Available online on 15.05.2021 at http://jddtonline.info

Journal of Drug Delivery and Therapeutics

Open Access to Pharmaceutical and Medical Research

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Review Article

A Review on *Woodfordia fruticosa Kurz* (Dhatki): Ayurvedic, Folk and Modern Uses

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Article Info:

Article History:

Received 23 March 2021;
Review Completed 21 April 2021
Accepted 30 April 2021;
Available online 15 May 2021

Cite this article as:

Thakur S, Kaurav H, Chaudhary G, A Review on *Woodfordia fruticosa Kurz* (Dhatki): Ayurvedic, Folk and Modern Uses, Journal of Drug Delivery and Therapeutics. 2021; 11(3):126-131
DOI: http://dx.doi.org/10.22270/jddt.v11i3.4839

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Abstract

Woodfordia fruticosa kurz is an herbal plant that belongs to the family *Lythraceae*. This plant is widely distributed throughout the tropical and subtropical regions of India, Sri Lanka, China, Malaysia, Indonesia, Japan and Pakistan. The plant possesses a long history of medicinal use. The flowers of *Woodfordia fruticosa* are recorded to possess potent therapeutic values. The various phytochemicals isolated from this plant are tannins, flavonoids, anthraquinone, glycosides and polyphenols. The extract of flowers and leaves are associated with useful therapeutic activities. These phytochemical compounds have many pharmacological properties such as antimicrobial, hepatoprotective, cardioprotective, antioxidant, antiulcer, immunomodulatory, antifertility and anti-tumor. These pharmacological activities of *Woodfordia fruticosa* plant are also mentioned in the literature of ayurveda, yunani and other traditional systems of medicine. This review is intended to provide brief information on the plant *Woodfordia fruticosa* on the basis of chemical constituents, folk usage, ayurvedic usage, modern usage and its biological activities.

Keywords: *Woodfordia fruticosa*, antimicrobial, Ayurvedic, flavonoids, Octacosanol

Introduction

Plant-derived drugs have been utilized by the majority of the world population for many years. Herbal drugs occupy an important place in both traditional and modern medicine [1,2]. The ethnobotanical knowledge is percolating down among the tribal population, but most of this knowledge is empirical at best and lacks scientific researches [3,4]. Among the various plant species utilized in folk medicine, *Woodfordia fruticosa kurz* has been utilized by practitioners for the treatment of bowel disorders [5]. All the parts of this plant exhibit therapeutic properties but flowers are majorly considered to possess great therapeutic activity. Its flowers make it a commercially important plant. There are several phytochemicals responsible for their therapeutic action. In Ayurveda, various Asavas and Aristhas were prepared from this plant. Aristhas are health tonics in nature. Aristhas have overall health-stimulating properties [6]. There are 18 aristhas mentioned in the Indian Ministry of Health and Family Welfare's monograph (CCRIMH, 1978) in which 17 have been found to contain *Woodfordia fruticose* extract. According to the Ayurvedic practitioner Charaka and Sushruta, flowers of *Woodfordia fruticosa* were utilized as a sweetened decoction for the treatment of fever, haemothermia, persistent dysentery and ulcers [7]. According to Yogaratnakara, the flowers of *Woodfordia fruticosa* have been utilized as a substitute for *Glycyrrhiza glabra* [8]. A wide range of chemical compounds isolated from the *Woodfordia fruticosa* plant includes tannins, flavonoids, anthraquinone, glycosides and polyphenols. These chemical compounds are associated with various pharmacological activities like antimicrobial, hepatoprotective, cardioprotective, antioxidant, antiulcer, immunomodulatory, antifertility and anti-tumor [9]. Many researchers are interested to study this plant in the modern times because of its therapeutic activities. Out of 87 research papers reviewed, 79 research papers describe the ethnobotanical significance of the plant [10]. The vernacular names and taxonomical classification of *Woodfordia fruticosa* are shown in table no. 1 and table no. 2

Table 1: Vernacular Names of *Woodfordia fruticosa*

Hindi	Ban-mahendi, Dhai, Dhatki, Dhatki, Dhatri, Dhaura
Sanskrit	Agnijwala
Kannada	Bela, Taamra pushpin, Daathakee Kusumka
Malayalam	Tamarpushi, Tatire, Tatiripushpi
Tamil	Dhathari-jagri, Dhattari
Telegu	Dhaarhupushpika, Dhaathaki
Tibetan	Dha-ta-ke , Me-togda tak ki
Urdu	Gul dhawa
Gujarati	Dhaavadi
Bengali	Dhai, Dawai, Dhai phul
Marathi	Dhalas , Dhayati, Dhadva
Punjabi	Dhavi
Farsi	Dhaava
Oriya	Dhobo, Jaliko, Harwari
Bihar	Dhai, Dawai
Jammu and Kashmir	Thwai
Nepali	Dhangera

Table 2: Taxonomical classification of *Woodfordia fruticosa*

Taxonomical Rank	**Taxon**
Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Order	Myrtales
Family	Lytheraceae
Genus	*Woodfordia*
Species	*fruticosa*

Botanical Description of *Woodfordia fruticosa*

Woodfordia fruticose kurz (Figure 1) belongs to the *Lythraceae* family. A fully-grown leafy shrub is long up to 3.5m and having long and spreading branches with fluted stems. The bark is smooth and characteristically cinnamon-brown in color, peels off in fibers, the young shoots and terete, often clothed with fine white pubescence. The leaves are opposite or sub-opposite. Flowers are bright red, innumerable, arranged in dense axillary paniculate-cymose clusters, with short glandular pubescent pedicles. The calyx is striated, long, covered with glandular dots, with a small bell-like base and slightly curved with the bright red tube that contracts above the included capsule. The petals are slightly longer than calyx-teeth. Petals are extended at the apex to a long fine point. The fruits are small capsules, ellipsoid and membranous. Fruits are usually irregular dehiscent and splitting the calyx nearthe base. The seeds are brown, numerous, smooth, shining, angular and obovate [11-13].

Figure 1: *Woodfordia fruticosa* (Dhatki Pushap)

Geographical distribution of *Woodfordia fruticosa*

Woodfordia fruticosa is widely distributed throughout India, Sri Lanka, China, Malaysia, Indonesia, Japan and Pakistan. In North-eastern India, it is found in Tenga and Salari to Nafra areas of East kameng district, Kawlkuth areas in Mizoram and limited northern part of West Bengal adjacent to South Sikkim district of Sikkim. It is also found in Gangetic plains [14].

Phytochemical constituents of *Woodfordia fruticosa*

The chemical constituents found in *Woodfordia fruticosa* are mainly phenolics, hydrolyzable tannins and flavonoids. Desai et al., first examined the presence of octacosanol and β-sitosterol in the stems of *Woodfordia fruticosa* [15]. These compounds were also isolated from the flowers whereas β-sitosterol detected even in the leaves of *Woodfordia fruticosa* [16,17]. Chauhan et al., demonstrated that flowers of this plant also contain other non-phenolic constituents like steroid sapogenin hecogenin and mesi-inositol. Dan et al., reported that the leaves of *Woodfordia fruticosa* contain other compounds like triterpenoids lupeol (2a), betulin (2b), betulinic acid (2c), oleanolic acid (3a) and ursolic acid (3b) [18]. Apart from flavonoids or tannins, the phenolic constituents and gallic acids are also isolated from this plant. Ellagic acid is found in the leaves and flowers of *Woodfordia fruticosa* [19]. The new constituent, norbergenin is isolated from the stems, chrysophanol-8-O--glucopyranoside from flowers, and the naphthoquinone pigment lawsone from leaves of the plant *Woodfordia fruticosa* [20]. The flavonoid constituents are characterized by various groups that include six quercetin glycosides [3-rhamnoside from flowers, 3-β –L-arabinoside from flowers and leaves and 3-O-α-D-xylopyranoside,3-O-α-L-arabinopyranoside, 3-O- β-D-xylopyranoside, 3-O-(6'' – galloyl)- β-D-glucopyranoside, and 3-O-(6''-galloyl)- β-D-galactopyranoside from leaves. Three myricetin glycosides were isolated from the plant. 3-O- β-D-galactoside present in flowers and leaves, 3-O-α-L-arabinopyranoside, 3-O-(6''-galloyl) β-D-galactopyranoside in leaves and naringenin 7- glucoside and kaempferol 3-O-glucoside in flowers. Nair et al., examined the flowers for the orange-red pigment that lead to the identification of pelargonidin 3,5-diglucoside. The new and known hydrolysable tannins have been isolated from the flowers of *Woodfordia fruticosa* [21]. The known tannins isolated are 1,2,3,6-tetra-O-galloyl- β- D-glucose, 1,2,4,6-tetra-O-galloyl-β-D-glucose, 1,2,3,4,5-penta-O, galloyl- β-D-glucose, tellimagrandin, gemin D, heterophyllin A and oenothein B [22].

Some novel constituents isolated from this plant are woodfordins A-C, woodfordin D, oenothein A, isoschimawalin A and woodfordins E-I. Woodfructicosin is the new hydro sable tannins found in the leaves of this plant. The structures of some major phytochemicals of *Woodfordia fruticosa* are shown in figure no. 2

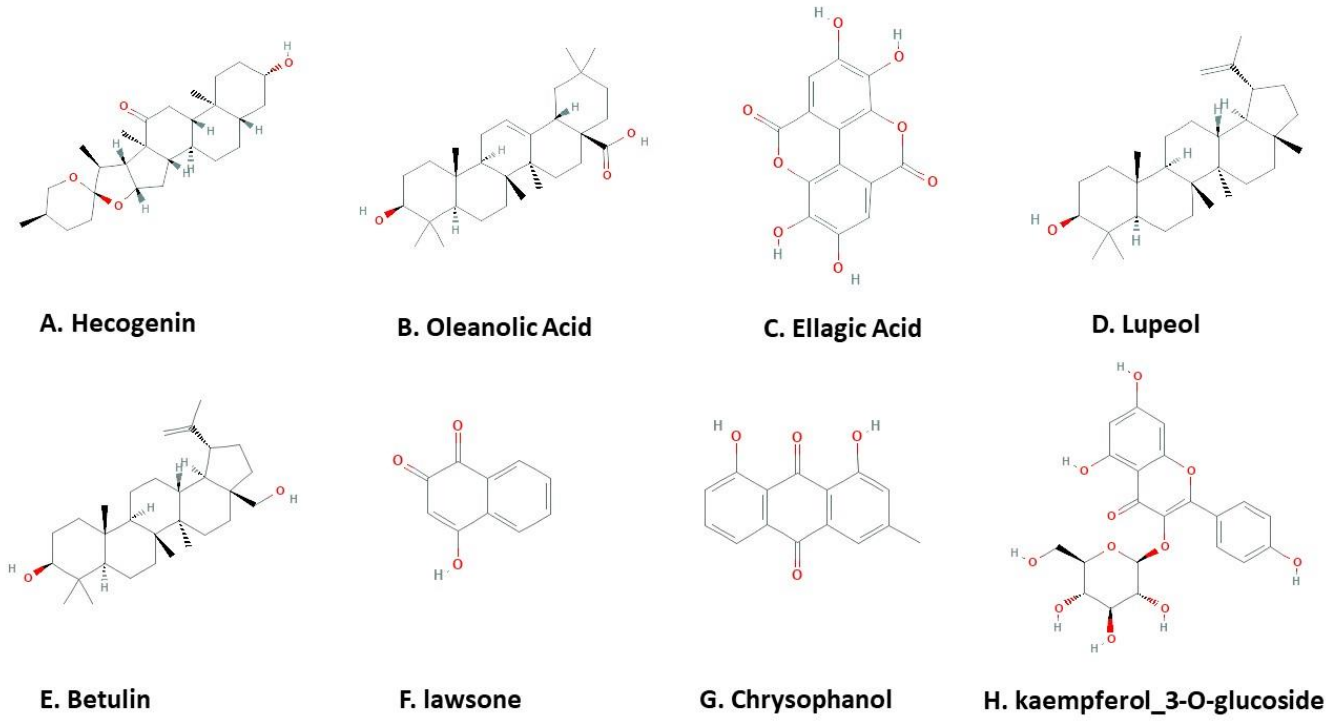

Figure 2: The structure of major phytochemicals of *Woodfordia fruticosa*

Traditional and Modern View

A. Ayurvedic View: *Woodfordia fruticosa* is also known as Dhatki and Fire flame bush. Dhatki plant was utilized in many ayurvedic formulations by traditional practitioners [23,24]. Although, all parts of the Dhatki plant possess valuable therapeutic properties but flowers are considered as a potent part because of their high demand in domestic and international markets for the preparation of herbal medicines [25]. According to the ayurvedic literature, Dhatki is a pungent, acrid, toxic, alexiteric, uterine sedative, and anthelmintic. It is also useful in thirst, dysentery, leprosy, erysipelas, blood diseases, leucorrhoea and toothache. Dhatki is considered as Kapha and Pitta suppressant according to the Ayurveda [26]. Dhatki pushpa are utilized in the formulation of herbal medicine. The medicine is called "Aristha's" and "Asava's" [27]. Aristha's are known to be general health tonics which stimulates overall health with specific emphasis on ameliorating or delaying one or the other systematic disorder. There are 18 Aristha's mentioned in the Indian Ministry of Health & Family Welfare's monograph in which 17 are found to have *Woodfordia frutica* extract. These herbal medicines are very popular in India and some other South Asian countries [28,29]. Dhatki Pushpa are also utilized as a principal ingredient in the preparation of a popular herbal medicine "Sidowaya" or "Sidawayah" [30]. Due to astringent taste, Dhatki pushpa has been utilized to treat dysentery, sprue, bowel syndrome, rheumatism, dysuria and hematuria [31].

Table 3: Rasa Panchak of *Woodfordia fruticosa* (Dhatki Pushpa)

Sanskrit/English	Sanskrit/English
Rasa/Taste	Kashaya/Astringent
Virya/Potency	Sheeth/Cold
Vipaka/Metabolic Property	Katu/Bitter
Guna/Physical Property	Laghu,Ruksh/Little,Dry

Some major benefits of *Woodfordia fruticosa* (Dhatki) Plant

Atisara: Very effective herb for the treatment of dysentery and diarrhoea

Pittasra: The plant is used in treating bleeding disorders.

Krimighana: It is helpful against infection and parasites.

Trushna: The herb possesses cooling property and is beneficial in excessive thirst.

Visarpa: The herb protects the skin and beneficial in skin related disorders and herpes, etc.

Visha: Also helpful in toxic conditions.

B. Folk View: *Woodfordia fruticosa* plant is utilized many years ago in the Ayurvedic and folklore medicinal system for its therapeutic activities. The fresh flowers of *Woodfordia fruticosa* were used to stop bleeding in emergency cuts by the tribal people of the Chhattisgarh district. They were also preferring dried flower powder on the cuts to heal them more efficiently. Oil-based flower extract has always been

recommended for open wounds. In case of a complicated wound, the flowers of *Woodfordia fruticosa* are mixed with another herb called Lodh (*Symplocos crataegoides*) in equal quantity and utilized among these tribes. A decoction of fresh flowers in combination with ginger (*Zingiber officinale*) or intrajua (*Wrightia tinctoria*) is utilized for the treatment of dysentery. *Woodfordia fruticosa* plant was utilized for the management of female-specific disorders like leucorrhoea and dysmenorrhoea among these tribes. The *Woodfordia fruticosa* plant was majorly used by various communities in India and these tribes are Gopala (Keonjhar district), kandha and Brahmin (Koraput district), Kandha, Dhoba and Kshatriya (Kandhamal District), Sabar (Baragarh district), Santal (Mayurbhanj district) and Sundhi (Malkangiri district). In Nepal and India, leaves of *Woodfordia fruticosa* are used as folk medicine to treat variety of diseases. A decoction of plant leaves in combination with sugar and dried ginger is recommended for the treatment of fever [32].

C. Modern View: Many issues are faced by the Global herbal drug industry in today's scenario mostly the practice of making these drugs adulterated. This is the major reason why people lost faith in these herbal drugs nowadays [33-37]. In today's time, intentional adulteration is practiced in many different ways like by substituting standard commercial variety, by substituting superficially similar but inferior drugs, by substituting artificially manufactured drugs, the substitution of exhausted drugs and by substituting toxic materials. Adulteration can be either intentional or unintentional. These adulteration processes ultimately degrade the quality of the original drugs. The herbal plant vendors use these adulteration techniques so smartly that these remain undetectable until and unless examination on a microscopic level and chemical level are implied [38-40]. The major disadvantages associated with adulteration are deterioration and degradation of drugs. Adulteration also increases the cost of drugs and produces adverse effects instead of showing actual biological affect [41,42]. The traditional herbal drugs and their formulations are associated with negligible toxicity and are free from any kind of adulteration [43]. Herbal plants have a very important place in both commercial industry and pharmaceutical industries. Ranganayaki and Ranganathan investigated the use of leaves and flowers of *Woodfordia fruticosa* for the production of tan-extract in fine tanning of soft leather [44]. Dastur et al., reported that the flowers are being used for the production of red dyes throughout India [45]. These all are commercial uses but this plant is also extensively used in the modern medication system. Traditional Ayurvedic herbal formulations of *Woodfordia fruticosa* plants are associated with a wide range of medicinal properties that cures a variety of ailments without causing any severe harm to the human body. Oshima et al., reported a polyherbal formulation containing for the prevention and treatment of dental plaque formation [46]. Several researches are going on the *Woodfordia fruticosa* flowers and leaves in the form of ointment for skin whitening [47-50]. Some of the cosmetic formulations were claimed to be capable of reducing the activity of hyaluronidase, elastase, and tyrosinase. Thus plant is found to be effective against skin roughness too.

Reported Therapeutic and Pharmacological Studies of *Woodfordia fruticosa*

Various researches have been conducted on this plant to find out its therapeutic and pharmacological uses. Large –scale scientific studies are still needed to prove the clinical efficacy of this herb, especially in skin diseases, immunomodulatory disorders and diabetes.

Antimicrobial Activity: Kumaraswamy et al., reported antimicrobial activity of dried flower extracts of *Woodfordia fruticosa.* The ethanol, methanol, petroleum ether, chloroform and water were used for extracting dried flowers. Out of these five extracts, petroleum ether extract showed significant antimicrobial activity when compared to Gentamicin (standard drug). Another In-vivo study showed antibacterial activity of crude methanolic extract of *Woodfordia fruticosa* when compared with the standard drug ciprofloxacin using the agar well diffusion method. Methanolic extract was found be most active against *Pseudomonas pseudoalcaligenes* [51]. Another study examined the antibacterial activity of diethyl ether, chloroform, petroleum ether extract against four bacterial species strains by using disc diffusion method. The extracts were found to be effective against all the strains [52,53].

Immunomodulatory Activity: Shah et al., reported immunomodulatory activity of ethanolic extract of the flowers of *Woodfordia fruticosa*. *In-vitro* immunomodulatory activity of the extract was evaluated in murine peritoneal macrophage phagocytosis and proliferation of bone marrow cells by sulforhodamine 'B' (SRB) assays. Results showed 60% increase in bone marrow cell proliferation and represents the stimulation of bone marrow [54].

Hepatoprotective Activity: Brinda et al., reported hepatoprotective activity of petroleum ether, alcohol, chloroform and aqueous extract of flower of *Woodfordia fruticosa* against phenytoin induced rats and carbon tetrachloride-induced toxicity [55]. Baravaia et al., reported hepatoprotective activity of methanolic extract of the flowers of *Woodfordia fruticosa* against acetaminophen-induced rats and diclofenac sodium-induced rats [56]. Both studies demonstrated the hepatoprotective activity of the *Woodfordia fruticosa* plant for the treatment of liver disorders.

Cardioprotective Activity: Lal et al., reported an Ayurvedic formulation for cardiovascular disorders. A decoction was prepared by fermenting the specific plant materials using flowers of *Woodfordia fruticosa*. The formulation was named as "Arjunaristha" which was beneficial for cardiac disorders [57].

Antioxidant Activity: Finose et al., evaluated the antioxidant activity of *Woodfordia fruticosa* flowers by using ABT and DPPH free radical scavenging models. The petroleum ether, chloroform and methanol extracts of the plant showed significant antioxidant activity in results [58].

Antiulcer Activity: Mihira et al., reported antiulcer activity of chloroform and methanol extract of roots of *Woodfordia fruticosa* against diclofenac sodium-induced female Wister albino rats. The result showed significant antiulcer activity in the stomach of female Wister albino rats [59].

Antifertility Activity: Kushlani et al., reported antifertility activity of various extract of dried flowers of *Woodfordia fruticosa* in female albino rats. The results revealed that the alcoholic extract of the plant showed significant abortifacient activity [60].

Anti-tumor Activity: Yoshida et al., reported anti-tumor activity of dried flower extract of *Woodfordia fruticosa* plant. Woodfordin C, a macro ring hydrolysable tannin dimer was found to possess anti-tumor activity [61].

Analgesic Activity: Rose et al., evaluated the analgesic activity of *Woodfordia fruticosa* stem bark in albino rats. The petroleum ether, chloroform, ethanol and aqueous extracts were administered orally to the rats at a dose of 200mg/kg according to their body weight. The standard group was

administered with Analgin (non-steroidal anti-inflammatory drugs). The aqueous and alcoholic extracts were found to possess analgesic activity in albino rats. It was also found that the aqueous extract showed most potent analgesic effect as compared to petroleum ether and alcoholic extract [62].

Antihyperlipidemic activity: Khera et al., reported antihyperlipidemic activity of methanolic flower extract of *Woodfordia fruticosa* in mice with a high cholesterol diet. Five groups of six Swiss albino mice were administered with 0.5 ml water, 30 mg cholesterol and 400mg/kg of methanolic extract of *Woodfordia fruticosa* flowers. The effects of the extract on the lipid profile showed lipid-lowering effect. *Woodfordia fruticosa* is considered as new potential natural product for controlling hyperlipidemia [63].

Anti-inflammatory Activity: Baravalia et al., reported anti-inflammatory activity of methanol extract of *Woodfordia fruticosa* flowers against the carrageenan, histamine, dextran, serotonin and formaldehyde-induced rats. The result showed significant anti-inflammatory activity in the animal model [64].

Antihyperglycemic Activity: Verma et al., reported the antihyperglycemic activity of flower extract of *Woodfordia fruticosa* in glucose metabolism and lipid peroxidation in streptozotocin-induced diabetic rats. After 21 days of treatment, it was found that the ethanolic extract of *Woodfordia fruticosa* significantly reduced the fasting blood glucose level and increases the insulin level in diabetic rats. The results suggested that ethanolic flower extract possesses a potent antihyperglycemic effect [65].

Anthelmintic Activity: Sengupta et al., examined the anthelmintic activity of methanol and petroleum ether extract of dried flowers of *Woodfordia fruticosa* against the Indian earthworm like *Pheritima Posthuma* [66].

Conclusion:

Woodfordia fruticosa is a popular therapeutic plant useful in various disorders since past times. It is utilized as an ointment in various regions of the world especially in India and Nepal. *Woodfordia fruticosa* plant is a rich storehouse of chemical constituents like Oenothein A, Woodfordin C, Woodforin F, Isoschimawalin A and many others. Various preparation containing *Woodfordia fruticosa* along with several other medicinal plants. These formulations are prescribed by the traditional medical practitioners to treat numerous disease. From reported studies, it is clear that the *Woodfordia fruticosa* plant contains various chemical constituents and they play a vital role in the pharmaceutical and industrial application to produce modern herbal formulations. Aristha's or Asava's are the main herbal formulation containing flowers of *W. fruticosa*. But there is a need to relook and revaluate these formulations scientifically. Besides this, the plant is associated with various therapeutic and medicinal properties like antioxidant, antidiabetic, hypertensive, antifungal, antibacterial, anti-tumor, antiviral, antispasmodic and many more.

Acknowledgement

Authors are very thankful to the Department of Research and Development of Jeena Sikho Lifecare Pvt. Ltd. Zirakpur, Punjab for giving us opportimity to explore this ancient medicinal plant.

Conflict of Interest

None

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