

Chemical Constituents and Therapeutic Properties of Himalayan *Rhododendron arboreum* - A Review

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ABSTRACT Nature has plentiful plant sources to fulfil the needs of human beings in terms of food and medicines. *Rhododendron* tree is one of them. The literature reviewed from online resources suggests that *Rhododendron arboreum* belongs to family Ericaceae and bears pale pink to deep red colour flowers. It is a national flower of Nepal and a state flower of Uttarakhand. The flowers generally blossom in the months of March to April and June to September. *Rhododendron* contains significant amount of minerals and many phytochemicals and secondary metabolites like alkaloids, flavonoids, glycosides, saponins, tannins and steroids. *Rhododendron arboreum* has various therapeutic properties like anti-diabetic property, anti-inflammatory property, antioxidant property, anti-hyperlipidemic property, anti-cancerous property, cardio protective properties. People of India use it in preparation of many valued products like jellies, squashes, ready to serve drinks etc. But their commercialized value added products are not available. This study suggests for more extensive studies on development of commercial product for utilization of its nutritional and therapeutic value.

INTRODUCTION

Mother Nature has gifted us a rich biodiversity in respect to plant foods. The plants having less use inspite of their food and medicinal value are called as underutilized as they remain uncared and are only confined to natural wild and semi-domesticated conditions. Many of temperate plants have remained unutilized even after their high nutritional, medical and therapeutic value. *Rhododendron arboreum*, an evergreen branched tree is considered to be one of the most impressive and admired *Rhododendron* species (Srivastava 2012). *Rhododendron* has been derived from Greek word 'Rhodo' meaning rose and 'Dendron' meaning tree. The plant is generally best grown in moist soil. It generally grows above the sea level between 1500 m and 2000 m (Devi and Vats 2017) and attains a height of over 100 feet (Rai and Rai 1994). The plant requires no shade to grow and can be grown in semi shade. It is one of the highly valued flowers grown at high altitude in India. The trunk is usually branched, reddish brown in colour and also is soft and rough (Chauhan 1999; Orwa et al. 2010). The leaves of this plant are 10-20 cm in length and 3.6 cm in width. It is glossy green in colour (Rai and Rai 1994). The fruit is 3.8 cm in length and 1.25 cm in width. The central column is ribbed and is

composed of fine lobes. The seeds of *Rhododendron* are dark brown in colour and of compressed shape (Negi et al. 2013). During the spring season, the locals of Himalayan regions of India and Asia collect the flowers and sell them at 50-60Rs/kg in the local market. They are the seasonal income source of locals of mountainous region. This tree has great importance with respect to horticulture point of view. It has good nutritional and phytochemical properties too. The mountainous regions use its flower in making various preserved products. Traditional use of its flower against microbial infection is also reported (Kumar et al. 2019). The pharmacological studies also indicates that the flowers of *R. arboretum* contain α -glucosidase inhibitors and are effective against diabetes (Sharma et al. 2013). But all these uses are confined only to the native places and lack of commercialization has resulted in their under-utilization. Studies have indicated that this ignorance can be a threat to this plant which can add it to endangered plants list (Sekar and Srivastava 2010).

Objectives of the Study

This study was planned to review the literature based on chemical constituents, therapeutic properties and food value of *Rhododendron*

arboreum flower so that future studies can be planned for exploration of its commercialization in pharmaceutical and food industries as a remedy to degenerative diseases.

METHODOLOGY

The literature on nutritional and therapeutic properties of *Rhododendron* was collected from online resources like CAB, Web of Science and EBSCO.

OBSERVATIONS AND DISCUSSION

Geographical Distribution

Rhododendron is generally grown in the South Eastern Asia, North East Asia, North America and Western Europe. The species of *Rhododendron* are widely distributed worldwide and the highest number of this species is found in China. About 80 species are found in India (Chaudhary et al. 2021).

In India, it is grown in the Himalayas, Kashmir, Assam, Arunachal Pradesh, Sikkim and Manipur (Kumar et al. 2019). *Rhododendron* belongs to family, Ericaceae. *Rhododendron arboreum* is locally known as “Laligurans”. It blossoms in the months of March-April and June to September and each tree of *Rhododendron* has around twenty blossoms (Srivastava 2012). Its appealing flowers have a religious significance in India. Various attempts are being done by Indian government to conserve this plant tree so that its valuable contribution can be passed to future generations. One of the initiatives is the attempt of the Indian Postal Department who started a postal stamp based on *Rhododendron* flower. Other initiatives by state and central governmental agencies include *in situ* conservations and extension of protected areas as biosphere reserve, national parks and sanctuaries so that human activity cannot disturb their habitats.

It is a National flower of Nepal and State flower of Uttarakhand and Himachal Pradesh (Kumari et al. 2015). The colour ranges from deep red or pale pink flowers (Prakash et al. 2016). The plant contains phytochemicals, alkaloids, saponins, glycosides, flavonoids, steroids and minerals which play a major role in protection from various non-communicable diseases (Kumar et al. 2019).

Chemical Constituents

There are many essential nutrients that are found in *Rhododendron* flowers. Flowers have been reported to have significant antioxidants property because of presence of water and fat soluble pigments. The total carotenoids and total anthocyanins content of flowers is 2685 µg/100 ml and 154.8mg/L, respectively. They are also significant source of flavanols and total flavonoids (288.7mg/100ml and 1276.5 mg/ml, respectively), thus finding great value in pharmacology (Kumar et al. 2019).

Their total ash content is around 2.30 percent thus contributing to good mineral profile if added in diet. *Rhododendron* also contain sodium (385 mg/L, iron (405 mg/L) and manganese (50.2 mg/L) and zinc (32mg/L) which play a very crucial role in maintaining bodily processes important for healthy life. Thus, they can also contribute in eradication of mineral deficiency among populations. The calcium and iron contents in *Rhododendron* flowers as reported by Devi and Vats (2017) are 16.64-27.29 mg/100g and 5.62-6.25mg/100g, respectively from two different regions of Himachal Pradesh. Similar results have been reported by Madhvi et al. (2019) while studying its phytochemistry and pharmacology through methanol extraction method.

The geographical region poses slight variations in protein content of flowers and it was observed that there was a slight variation in protein content of flowers with from 4.85 to 5.59 percent (Devi and Vats 2017). The reasons highlighted for this may be change in soil condition and temperature variations. The flowers though appreciated for their appearance property also report to contain 16 different amino acids (Saklani and Chandra 2015).

Rhododendron contains many phytochemicals and secondary metabolites like alkaloids, flavonoids, glycosides, saponins, tannins and steroids are abundantly present in *Rhododendron* and thus contribute towards anti-oxidant content when taken in diet (Kumar et al. 2019).

According to Sonar et al. (2012), *Rhododendron arboreum* contains many polyphenolic compounds. It also contains steroids, saponins and flavonoids. The author also reported quercetin, a polyphenolic compound while extracting as one of the biologically active compounds. The abundance of phytochemicals is not only limited

to flowers but its bark, root and stem are also good source of phytochemicals as studied by Nisar et al. (2011) and Shrestha and Pratapsingh (2012).

Therapeutic Properties

Rhododendron arboreum has various therapeutic properties like anti diabetic property, anti inflammatory, antioxidant, anti hyperlipidemic, anti cancerous, cardio protective properties. The dried leaves of *Rhododendron* are known to treat gout and rheumatism (Sonar et al. 2012). The author also suggested that quercetin (a flavonoid) may be responsible for the anti-microbial activity. The therapeutic properties of *Rhododendron* are discussed as:

1. Anti-Diabetic Property

Bhandary and Kuwabata (2008) studied the anti-diabetic potential of *Rhododendron* in production of medicines or functional food for diabetes. Anti-diabetic activity is because of active compounds such as phytochemicals present in it. The methanolic aqueous extract of the flower showed inhibitory activity on the intestinal alpha-glucosidase of rat. The ethyl acetate soluble portion of the methanolic aqueous extract showed higher activity. Quercetin-3-O- β -D-galactopyranosidase was isolated from the ethyl acetate soluble portion with the help of enzyme assay separation.

The deficiency of insulin can lead to diabetes mellitus. Bhatt (2018) also reported that aqueous extract of ethanol of *Rhododendron* has anti hyperglycaemic and anti hyperlipidemic properties which promotes insulin secretion. *Rhododendron* is used as a home remedy traditionally in the treatment for various diseases and the leaves and flowers of the *Rhododendron* possesses anti diabetic activity due to the presence of certain phenolic acids (Kumar et al. 2019).

2. Cardio Protective Property

Among many health problems, cardio vascular problems are the leading cause of death which is further susceptible to chronic diseases. The antioxidants present in the *Rhododendron* are directly linked with the reduced risk of cardiovascular diseases (Monika 2016).

Excess production of the free radicals lead to cardiovascular problems. Bhatt (2018) revealed the cardio protective property of the *Rhododendron arboreum*. The fresh red petals of the flower were found to possess heart friendly properties. *Rhododendron* is known to treat cardiovascular diseases such as atherosclerosis, heart attack, myocardial infarction and stroke as it contains good amount of quercetin, rutin and coumaric acid. Quercetin can be taken in the form of supplements to treat hypertension, atherosclerosis and other cardiovascular diseases. Rutin helps to stop the blood clot formation which further prevents heart attacks. An antioxidant, namely, p- coumaric acid present in the *Rhododendron* reduces the chances of heart diseases. Flavonoids are known to guard the cardiac muscles and also to improve the function of the cardio vascular system. The author also reported that the n-butanol fraction of the *Rhododendron arboreum* flowers has cardio effective properties.

3. Anti-oxidative Property

The species of *Rhododendron* have antioxidative properties which reduces the formation of free radicals by reducing the process of oxidation in the body. The antioxidant property of the flower is known to be the best and also plays a vital role for human health (Monika 2016).

The ethanol extract of *Rhododendron* had certain antioxidative properties. The research was done on rats and mice. Anoxia stress tolerance, swimming endurance and immobilization stress models were selected to evaluate the antioxidant activity. The doses of 250 and 500 mg/kg of the ethanolic extract were used for treatment. The study reported an increase in the stress tolerance and swimming endurance as compared to that of control. It also possesses antioxidant property as it has flavonoids, saponins, tannins and other phytochemicals (Srivastava 2012).

According to a study conducted by Devi et al. (2018), flowers of *Rhododendron* have antioxidant property due to the presence of ascorbic acid and some of the major pigments like anthocyanins and flavonols. In the study, the anthocyanin content was found to be around 208-212mg/100g in flowers.

4. Other Properties

Rhododendron possess other nutritional and nutraceutical properties which can be used to

treat various diseases. It has been reported to have significant amount of flavonoids, saponins, tannins reducing sugars and other phenolic compounds. The anti-diarrhoeal property as reported by many researches is due to the tannins, reducing sugars and sterols. *Rhododendron* is also used to treat uric acid and rheumatism and also possesses anti inflammatory properties. The dried flowers of this plant are used to treat diarrhoea and blood dysentery (Srivastava 2012).

Because of its high content of phenols and free radical scavenging activities, it is known to reduce the risk of cancer. It is also used to treat fever, inflammation, detoxification, constipation, bronchitis and asthma (Monika 2016). Gill et al. (2015) also revealed that the *Rhododendron* has been used in curing ailments from olden times. The plant possesses antifungal, antimicrobial and anti inflammatory properties because of certain naturally occurring chemical compounds like phytochemicals. Alkaloids of *Rhododendron* flowers have a metabolic role with protective properties. Similar results were reported by Kumar et al. (2019) who revealed that they are used to treat diarrhoea, headache and inflammation, bacterial and fungal infections. The leaves of activity due to the presence of phenolic acids in them. This property is also reported to act against human immunodeficiency virus.

Product Development Potential

Rhododendron can be used to make many products because of its high nutritional value. The edible wild flowers of *Rhododendron* play a very vital role in the preparation of squashes, juices, pickles, sauce and other value added products (Monika 2016). Srivastava (2012) revealed that the sweet and sour taste of *Rhododendron* can be utilized to make many value added products which are helpful for the treatment of many nutritional related disorders. Fresh juice prepared from the flowers of the *Rhododendron* is known as Rhodo juice or *Sharbat*. It can also be used to prepare squash, jam, local brew and jellies. *Barah ki Chutney* (Indian sauce) can be prepared using fresh flowers (Krishna et al. 2010). The fresh petals can be used in making a jelly which is slight acidic and a famous *Sharbat*. Local brew prepared from *Rhododendron* is also very refreshing and is used to prevent high

altitude sickness (Bhattacharya 2011; Kumari et al. 2015).

Rhododendron flower juice can be extracted with the help of two methods, cold pressing and hot pressing methods. The *Chutney* from *Rhododendron* is made by adding mint leaves, tamarind extract, salt and pomegranate seeds to the crushed flowers (Kumar et al. 2019).

Devi et al. (2018) conducted a study to investigate the nutritional value of *Rhododendron* flowers of different areas of Himachal Pradesh to standardize the technique of juice extraction. The procurement, grading and sorting of the flowers were done and then they were washed under running water. Three different juice extraction techniques namely blanching, steaming and manual were performed in the laboratory with 100 grams of petals to figure out the best extraction technique in terms of taste, colour and the amount of juice extracted. The author revealed that the blanching method was found to be the best for extraction. The juice extracted by blanching method was good red in colour with the yield of 70 percent. The author also reviewed that the flowers of the *Rhododendron* are sweet and sour in taste. The extract of flowers in hot water can be naturally used a food colouring agent.

Rhododendron wine is also made from the flowers which is a very energizing drink. The author also reviewed that the nectar of the flowers may be harmful if taken in excessive amount. Similar results have been reported by Kumar et al. (2019).

Honey can also be prepared from the *Rhododendron* and is made when the honeybees take the nectar from the *Rhododendron* and is known as *Rhododendron* honey. Honey is prepared by bees which use nectar from flowers of *Rhododendron*. It also known as anti-toxic or wild honey and is known to cure many disorders (Monika 2016).

Krishna et al. (2014) had attempted to prepare an improvised squash blended with ginger from fresh *Rhododendron* flowers. In this study, the control sample taken was the squash of *Rhododendron* available in the market which was compared with that prepared from improvised method. Sensory evaluation was conducted to find the most acceptable between plain squash, ginger blended squash and control sample. The study found that there are significant

differences in the colour, texture, appearance and flavour of the prepared squash. The results showed that the squash blended with ginger was most acceptable and the control sample was scored the least by the panel members.

CONCLUSION

The flowers of this tree are rich in minerals like manganese, iron, zinc, copper, sodium, chromium, cobalt and selenium and also possess phytochemical properties. Tribes of *Himalaya* use this flower to prepare many value added products like jams, jellies, squashes, ready to serve etc. These are also rich in antioxidants and researchers have concluded them as anti hyperlipidemic, antidiabetic and cardio protective. But their commercial use is currently unavailable. The flower can be utilized commercially for the product development available throughout the year. The use of this plant can be beneficial to the local livelihood.

RECOMMENDATIONS

This review study recommends that flowers of *Rhododendron* being rich in nutraceutical compounds can be well used as in development of functional foods. These properties of *Rhododendron* can be well utilized in benefit of society in term of maintaining health and preventing non-communicable diseases. The present study calls for more extensive in vitro and in vivo evaluation of *Rhododendron* flowers so that it can be commercialised and its benefits can be well utilised by the Indian as well as other population of world.

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