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A review on phytopharmacological properties of Bisfaij

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Abstract

Polypodium vulgare L. is a perennial fern belonging to Polypodiaceae family. It has been cultivated throughout the world and used for essential oil application, aroma flavor and in traditional medicine. Mostly *Polypodium vulgare* contain polypody rhizome having saponins (polypodosapogenin), ecdysteroids, phloroglucins, volatile oil, fixed oil, and tannins. The extent of each of these chemical constituents varies depending on the type of species or cultivars as well as cultivation conditions such as spore type, weather, artificial condition (green house). It is an essential component of several industrial applications that ranges from food to pharmaceutical application. More uses and applications of *Polypodium Vulgare* by products are continuously added. Further research to maximize yield per hectare and optimum preservation and oil extraction methods are needed, particularly in the developing world where basil leaf and flower harvesting and postharvest processing methods are much traditional.

Key words: Bisfaij, *Polypodium vulgare*, fern

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1. Botany

1.1. Introduction

Polypodium vulgare L. is a perennial fern belonging to family Polypodiaceae. It has been used traditionally in herbal medicine as vermifuge and purgative and has been the most important ingredient of cooking due to its sweet taste and aroma. The *Polypodium* genus contains 60 to 200 species which are native to Africa, Asia, Europe and northern and upland areas. There is an uncertainty in the species and also within the genus that has mainly attributed to the variability between the species. *Polypodium vulgare* is known by different names depending where you are in the world. In English, it is typically called, common Polypody. It is known as Aghrasul, Hijr, Tashtiiwan in Arabic. In Urdu, it is specially called Basfaij. In Latin it is known as Bazbodia, in Persian is known as Bispaikz and in Egyptian is known as Ashtiwan. It has a wide range of cultivars varying in leaf color, origin and uses [1]. Popular examples include *Polypodium glycyrrhiza, Polypodium cambricum and Polypodium cornubienes and Polypodium mantoniae* [2]. The plants have hardy ferns, leathery foliage with spore bearing organs and can grow upto a height of 30cm depending on the different species of *Polypodium vulgare*. Leaves can be smooth, wavy frond margins; they can be grey-green to sliver green and blue-green. Flowers color can range from yellow to greenish red. This fern has great value due to its beautiful rhizomes and leaves. It is valued both as herbal medicine and as ornamental plant. It also contains cocaine like chemicals. The essential oil contents and composition is equally variable between species and cultivars, depending upon climatic conditions, locations, and other environmental factors [3-6]. Essential oils are usually characterized by GC-MS analysis in order to find out bioactive components in oil [7-8]. Sesquiterpenes and their oxidized forms are the main components of essential oils while monoterpenes, diterpenes and their oxidized form, aldehydes, alcohols and fats are minor constituents of *Polypodium vulgare*. Plant has wide variety of applications which will be explored in more detail below.

1.2. Demography/Location

Polypodium vulgare is grown in natural as well as different artificial environments (glasshouse). It has regular sporing periods that have interaction with nutritional factor in natural environment. There is a change in sporing behavior when it is transferred to artificial environment (glasshouse). In glasshouse, it has two genetically matched populations. In controlled- climate glasshouse one population is placed and second is left outdoor. Through the winter the indoor population has high sporing fronds activity than the inside population of glasshouse. Temperature, light, some elements in glasshouse are the ecological requirements for the cultivation of continuous sporing in those ferns [9]. *Polypodium vulgare* is grown widely in the following countries: Scandinavia, Southern part of the area, Asia,

America, Africa, Europe, Norway nearly to North Cape, Eastern Asia and along the Atlantic Asia.

1.3. Botany, Morphology, Ecology

P. vulgare is small winter green fern, usually 10-30 cm height, scaly stem and the thick fern bearing the scaly and densely hairy rhizome fronds. The stem scales are variable in size usually 4 mm long, narrowly triangular and red brown in color. It has glabrous pinnatified, pinnatisect, long and dull green color leaves and on the upper stem side, it is born in two alternate rows. The blades of leaves are one to three times longer than the petiole. The leaves are herbaceous to leathery. On the dorsal side, it is brownish yellow to rusty brown and round sori in two rows; in the upper half blade on each side of midrib. It is bean-shaped, strikingly yellow with water-flooded surface, with 60-75 um long spores [10]. The rhizome is internally green and externally yellowish brown in color that occurs in thickness of quill and in various pieces length. *Polypodium Vulgare* requires the full sun and bright light filter. The different temperatures are required for the germination of rhizome. The optimum temperature for the germination of evergreen ferns and winter green leaves range from 25-40°C but a temperature of 5-17.5°C can damage the germination of rhizomes ferns. The *Polypodium vulgare* cannot tolerate the temperature below -5 °C and cold climates can kill the green ferns. *Polypodium vulgare* grows well in dry or damp soil. Its growth requires a pH range from 5.4 to 8.3.

2. Chemistry

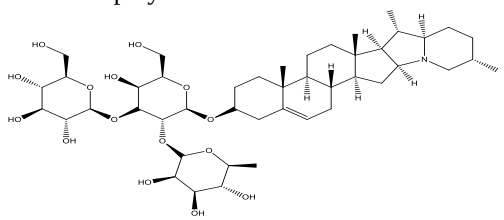
Polypodium vulgare is an aromatic plant that is used in cooking because of its sweet taste. Large number of Polypodium ecotypes has been described on the basis of their rhizome taste, aroma and essential oil contents. Aroma in Polypodium vulgare is due to the presence of essential oils in leaves and roots. Mostly it contain triterpenoids, ecdysterone, cyclopodmethyl and mevalonic acid [11]. Other aromatic compounds include different triterpenoids like epoxyhopane, norcycloartanol, cycloartanol, cyclolaudenol and fernene [12].

2.1. Chemical composition

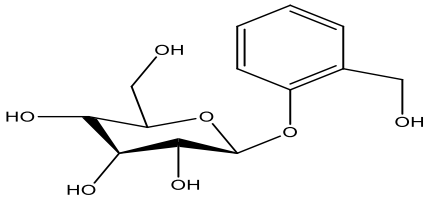
Polypodium rhizome contain saponins, volatile oils, fixed oils, phloroglucins [12]. It can also contain low amount of fats, ethereal oil, slime contents and bitterness [13]. It can also have pharmacologically active compounds polypodin A and polypodin B. Its leaves are rich with carbonate and potash. It can also be the good source of ecdysteroids compounds and phytoecdysteroids [14]. In the rhizome (0.07%-1%) ecdysone is present. It can also have cocaine like chemicals and the root has sugar, 4.2% glucose, 15.5% sucrose. Extract of rhizome possess anti-elipeptic activity. The C_{20} acid and caffic acid is also present in it. However, there is no toxicity in ferns but it can also has health risk when administered in large doses because ferns contains carcinogenic compounds and it also contains thiaminase enzymes that are rich source of Vitamin B complex and this enzyme in small amounts is not harmful to human health but in large dosage it can cause serious health problems.

2.2. Phyto-chemistry

Polypodium vulgare has sweetish odor due to the presence of saponin, which is largely confined in rhizomes. Beside the essential oil, it also contains tannis, osladin, saponin and glycoside [15]. The other components are hyperin, rutin, kaempferol-3-O-glucoside, C-glycoside schaftoside, isoschaftoside and arabinosie- 7-O-rhamnoside. Structures of important phytoconstituents are shown in figure 1. In the essential oils, 88 components are identified. The essential oil from leave is comprised of aldehyde, alcohol and acid. Essential oil carries monoterpenes, diterpenes, sesquiterpenes and their oxidized form and its essential oil also contain alcohol, aldehydes, acids and other compounds. Monoterpenes and diterpenes are minor components and sesquiterpenes and their oxidized form (39.4%) are also minor components (21.9%) and fatty acids, alcohol and aldehye (17.6%) are also present [14]. From the spores, the fatty acid constitutions of lipids have been isolated and spore lipids are triglycoside and the major components are palmitic acid, linoleic and linoleic acid and sporophylls has C-20 polyunsaturated acids.



Saponin



Glycoside

Fig.1. Structures of important phytochemicals found in *Polypodium Vulgare*

3. Post-Harvesting Technology

Conventionally, the best harvesting time of *Polypodium vulgare* is the spring and early summer and is grown well at a temperature of 15-18°C. The color of dust like spore changes from orange to brown color and are stored in white paper if they fall from the fronds. It can also be stored when it is wrapped in moist cheese clothes than in wax paper. For the storage of parenchyma of their rhizome, transmission electron microscopy is used after dehydration and subsequent rewetting. For the protection of cell against ultra-structure damage they are treated with Abscisic acid and the purpose of dehydration is that to enhance the ability of rhizome parenchyma to stand against water stress [16].

4. Processing

Polypodium vulgar, like the herbal plant consumed for various purposes and common processing methods

include drying, storage, rewetting and extraction of phenolic compounds. For drying of the *Polypodium vulgare's* colorless sporangia with pinnae are stored in ethyl alcohol and then drop of Hoyers medium is added and the slides are heated and pressed between the towel paper weight and are allowed to dry. The Hoyers medium is used to obtain the permanent slide. In rhizome dehydration, the phenol compounds are used after dehydration in mannitol solution and control desiccation treatments with or without abscisic acid (ABA). The phenolic compounds are distributed in cortical and vascular parenchyma, steral elements, epidermis and pericycle sieve cell. The contents of phenolic compounds are presented in greater amount in untreated ABA rhizome and dehydrated in mennitol solution and then rehydration. In controlled desiccation in ABA- untreated rhizome, the phenolic contents are increased and phenolic compounds are used as a protective chemical barrier against environmental stress [17]. For the extraction of osladin from glycosides mixture, it is freed from phenolic compounds and then passed on silica gel column that contain chloroform–methanol- water mixture which on acid hydrolysis give rhamnose and glucose [15].

5. Value Addition

Polypodium vulgare are useful for the manufacturing of different types of natural healthy foods and medicines. This is the first fern which is used in cooking and it can also be used as spice for nougat. This plant is extremely sweet that makes it the most important substitute of sugar and due to its sweet taste it is most commonly used in cooking. On cooking, it has aromatic smell due to the presence of osladin that is 500 times sweeter than sugar and due to its sweet taste and aromatic smell it is frequently used in nougat. The root of this plant is used as tonic and it can also be used for making of infusion and syrup. It is an important ingredient in natural cosmetic for anti-acnes, smoothing and healing of skin and mixed with beeswax and olive oil to make salve that is used for rashes and the fresh leaves and roots are mixed with honey and used for the treatment of polypus. Due to its rhizome aromatics, it has been used in different confectionery items. The rhizome polypod is cooked with sugar and milk for making of candy-sugar and liquorice for the treatments of respiratory catarrhs [10].

7. Uses

There are a number of curious uses of *Polypodium vulgare*. In Germany, there is a folk tale story that are associated with a use of this plant, sprang milk of this plant is used by female diets in polytheistic religious, as Freya mean in birth, death and in marriage. In France due to sweet taste of rhizome, it is used as the name liguorice, regliess. The anti-epileptic activity of *Polypodium vulgare* rhizome extract is frequently studied. In rhizome the ecdysones (0.07%-1%) is present that act on different varieties of arthropods and cause molting and death. Its analogues are not only useful in insecticides but also in miticides.

Polypodium vulgare has many traditional medicinal uses. Pliny uses the root (*filicula*) to treat polypus. In Europe its stems are used for air passage such as adenoids, cough and multitude of other purpose. It can also be used as vermifugal and purgative. It is also used in China, Unani and Ayurvedic tradition for therapeutic purposes. It is used to treat hive, pleurisy, stomachaches, sore throat and inflammation in American and Indian. In Greek, it is used to treat purge phlegm. The rhizome is used to treat pleurisy and liver aliments. In Denmark, the stem can also be used in Swedish due to its sweet taste. It is also used to treat hepatitis, diuretic, laxative and jaundice and for skin rashes. The root tea is used to treat spleen and liver disorders and stomach ache. Polypody contains a large number of remedial attributes and various plant formulations are used for the treatment of different health conditions and also enhance the secretion of bile and act as mild laxative. It can also be used as testosterone booster in males. Polypodium vulgare fresh root is used as powder and decoction for the treatment of rheumatic joint swelling and for melancholia. The root distilled water is used for the treatment of malaria and fever. It can also be used for epileptic disorder, claw hand, acne, crack of inter pharyngeal space, indolent tumor, rheumatic pain and leprosy. The rhizome of Polypodium vulgare used for cholagogue, congestion, bronchitis and pleurisy.

8. Pharmacological uses

8.1. Antioxidants activity

Antioxidants are the most important substances that protect the body from the damage caused by free radical scavenging that is induced due to oxidative stress and in body different types of antioxidants are present which are derived from dietary sources [18]. In this study, methanol extract of selected plant materials have radical scavenging and antioxidants activity that are used as folk remedies by Iranian population and also evaluated against 2,2 –diphenyl-1-picrylhydrazyl radical and linoleic acid peroxidation This activity is expressed as IC50 ranged from 63.48ng/ml in Polypodium vulgare to 1.28ng/ml in Biebresteinia multifida. The Polypodium vulgare has high antioxidant free radical scavenging activity [19].

8.2. Neuro-psychopharmacological activity

Polypodium vulgare aqueous extract also possess Neuron psychopharmacological activity. In rats and mice that also decreased locomotor's activity, decreased alertness and mild passivity [10].

8.3. Hypertensive Activity

Aqueous extract of the roots of *P. vulgare* (PV) produced CNS depressant effect. It decreased the spontaneous motor activity, prolonged the pentobarbitone induced hypnosis, reduced body temperature and increased the reaction time to pain stimuli. In anaesthetized dogs, the *Polypodium vulgare* extract at low dose produced a fall in blood pressure and which in short duration is rapid at onset. However, with a high dose there is a rise in blood pressure

and then it suddenly fell down due to β-andrenergic receptor and vasodilation. *Polypodium vulgare* showed hypotensive effect that is caused due to catechins [20].

8.4. Antimicrobial Activity

Essential oils extracted from the aromatic plants generally showed good antimicrobial activity [21]. The methanol extract of *Polypodium vulgare* is screened for antimicrobial activity by measuring the minimum bacterial concentration (MBC) and minimum inhibitory concentration (MIC) values against the gram negative and gram positive bacteria named *Staphylococcus aureus* and *Escherichia coli* by standard assay. The Dryopteris affine extract has maximum activity with 2 ug /ml MIC value and Polystichum aculeatum has same antibacterial activity against *Staphylococcus aureus*. Some extracts have moderate and some have strong antibacterial activity (2-8ug/ml). The phytochemical analysis of the aerial parts and rhizome showed the presence of most important secondary metabolites poly-phenols and triterpenoids. It is indicated that Polypodium vulgare ferns have highest antibacterial activity and it is the most suitable source for the discovery of antibiotic drug [22].

8.5. Anti pyrectic Activity

In rats, the extract of *Polypodium vulgare* caused gradual decreased in rectal temperature. In rabbits the administration of the same dose extract significantly prevented and reduced the pyrexial response of Typhoid-Paratyphoid A and B injection [20]

8.6. Analgesic Activity

In rats, *Polypodium vulgare's* aqueous extract exhibited analgesic activity and also increased the reaction time by post administration [10].

8.7. Antibiotic Activity

In dried polypod rhizome polydin is present that has shown antibiotic activity and it can also be used for cold and cough [23].

8.8. Smooth muscles relaxant Activity

Polypodium vulgare has dual receptor block mechanism that arbitrates smooth muscle relax effect. A study demonstrated the uses of *Polypodiumm vulgare* in smooth muscle's contraction and also described its applications to in vivo and in vitro experimental techniques with its possible underlying mechanisms. In the isolated jejunum rabbit, urinary bladder and trachea the *Polypodium vulgare* rhizome extract has highest K^+ (80mM) and carbachol (1µM) mediated concentration and with similar dicyclomine it has higher potency against carbachol than high K^+. In the response curve of carbachol cumulative there are right shift similar to dicylomine in crude extract (1-3 mg/ml). Castor oil induced the crude extract has dose dependent protective effect. Crude extract has smooth muscle relaxant effect which showed first time that Polypodium vulgare has the significant medicinal properties in respiratory, urinary bladder and GIT disorders [24].

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