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Review Article

Drynaria quercifolia: A review on phytochemical and pharmacological profile

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Abstract

Drynaria quercifolia is a medicinal fern belongs to the family polypodiaceae. The rhizome powder and extracts are being used to treat Tuberculosis, rheumatoid fever, dyspepsia, cough and in healing bone ailments. This review on *Drynaria quercifolia* attempts to put together the available literature with respect to its pharmacognostic characters, traditional uses, chemical constituents and summary of its various pharmacological activities and clinical effects.

Keywords: *Drynaria quercifolia*; Phytochemicals; Bioactive components; Anti-oxidant activity; Anti-diabetic property.

Introduction

A medicinal plant is defined as any substance that can be employed for therapeutic purposes or as a precursor for the production of pharmaceuticals. In the last few years, researchers are becoming highly interested in the usage of physiologically active chemicals found in nature of therapeutic value. Medicinal plants include a variety of compounds that can be used to treat a variety of ailments. Flavonoids, alkaloids, tannins, and other phytoconstituents saponins, quinines, terpenoids, glycosides, and polyphenols are some of the compounds found in plants [1]. A wide number of therapeutic plants are available. Many plants are yet to be researched for their potential benefits and medicinal significance.

Drynaria quercifolia is a medicinal fern with a wide range of uses in treating a variety of ailments. As a result, in this research, an attempt has been made to supply a detailed description of the phytochemical properties of the rhizome. *Drynaria quercifolia*'s pharmacological properties can be utilised as a starting point for more investigation. Drynaria ferns can be epiphytic (meaning they grow on trees) or xerophytic (meaning they grow on the ground) or epipetric (they grow on rocks). They are well-known for having nectar-secreting structures that can be found at the base or on the sides of lobes on the underside of the fronds. They make nectar, which is sweet. The spores of *Drynaria quercifolia* are used for its replication process. Despite the fact that it is not harmful, it is widely utilised [2].

Drynaria quercifolia is a terrestrial fern that can be found in fissures, shelves, or in the soil among boulders. They can also be found as epiphytic on trees, open forests and rainforest trunks. It is a tropical species predominantly found in Africa, Asia, Australia, Oceania, Western Europe. Australia, as well as India, Southeast Asia, and Malaysia, are all part of the Asia-Pacific region. It is cultivated in China, Vietnam, Thailand and Taiwan [2].

Plant description

Branches and leaves (fronds)

The presence of two types of fronds distinguishes basket ferns: fertile foliage fronds and sterile nest fronds. The dark green fronds have extended stalks and are 2–4 feet (0.61–1.22 m) long. They have structures that produce and contain spores on the bottom surfaces and are strongly lobed or pinnate. The nest fronds are spherical leaves that are smaller than the foliage fronds. They produce a distinctive 'basket' that collects litter and organic material after turning brown and dying, hence the common name. The gathered material decomposes into humus, which provides nutrients to the plants. Both the frond types grow from rhizomes which are basically anchored to a tree or a rock [3, 4].

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Rhizome

The Rhizomes are 2cm thick and creeping with a dense brown covering. Scales are 20-25mm long and 0.7-2.5mm broad and come in a variety of colours. The base of the rhizome is winged, but the lamina is not. Spores are 37.5-55 microns in length and 22.5-37.5 microns broad [5].

Medicinal applications

Drynaria quercifolia can aid in the healing and strengthening of damaged bones. It promotes bone density and protects against osteoporosis and aids in the recovery of fractured bones ligaments. Drynaria tonic is good for the liver and kidneys. They can aid in the treatment of bleeding gums and toothaches, as well as teeth will be strengthened if you consume it on a regular basis. Plants from the Drynaria genus can be used topically as a hair tonic to promote hair development and to improve the condition of the hair. Drynaria as a whole plant can be used to treat Tuberculosis, rheumatoid fever, dyspepsia, and cough. The pounded fronds were applied to the affected areas of inflammation. On the forehead, a macerated rhizome paste was applied for the relief of headache. Drynaria was employed as an anthelmintic in its application as a whole plant source in the therapy of chest and skin diseases. The plant's tonic has an astringent effect on the bowels. It is utilised in traditional medicine by a variety of people to address variety of health issues, including urinary tract infection [6] [7] [8].

It is known as 'Ashwakatri' in Ayurvedic medicine and is used as a pectoral, expectorant, and anthelmintic agent. Chest disorders, cough, and hectic fever, as well as dyspepsia, loss of appetite, chronic jaundice, and skin affections, are all treated with it [9].

Drynaria rhizome is used to treat arthritis in Tamil Nadu. These rhizomes are employed in the treatment of agitated mental problems in Bangladesh. Drynaria rhizome decoction is used as an antipyretic in Southeast Asia. Fronds are used as a poultice on treating swelling ailments in Malaysia. The leaves and rhizome are used to treat intestinal worms and stomach pain in Tripura [10-12].

Chemical description

Drynaria quercifolia contains phenols, tannins, alkaloids, proteins, xanthoproteins, carboxylic acid, coumarins, and saponins. Other phytochemicals like catechins, flavonoids, steroids, and triterpenes are also present. β-amyrin, β-sitosterol, 3, 4 dihydroxyl benzoic acid, 3- β-D-glucopyranoside, acetyl lupeol, naringinin aglycone, flavone glycosides naringin, friedelin are found in dried rhizomes.

Sample analysis

The powdered sample of *Drynaria quercifolia* rhizome were subjected to several physico-chemical analyses, phytochemical analysis, proximate analysis, GC-MS analysis and also analysed for its antioxidant property, antibacterial activity, anti-inflammatory role, anti-arthritic property and antidiabetic property.

Proximate analysis

The plant rhizome powder was subjected to proximate analysis. The moisture content was 3 percent, overall ash value was 9.93 percent, and the acid insoluble ash value was 4.49 percent. The water-soluble ash value was 6.96 percent. Alcohol and water extractive values were found to be 9.87 percent and 13.94 percent, respectively [13].

Metal analysis

A Shimadzu AA-7000F atomic absorption spectrophotometer (AAS) was used to analyse the metals in the *Drynaria quercifolia* rhizome powder sample. Cadmium, chromium, copper, iron, and manganese were measured using a BGC-D2 lamp mode at wavelengths of 228.8 nm, 357.9 nm, 324.8 nm, 248.3 nm, and 279.5 nm, respectively. The concentration of cadmium and chromium were found to be below detectable limit (BDL) and that of copper, iron and manganese were found to be 10.38 ppm, 11.70 ppm and 9.82 ppm, respectfully [14].

Solvent extraction

The powdered rhizome sample was subjected to solvent extraction with different solvents like methanol, chloroform, petroleum ether and water based on their polarity. The alcohol soluble and water-soluble extractive values were found to be 9.87 percent and 13.94 percent, respectively. The extractive yield of petroleum ether, chloroform, methanol and water were found to be 3.12 percent, 5.72 percent, 19.67 percent and 16.33 percent, respectively [13,15].

Radical scavenging activity

Methanol, petroleum ether, chloroform and water-soluble extracts of *Drynaria quercifolia*

were subjected to free radical scavenging activity with DPPH assay and FRAP assay. All the extracts were tested at different concentrations from 50ppm to 500ppm. All the extracts showed best radical scavenging activity at 500 ppm. Methanolic extract showed the highest scavenging activity in both the assays. Maximum scavenging activity of 94.37% at 500ppm concentration in DPPH assay and FRAP value of 2.78% at 300ppm concentration were observed for the methanolic extract [13] [16].

Qualitative phytochemical screening

Drynaria quercifolia's bioactive components were extracted using ethanol, methanol, chloroform, and petroleum ether. Initial screening, revealed the presence of saponins, flavonoids, steroids, coumarin, and other substances. Ethanol extract contains tannins and terpenoids. In the methanol extract, saponins, steroids, coumarin, tannins, and terpenoids have been screened. Steroids and tannins are identified in chloroform and petroleum ether extracts [15-18].

Phenolic profile

Different extractives of DQ rhizome exhibited a considerable level of phenolic compounds ranging from 103.43 to 132.23 mg of GAE/g of extractive when phenolic profiles were determined. Catechin, coumarins, flavonoids, phenolics, saponin, steroids, tannins, and triterpenes all tested positive in phytochemical examination. DQ had 244 mg/g of total phenolics and 0.048 percent naringin [17].

Histochemical studies

Histochemistry is a branch of histology that deals with identifying the chemical components of cells and tissues; it's a useful technique for locating trace amounts of compounds in biological tissues. The histochemical study revealed the presence of phytochemicals such as flavonoids, saponins, phenols, tannins and alkaloids in the amount of 36.84 mg/gm, 32.74 mg/gm, 84.56 mg/gm, 45.23 mg/gm and 6.38 mg/gm respectively [13].

UV-VIS and FTIR spectroscopic analysis

Spectroscopy, both UV-VIS and FT-IR, has been shown to be a reliable and sensitive approach for detecting biomolecular composition. We can confirm the functional elements contained in the plant extract, identify the medicinal materials from the adulterants, and even assess the medicinal material's quality using FT-IR.

The methanol extract of D. quercifolia rhizome was subjected to spectroscopic examination such as UV-VIS and FT-IR. The extract was scanned with a wavelength range of 100 to 1100 nm using the Lamda 35 model spectrum to detect the UV-VIS spectrum profile. A Perkin Elmer Spectrophotometer system was used to detect the distinctive peaks and their functional groups using FT-IR analysis in the 400 to 4000/cm range. Both UV-VIS and FT-IR peak values were observed.

Because of the sharpness and correct baseline, the UV-VIS spectrum profile of methanol extract of *D. quercifolia* rhizome was collected at the wavelength of 100-1100 nm. Peaks of absorption of 2.60 and 0.92 were found at 214 and 279 nm, respectively, in the result profile. The extract's functional group of active components was identified using the FT-IR spectra. At peak values of 3436, 2917, 2360, 2125, 1722, 1626, 1447, and 815, respectively, amines (C-N str), alkanes (C-H ben), denatured amines, alkynes (C=C str), carboxylic acids (C-O str, OH str, and C=O str), alkenes (C-H ben), alkanes (C-H ben), alkenes were noted [19].

Analyses of bioactive components using GC-MS

Perkin Elmer's GC Clarus 500 was used for the GC-MS analysis. On an Elite-1 capillary column (100 percent Demethly-polysiloxane), compounds were separated. The split ratio of the samples was 10:1 and the flow rate of helium (carrier gas) was 1ml/min. Turbo Mass gold–Perkin Elmer mass detector Turbo mass 5.1 was utilised as the detector software. Other requirements include an oven temperature of up to 110 ºF for 2 min. Hold up to 280 ºF at a rate of 5 ºF per minute for 9 min. The temperature of the injector was kept at 250 degrees. After comparing the components to those in the Computer Library (NIST ver. 2.1) attached to the GC-MS instrument, the constituents were identified and reported.

In a methanolic extract of *Drynaria quercifolia* rhizome, thirty components were discovered. The GC-MS analysis was performed using a Perkin Elmer GC Clarus 500 instrument.

The experiment lasted 35 minutes. The active principles were listed, together with their

retention time (RT), molecular formula, molecular weight (MW), and concentration (peak area percent). In the retention time range of 21.731 to 25.700, the chromatogram reveals four strong peaks. The peak area of 36.05 percent is found at 21.731 retention time. The presence of 1, 2-Benzenedicarboxylic acid diethyl ester causes the highest peak. The presence of 1,2-Benzenedicarboxylic acid, methyl ester causes the second less prominent peak at 21.633 retention time with a peak area of 13.95 percent, followed by the third less prominent peak of 4, P-chlorophenyl-2-dimethyl amino-5-nitrosothiozole (6.57 percent) with a retention time of 32.608, and the fourth less prominent peak of 1,3-diphenyl-1, 3, 5, 5-tetra methyl cyclotri n-Hexadecanoic acid is a phytochemical with antibacterial, antioxidant, and larvicidal activity. Another phytochemical with anti-inflammatory and anti-arthritic properties is 9, 12, Octa decadienoic acid (Z, Z) [18,20].

Isolation of compounds and anti-bacterial activity

The ethyl acetate soluble fraction exhibited strong antibacterial activity and was subjected to column chromatography with increasing polarity chloroform and methanol. A total of 32 fractions were obtained using column chromatography. The fractions eluting with 10-25 percent methanol in chloroform had substantial antibacterial activity, therefore they were treated to preparative TLC (mobile phase 15% methanol in chloroform) to yield compound 1 (89 mg). Compound 1 was sparingly soluble in water and easily soluble in ethyl acetate, methanol, and acetone in a solubility test.

The chloroform soluble fraction demonstrated moderate antibacterial activity and was subjected to column chromatography with increasing polarity n-hexane, chloroform, and methanol. A total of 41 fractions were obtained using column chromatography. The fractions eluting with 5-10% chloroform in n-hexane showed antibacterial activity, thus they were treated to preparative TLC (mobile phase 40% chloroform in n-hexane) to yield compound 2 (25 mg), which had a negligible antibacterial effect.

TLC analysis revealed that chemical 1 is present in these fractions (5-10 percent chloroform in n-hexane), but in small amounts. The petroleum ether fraction's, antibacterial activity was negligible.

The chemical 1 crystallised as a brownish needle-like crystal with a melting point of 199-200 degrees Celsius. Compound 1 was used sparingly in the solubility test with water and easily soluble in ethyl acetate, acetone, acetate, and methanol. Liquid chromatography/mass spectroscopy by electrospray in the positive ion mode of (LC/ES-MS), the molecular structure of chemical 1 was discovered [M+H] + at a peak point m/z 154.8, with molecular formula C7H6O4. Bands at 1240, 1375, 1739, 2877, 2908, and 2985 cm-1 were found in the infrared spectrum. Compound 1's 1 H-NMR, 13C-NMR, HSQC, and HMBC spectral data were in good agreement with 3,4-dihydroxybenzoic acid spectral data reported in the literature. With a melting point of 218-220 degrees, compound 2 was produced as a needle-like crystal. In the positive ion mode of 2, the liquid chromatography/ electrospray-mass spectroscopy (LC/ES-MS) revealed a molecular [M+H] + peak at m/z 469.5, corresponding to a molecular formula of C32H52O2. Bands at 1240, 1650, 1700, 1735, and 3065 cm-1 were found in the infrared spectrum. The NMR spectral data of chemical 2 were in good agreement with acetyl lupeol spectral data published in the literature. The isolated compounds 1 and 2 were identified as 3,4-dihydroxybenzoic acid and acetyl lupeol, respectively, based on these findings. Both of these chemicals were isolated for the first time from *Drynaria quercifolia*.

Traditional applications of *Drynaria quercifolia* rhizome for cough, TB, and typhoid fever may be linked to the plant's antibacterial constituent(s). *Drynaria quercifolia* rhizome has also been shown to have antimicrobial properties in the past. The antibacterial activity of 3,4-dihydroxybenzoic acid and fractions containing 3,4-dihydroxybenzoic acid suggests that this is the main ingredient in the *Drynaria quercifolia* rhizome. The antibacterial activity of 3, 4-dihydroxybenzoic acid was further demonstrated by its MIC values against tested microorganisms (8-64 g/mL) [21-23].

Anti-dermatophytic activity

The ethyl acetate extract of D. quercifolia rhizome includes coumarins, according to HPTLC results. Before derivation, it was visible as a conspicuous quenching zone (coumarin blue florescence) in UV-366 nm and UV-254 nm with nine peaks. It was shown with seven peaks in UV-366nm following derivation with vanillin sulphuric acid. According to literature, the ethyl acetate extract of *D. quercifolia* rhizome includes triterpenes, as evidenced by a blue fluorescent zone of triterpene in UV-366 nm before derivation and six peaks in UV-254 nm. There were 13 peaks and a violet zone at visible UV-366nm after derivation with anisaldehyde sulphuric acid. Coumarins are only soluble in semi-polar solvents like di-ethyl ether, whereas terpenoids are soluble in water, ethanol, and methanol. As a result, coumarins are likely to be responsible for this plant's anti-dermatophytic function [24].

Acute toxicity test (in-vivo method)

Prior to the experiment, the acclimatised animals (mice weighing 20-30gm of either sex) were permitted to fast for 18 hours by withholding food and drink. The produced extracts were given intraperitoneally (i.p.) using the CPCSEA fixed dose method (OECD Guideline no. 423, Annexure 2d). Following dosing, the animals were thoroughly monitored for the first two hours for any signs of toxicity. Within 7 days of monitoring, common adverse effects of treated animal groups included minor diarrhoea, weight loss, and depression. In all cases, the toxicological effects were measured in terms of death at a dose of 2000 mg/kg body weight, which was stated as the acute fatal dose (ALD50).

At a dose of 2000mg/kg body weight, samples showed no signs of mortality in an acute toxicity evaluation. As a result, according to OECD guideline 423, a dose of 2000mg/kg was designated as the ALD50 cut-off dose under GHS category 5 of safe dose (Annexure 2d). Furthermore, no significant changes in haematological parameters, including effects on other factors, were identified during subacute toxicity studies, indicating that it was safe to use as a medicine.

Effects on hematological parameters

After 28 days of therapy, the effect of methanol extract on haematological parameters in the control and treated groups of rats showed a slight improvement with the parameters. The control values of RBC (million cells/cu.mm), WBC (10^3 cells/cu.mm), Haemoglobin (gm %) and Platelets (10^3 /cu.mm) were 4.333±0.42, 5.500±0.56, 13.17±0.4 and 273.3±3.57 respectively. Whereas, with methanol extract treated (150mg/kg wt.) the values raised to 4.833±0.70, 5.833±0.47, 14.33±0.3 and 289.2±5.54 respectively [22,25].

Study on anti-diabetic property

In general, in vitro antidiabetic tests aid in the evaluation of drugs effects on the inhibition of two major enzymes involved in carbohydrate metabolism, namely alpha-amylase and beta-glucosidase, as described by various authors. Inhibition of these enzymes causes a delay in the breakdown of starch and oligosaccharides, which reduces glucose absorption and hence prevents postprandial hyperglycemia. The long-term maintenance of plasma glucose content is one of the most significant and tightly regulated processes found in humans and other mammals under a variety of dietary situations.

Limiting intestinal carbohydrate digestion is one strategy to manage Type 2 diabetes (T2DM). Although the gastrointestinal tract plays no role in the aetiology of T2DM, inhibition of the carbohydrate hydrolyzing enzymes alpha-amylase, and beta-glucosidase, can be utilised to reduce post-prandial hyperglycemia. The alpha-amylase inhibition assay was performed on different concentrations (25, 50, and 100 g/ml) of methanol extract of chosen plant sections in our study. As a control, metformin was employed. At concentrations of 25, 50, and 100 mg/ml, the inhibition percentage of plant extract was determined to be 40.1, 65.7, and 79.8, respectively. It was 85.077.2 for normal medication.

In the current work, alpha-amylase inhibition was detected in plant extract-treated cells in a dose-dependent manner. The inhibition of alpha-amylase activity was considerably (p0.001) enhanced as the concentration was raised. Plant extract provided considerable inhibition as compared to the standard. Metformin is a common medicine used to treat diabetes. It has a

number of adverse effects, including gastrointestinal distress, lactic acidosis, and weight loss. Medicinal plants, on the other hand, have far less adverse effects than manufactured medications, and are consequently preferred in our modern health-care system.

When compared to control, incubation of D. quercifolia extract (5.0, 10, 20, and 40 g/ml) with metformin (0.01mM) in muscle cells in the presence of insulin (1mol/L) resulted in substantial (p0.001) glucose uptake activity. Glucose uptake was 6.130.28, 6.230.19, 6.390.54, and 6.730.41 in the presence of insulin at concentrations of 5.0, 10, 20, and 40 g/ml of plant extract, respectively. Similarly, it was discovered to be 5.02, 4.98, 4.06, and 3.16 in the absence of insulin. In the presence and absence of insulin, standard metformin has glucose consumption of 7.070.30 and 4.810.31, respectively.

In this study, we looked at the glucose uptake activity of *D. quercifolia* rhizome extract in L6 rat skeletal muscle cells; the results showed that the standard drug metformin significantly (p0.001) increased glucose uptake activity, which was higher than plant extract in both the presence and absence of insulin. In the absence and presence of insulin, plant extract did not have a stronger glucose uptake effect than the usual treatment metformin. However, when compared to a vehicle control, data showed that plant extract increased glucose uptake activity in the presence of insulin but not in the absence of insulin, and that plant samples exhibited dose-dependent glucose uptake action. The plant drug successfully modulates lipid metabolism by preventing hyperglycemia [26].

Conflict of interest

Authors declare there are no conflicts of interest.

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