, arjunoside II,

arjunaphthanoloside and terminoside A; sitosterol; flavonoids, including arjunolone, arjunone, bicalein, luteolin, gallic acid, ethyl gallate, quercetin, kempferol, pelargonidin, oligomeric and proanthocyanidins; tannins and minerals. The bark also contains large amounts of carbonates of calcium and sodium. It is thought the saponin glycosides might be responsible for inotropic effects of arjuna, while the flavonoids and OPCs provide free radical antioxidant activity and vascular strengthening.^{20,21,22}

Actions

Cardioprotective, heart tonic, hypotensive, hypolipidaemic, inotropic (changes the force of the hearts contractions), antioxidant, anti-inflammatory, cytoprotective, antiulcer, apoptosis inducing, antidiabetic, antibacterial, antiviral, vulnerary, astringent, febrifuge, demulcent, expectorant, antidysenteric.

Pharmacological Activity

Cardiovascular and Cardioprotective Activities

A number of experimental and clinical studies have been conducted to explore the therapeutic potential of arjuna in cardiovascular ailments, especially in patients of coronary heart disease. Many experimental studies have reported its antioxidant, anti-ischemic, antihypertensive and anti-hypertrophic effects, thus indicating its therapeutic potential in cardiovascular diseases in humans. Several clinical studies have reported its efficacy mostly in patients with ischemic heart disease, hypertension and heart failure. The cardioprotective effect of arjuna has been well documented in experimental animal models in which it shows its potential effect via induction of the endogenous antioxidant system.²³

A 2015 Indian review was conducted to provide updated, comprehensive and categorised information on the history and traditional uses of garlic (*Allium sativum*), guggul (*Commiphora wightii*), hawthorn (*Crataegus oxyacantha*) and arjuna. The reviewers also wanted to explore the plants' therapeutic potential and evaluate future research opportunities. The reviewers concluded that although the mechanisms of action are not very

clear there is enough evidence of the plants efficacy in various cardiovascular disorders. Although these plants have been used in the treatment of heart disease for hundreds of years current research methods show that they can be utilised effectively in the treatment of cardiovascular diseases including ischemic heart disease, congestive heart failure, arrhythmias and hypertension.²⁴

Chronic Heart Failure

A 2016 double-blind, parallel, randomised, placebo-controlled add-on clinical trial found that arjuna improved functional capacity, antioxidant reserves and symptom related quality of life in some chronic heart failure patients. In the 12 week study 100 chronic heart failure patients took 750mg of a 1:1 arjuna extract or matching placebo twice daily.²⁵

Cardiomyopathy

The results of a small study suggest that arjuna may be a beneficial adjunctive therapy in chronic disease of the heart muscle (cardiomyopathy). Twelve patients with refractory chronic congestive heart failure, related to idiopathic dilated cardiomyopathy (10 patients), previous myocardial infarction (one patient) and peripartum cardiomyopathy (one patient), received arjuna bark extract (500mg eight hourly) or matching placebo for two weeks each, separated by two weeks washout period, in a double-blind cross over design. Arjuna, compared to placebo, was associated with improvement in symptoms and signs of heart failure. On long term evaluation where participants continued arjuna (500mg eight hourly) in addition to flexible diuretic, vasodilator and digitalis dosage for 20 to 28 months on outpatient basis, patients showed continued improvement in symptoms and signs with improvement in quality of life.²⁶

Angina

A small study found arjuna beneficial in angina pectoris and congestive heart failure. A dose of 500mg eight hourly was administered postoperatively to 10 patients of postmyocardial infarction angina and two patients of ischaemic cardiomyopathy for a period of three months. The patients were also on conventional treatment comprised of nitrates, aspirin and/or calcium channel blockers. Twelve matched patients of postmyocardial infarction angina receiving

only conventional treatment served as controls. Significant reduction in anginal frequency was noted in both groups. However, only the arjuna treated patients showed significant improvement in left ventricular ejection fraction and reduction in left ventricular mass on echocardiography following three months of therapy. Both patients with ischaemic cardiomyopathy showed significant symptomatic relief in coronary heart failure.²⁷

The results of another small study suggests that arjuna is effective in patients with symptoms of stable angina pectoris. The effect of arjuna on anginal frequency, blood pressure, body mass index, blood sugar, cholesterol and HDL-cholesterol was studied in 15 stable and five unstable angina patients before and three months after arjuna therapy. There was 50% reduction in anginal episodes in the stable angina group. Tread mill test performance improved from moderate to mild changes in five patients and one with mild changes became negative for ischemia.²⁸

The beneficial effects of arjuna on stable angina was confirmed in another pilot study. Ten patients with stable angina pectoris were given two capsules containing 100mg of arjuna (in an Ayurvedic formula with other herbs) twice daily for six weeks and one capsule twice daily for the next six weeks. Efficacy was assessed by considering the reduction in the number of anginal episodes and improvements in a stress test. The results were compared with 10 patients of stable angina pectoris who were on 20mg, twice daily, of the angina drug isosorbide mononitrate. Arjuna provided symptomatic relief in 80% of patients and isosorbide mononitrate in 70%. The number of anginal attacks were reduced from 79 a week to 24 a week. Arjuna improved blood pressure response to the stress test in two patients and ejection fraction in one. Arjuna was better tolerated than isosorbide mononitrate.²⁹

In a larger study arjuna (500mg) was comparable with isosorbide mononitrate (40mg per day) in improving clinical and treadmill exercise test parameters in men with stable angina. Fifty-eight males with chronic stable angina received arjuna (500mg eight hourly), isosorbide mononitrate (40mg daily) or a matching placebo for one week each, separated by a wash-out period of at least three days in a randomised, double-blind, crossover design. Arjuna therapy was associated with a

significant decrease in the frequency of angina and the need for isosorbide dinitrate (another angina drug). The treadmill exercise test parameters improved significantly during therapy with arjuna compared to those with placebo.³⁰

Arjuna may also be beneficial in ischaemic mitral regurgitation, a valve disease. In a study of 40 patients suffering ischemic mitral regurgitation following acute myocardial infarction, 500mg of arjuna significantly decreased the mitral regurgitation, improved E/A ratio (a marker of the function of the left ventricle of the heart) and reduced angina frequency compared to placebo after three months therapy.³¹

Hypercholesterolaemia

Arjuna has been found to have a significant antioxidant action that is comparable to vitamin E and also has a significant hypocholesterolaemic effect. In a study on 105 patients with coronary heart disease 35 people received placebo capsules, 35 received vitamin E capsules (400 units per day) and 35 received 500mg of arjuna in capsules daily. Neither Vitamin E, nor placebo, caused any significant changes in total, HDL, LDL cholesterol and triglycerides levels. In the arjuna treated group there was a significant decrease in total cholesterol and LDL cholesterol. Vitamin E and arjuna both decreased lipid peroxide levels significantly.³²

A study found arjuna, along with statins for three months, resulted in a 15% decrease in total cholesterol, 11% in triglycerides and 16% in LDL-cholesterol. The results suggest that arjuna may work synergistically with statins in hyperlipidaemia.³³

Arjuna may be useful in the prevention and management of atherosclerosis a 2016 *in vivo* study found. The study evaluated the effect of arjuna on protein expression in aortic plaques of hypercholesterolaemic animals using a proteomic (the study of proteins) approach. Serum lipids were found to be significantly increased by a high fat diet and reduced by arjuna both at three and six months. Arjuna significantly weakened the protein expression of proteins which are known to be consistently associated with endothelial dysfunction, inflammation, plaque rupture and immune imbalance.³⁴

The results of a 2015 *in vivo* study suggest that arjuna offers cardioprotection against oxidative

stress associated with myocardial ischemic reperfusion injury. Arjuna induced a myocardial heat shock protein which suggests it could have an important role in myocardial cell protection after regional myocardial ischemic reperfusion injury.³⁵

A 2015 *in vivo* study found that a hydroalcoholic extract of arjuna reduced oxidative stress, apoptosis and improved antioxidant status in induced cardiotoxicity.³⁶

A recent experimental study showed that arjuna increased the force of contraction of cardiac muscle in a number of experimental models. The inotropic effect is considered to be mediated through the high concentration of calcium ions present in the plant.^{37,38}

There is also a growing body of evidence suggesting that antioxidants contribute to cardioprotection. Nine key plants in Ayurvedic formulations used in the therapy of cardiovascular diseases were investigated to determine whether antioxidant activity was one of the mechanisms by which these plants exert cardioprotection. Only arjuna demonstrated significant antioxidant effects (reduction in cardiac lipid peroxidation).^{39,40,41,42}

Arjuna may be beneficial in the treatment of ischemic heart disease having been shown preclinically to increase endogenous antioxidant compounds and also prevent oxidative stress associated with ischemic reperfusion injury of the heart. Arjuna was administered orally to experimental animals in two doses (500 and 750mg per kg) six days a week for 12 weeks. The rat hearts were then subjected to *in vitro* ischemic-reperfusion injury and it was shown that arjuna (500mg/kg) raised the levels of endogenous antioxidants (superoxide dismutase (SOD), reduced glutathione (GSH) and catalase (CAT)) and significantly protected the hearts against oxidative stress.⁴³

Oral administration of arjuna for 12 weeks in rabbits confirmed that arjuna increases myocardial antioxidants, SOD, CAT and glutathione, along with induction of heat shock proteins. Arjuna has furthermore been shown to prevent oxidative stress, cardiac tissue injury and haemodynamic disturbance induced by ischemic-reperfusion injury in rabbits.⁴⁴

Arjuna has been shown to reduce induced cardiac oxidative stress *in vivo*. Arjuna significantly restored the activities of all antioxidant enzymes (SOD, CAT

and glutathione-S-transferase), as well as increased the level of GSH and decreased the level of lipid peroxidation end products.⁴⁵

Recently it has been suggested that the cardioprotective role of arjuna bark extract is mediated through alterations in thyroid hormones. Supplementation with L-thyroxine was found to increase the level of thyroid hormone and increase both cardiac and hepatic lipid peroxidation. Co-administration with arjuna extract decreased the level of thyroid hormones and also cardiac lipid peroxidation suggesting a possible mediation of the drug action through an inhibition in thyroid function. These effects were comparable to a standard antithyroid drug propylthiouracil.^{46,47}

Hypolipidaemic Activity

In a 2016 investigation hypolipidaemic and antioxidant properties of arjuna added to vanilla chocolate dairy drink was evaluated in high cholesterol fed rats for 60 days. At the end of the experimental period a significant decrease in the body weight gain, serum lipids such as triglycerides, total cholesterol, low-density lipoprotein cholesterol, very-low-density lipoprotein cholesterol and atherogenic index was observed in rats receiving arjuna compared to high cholesterol fed rats.⁴⁸

A 50% ethanol extract of arjuna has been shown in a small *in vivo* study to significantly lower total and LDL cholesterol and improve the LDL to HDL ratio in diet induced hyperlipidaemic rabbits.⁴⁹ Smoking, largely through increased oxidative stress, causes endothelial dysfunction which is an early key event in atherosclerosis. Smoking cessation and antioxidant vitamin therapy are shown to have a beneficial role by restoring altered endothelial physiology. Smokers have impaired endothelium-dependent but normal endothelium-independent vasodilation as determined by brachial artery reactivity studies. A small study has found that arjuna therapy for two weeks leads to significant regression in endothelial abnormality in smokers compared to matched controls.⁵⁰

Anti-inflammatory activity

The anti-inflammatory and immunomodulatory effects of arjuna may reduce ongoing inflammation and immune imbalance in medicated coronary artery disease (CAD) subjects. A 2015 study evaluated

the cardioprotective effects of arjuna on classical and immuno-inflammatory markers in CAD as an adjuvant therapy. One hundred and sixteen patients with stable CAD were administered placebo or arjuna (500mg twice a day) along with medications in a randomised, double-blind clinical trial.⁵¹

Arjuna could find clinical application in the management of rheumatoid arthritis and associated disorders after the results of a recent *in vivo* study demonstrated its antioxidant and antiarthritic activity.⁵²

Gastric Ulceration Activity

The antioxidant and cytoprotective activities of arjuna are thought to be responsible for its protective effect against gastric ulceration. *In vivo* studies have shown arjuna to protect the gastric mucosa against induced gastric ulceration in rats. The researchers suggested the gastroprotective effect of arjuna is probably related to its ability to maintain the membrane integrity, by its antilipid peroxidative activity that protects the gastric mucosa against oxidative damage and its ability to strengthen the mucosal barrier, the first line of defence against exogenous and endogenous ulcerogenic agents.^{53,54,55}

Antioxidant Activity

A 2016 study evaluated the antioxidant and antiurolithiatic (dissolving or preventing kidney stones) properties of arjuna. The results indicated that arjuna is a potential candidate for phytotherapy against urolithiasis as it has the ability to inhibit calcium oxalate crystallization and scavenge free radicals *in vitro* along with a cytoprotective role.⁵⁶

In 2015 the same authors did a study which suggests that arjuna has the potential to scavenge free radicals and inhibit calcium oxalate crystallization *in vitro*. Arjuna was traditionally used to prevent the formation of kidney stones. For most cases, urolithiasis is a condition where excessive oxalate is present in the urine. Many reports have documented free radical generation followed by hyperoxaluria (excessive urinary excretion of oxalate) as a consequence of which calcium oxalate deposition occurs in the kidney tissue. Arjuna exhibited a concentration dependent inhibition of nucleation (the beginning of crystal formation) and aggregation of calcium oxalate crystals. The

aqueous extract of arjuna also inhibited the growth of calcium oxalate crystals.⁵⁷

Arjuna has been shown to protect the liver and kidney tissues against induced oxidative stress probably by increasing antioxidative defence activities.⁵⁸

Arjuna may also have important anticarcinogenic activities by reducing oxidative stress along with inhibition of anaerobic metabolism, both of which are strong features of cancer. Constant production of reactive oxygen species (ROS) during aerobic metabolism is balanced by the antioxidant defence system of an organism. Although low level of ROS is important for various physiological functions, its accumulation has been implicated in the pathogenesis of age-related diseases such as cancer and coronary heart disease, and neurodegenerative disorders such as Alzheimer's disease. It is generally assumed that frequent consumption of phytochemicals derived from vegetables, fruits, tea and herbs may contribute to shift the balance towards an adequate antioxidant status. Arjuna extract has been shown to increase levels of lipid peroxides associated with induced liver cancer in rats.⁵⁹

The antioxidants, CAT, SOD and glutathione S transferase are low in lymphoma-bearing mice indicating impaired antioxidant defence system. Oral administration of arjuna has been shown to significantly increase the activities of CAT, SOD and glutathione S transferase.⁶⁰

High doses of arjuna ethanolic extract (250 and 500mg/kg body weight) have been shown to produce a significant reduction in lipid peroxidation in induced diabetic rats. The results of an earlier study indicate that arjuna exhibits antioxidant activity through correction of oxidative stress which supports the traditional use of arjuna in diabetes.⁶¹

Antimicrobial Activity

Arjuna exhibited antimicrobial activity in a 2016 study. The researchers suggested arjuna may have the potential to extend the shelf life, or be used as a natural preservative, in fruit juices. Arjuna was examined against *Bacillus cereus*, *Serratia sp.*, *Rhodotorula mucilaginosa*, *Aspergillus flavus* and *Penicillium citrinum* isolated from juices.⁶²

Arjuna may be used to treat bacterial ear pathogens. A recent study assessed the antimicrobial potential of arjuna against *Staphylococcus aureus*, *Acinetobacter sp.*, *Proteus mirabilis*, *Escherichia coli*, *Pseudomonas aeruginosa* and *Candida albicans* which are pathogens causing ear infections.⁶³

Arjuna showed significant antibacterial activity in assays against *Escherichia coli*, *Klebsiella aerogenes*, *Proteus vulgaris* and *Pseudomonas aerogenes* (gram-negative bacteria).⁶⁴

Metabolic Syndrome Activity

A case study of a patient suffering metabolic syndrome suggests that arjuna may be beneficial in metabolic syndrome. Lipoprotein levels diminished significantly following therapy with arjuna.⁶⁵

Analgesic Activity

Arjuna was evaluated for its analgesic activity in animals to substantiate traditional claims about its use in pain management. Arjuna possessed analgesic activity in all experimental models of the 2014 study.⁶⁶

Miscellaneous Activity

A 2016 study indicates the diuretic potential of arjuna and its possible use as a prophylactic to prevent vascular leakage during acute mountain sickness at high altitude.⁶⁷

Indications

- Chronic cardiovascular diseases including chronic, stable angina, mild congestive heart failure, weakness of the heart, hypercholesterolaemia, hypertension and metabolic syndrome
- Adjuvant during chemotherapy
- Antioxidant therapy in diabetes
- Gastric ulceration
- Difficulty in urination
- Diarrhoea
- General detoxification
- Menstrual disorders such as menorrhagia
- Externally to improve wound healing, bleeding gums

Energetics

The Taste (*Rasa*) is astringent and bitter; the Energy (*Virya*) is cooling with the post-digestive effect (*Vipaka*) pungent; the Quality (*Guna*) is light (*laghu*) and dry (*ruksha*); the target tissue (*Dhatu*) is blood, bone and reproductive; the Channels (*Srotas*) are circulatory and reproductive. It affects all *Dosa* and purifies excess *pitta* from the blood. It alleviates the *kapha* and *pitta dosas* but vitiates (impairs) the *vata dosa*.⁶⁸

Use in Pregnancy

Traditionally not used during pregnancy.

Contraindications

None known.

Drug Interactions

It has been used concurrently with statins (cholesterol lowering drugs) with good results although information about interactions with long-term statin therapy is lacking.⁶⁹

Administration and Dosage

| | |
|------------------------------|------------|
| Liquid Extract: | 1:1 |
| Alcohol: | 45% |
| Weekly Dosage: ⁷¹ | 15 to 40mL |

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