# Health benefits, Utilization and Characterization of *Rhododendron arboreum* (*Ericaceae*)

## 1. Abstract

*Rhododendron arboreum* is a small tree, mostly found in the mountain areas with pale pink or deep pink flowers, widely spread throughout the world. It is a member of the *Ericaceae* family, and it is well-known for its lovely flowers. *R. arboreum* species is distributed widely among the 80°N and 20°S latitudes and is designated as 'State flower' of Himachal Pradesh (India) and 'National flower' of Nepal. Due to its many inherent phytochemical properties, it is used as a treatment for various diseases such as bacterial infection, diarrhoea, and headache, infamy, and fungal infections. The people living in the mountainous area historically use the flowers of this plant to make variety of products viz. juice, squash, jelly, syrup, pickle, honey. *R. arboreum* have several important polyphenolic and bioactive compounds such as saponins, flavonoids and steroids. This review highlights *Rhododendron's* nutritional properties, potential properties and medicinal properties and various products developed, which boost livelihoods of the rural tribal community for sustainable growth and treatment of various diseases.

**Keywords:** *Rhododendron Arboreum*, antimicrobial activity, anti-inflammatory, phytochemicals.

## 2. Introduction

Nature has given us access to a wide variety of plants with different uses, such as decoration, medicine, fruiting and flowering. The commercial cultivation of plants now days is mainly for the medicinal purposes and researchers are studying the underused plants with traditional therapeutic values. India is famous for its immense biodiversity and its traditional rich medicinal system that is 'Ayurveda', which is a powerful base for the exploration of the different types of plants in health care. *R. arboreum* is one of those plants that has specific place in the cultural lives and economical lives of the people. The name '*Rhododendron'* is derived from greek word *'Rhodon',* meaning rose and '*dendron',* meaning "tree". *R. Arboreum* is from the *Ericaceae* family, and it was first described in year 1837 by scientist Carl Linnaeus. *Rhododendron Arboreum* comprises 1200 species and forms largest genus of *Ericaceae* family (Ahmad *et al.*, 2021).

The plant is taxonomically classified as follows (Philipson et al., 1975) (Srivastava, 2012), (Tiwari and Chauhan, 2006).

**Kingdom:** Plantae
**Phylum:** Magnolliophyta
**Class:** Angiospermae
**Order:** Ericales
**Family:** Ericaceae.
**Genus:** Rhododendron
**Species:** *Rhododendron arboretum*

## 3. Distribution of *Rhododendron* species

Approximately, estimation of 1200 *Rhododendron* species worldwide, China has the most species, with 571 species out of the total of the world's species, 409 of which are endemic. Around 80 species, 14 varieties and 10 subspecies occur in India. According to existing records, Sikkim has 72% of the *rhododendron* species while the Himalayan area has 98% of the *rhododendron* species. (Singh et al., 2003), (Sekar and Srivastava, 2010), (Tiwari and Chauhan, 2006).

*Rhododendrons* are high-altitude plants that can be found in Nepal, Northeastern India, Eastern Tibet, Northern Burma, and Western and Central China. This region contains more than 90% of the world's *rhododendron* population. (Tiwari and Chauhan, 2006). More than 700 species of *Rhododendron arboreum* are native to China, accounting for around 70% of the total (Wu et al., 2015). In India, it is found mainly in the region of Assam, Valley of Himalayas, Kashmir, and Manipur. *Rhododendron arboreum* can also be in some areas of Bhutan (Srivastava, 2012), (Justice, C., 2000), (Tiwari and Chauhan, 2006).

*R. arboreum*, associated with "banj" and "kharsu" trees, have red or pink, scarlet flowers. It is an evergreen tree with a height of 30 metres and a diameter of 1metre at the base. Between months of January and March, the flowers bloom, and between October and December is when the fruit matures. (Shen et al., 2015), (Chamberlain, D. F, 1982).
Mostly occurring in Himalayan forests or Nilgiri hills of South India at 1500 m to 6000 m high altitude. *R. arboreum* is the national flower of Nepal, where it is locally known as the ‘Lali

Guras' meaning 'rose tree'. In India, it is the state tree of Uttarakhand and state flower of Nagaland and is very popular flower in making chutney and various food products (Maiti and Chauhan, 2000), (Broadhurst C.L, et al, 2000), (Sonar *et al.*, 2012), .

It is mainly distributed among all types of *Rhododendron* species, and based on the morphological data that is leaves, hair and flower etc., (Hooker, J. D 1949) taxonomists have made numerous classifications of *R. Arboreum*. Table 1 (Srivastava, 2012) shows the most commonly found subspecies of the *Rhododendron* species, its characteristics and distribution.

**Table 1: - Subspecies of *Rhododendron Arboreum*, its flower characteristics and its distribution** (Srivastava, 2012)**.**

| **Subspecies** | **Flower Characteristics** | **Distribution** |
|---|---|---|
| *Arboreum Rhododendron arboreum* spp. | Red flowers. | Western Himalayas. |
| *Cinnamomum Rhododendron arboreum* spp. | White, pink, and red flowers. | Central Himalayas. |
| *Delavayii Rhododendron arboreum* spp. | Red flowers. | Eastern Himalayas. |
| *Nilagiricum Rhododendron arboreum* spp. | Red flowers. | Nilgiri hills (South India) |
| *Zeylancium Rhododendron arboreum* spp. | Orange-red flowers. | Sri Lanka. |

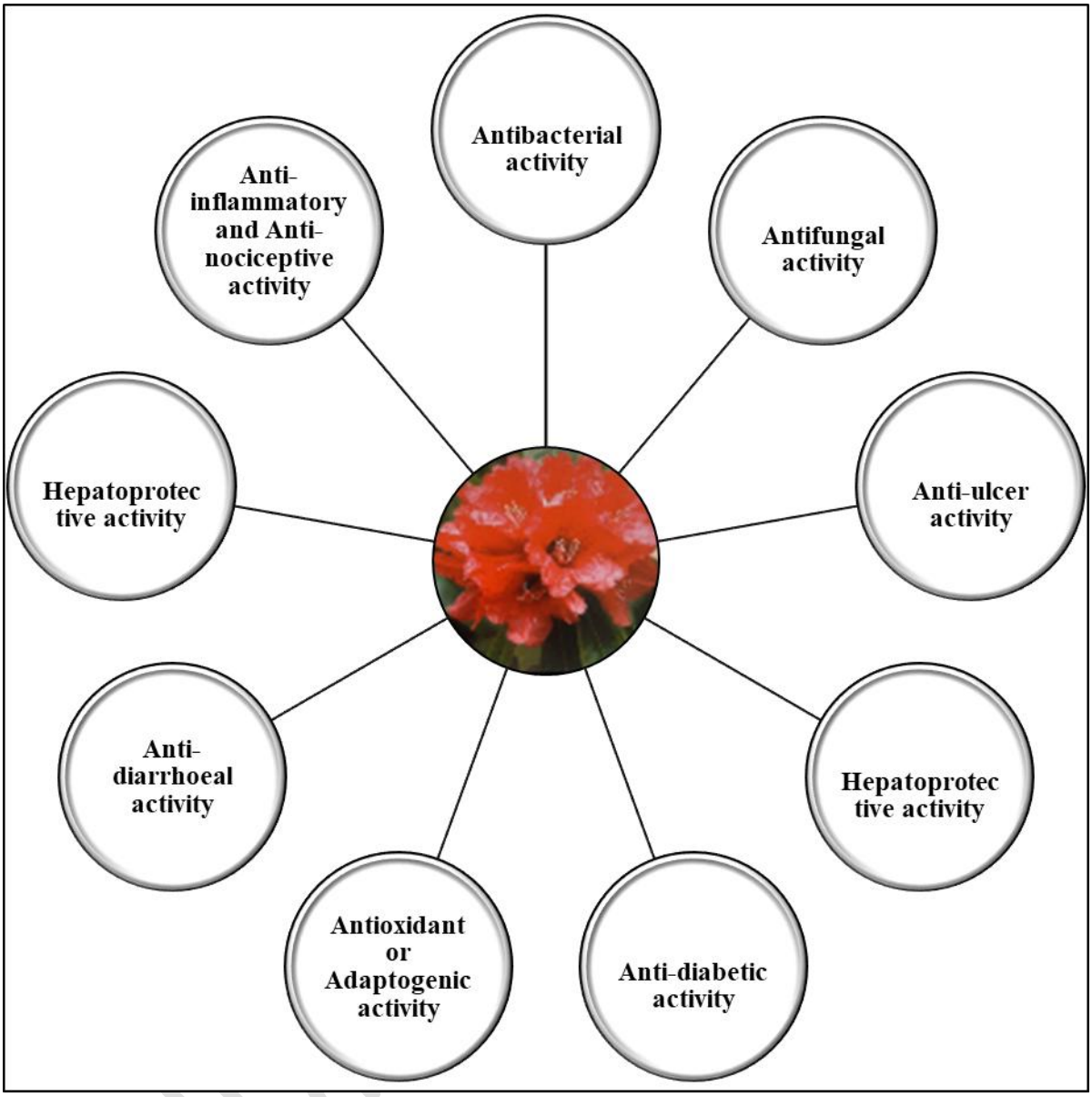


**Figure 1: *Rhododendron arboreum* (*Ericaceae*) and its activity (Source: Srivastava, 2012, Kumar *et al.*, 2019).**

## 4. *Rhododendron arboreum* composition

*R. Arboreum* is composed of mineral such as copper, manganese, iron, sodium, zinc, chromium, cadmium, cobalt, lead, molybdenum, Nickle, arsenic, and lead. Some processes of physicochemical which are important for the life are maintained by minerals which plays an important role in maintenance (Cullen, J et al, 1978). The essential cofactors present in the structure of some enzymes are manganese, selenium, copper, zinc, molybdenum, and iron which

are indispensable in various biochemical pathways. Sodium plays very important role, and it is used for maintenance of osmotic balance between interstitial fluid and cells (Soetan, Olaiya and Oyewole, 2010).

The *Rhododendron arboreum* contains high number of secondary metabolites which includes flavonoids, tannins, alkaloids, saponins, glycosides, phlobatannins and steroids (Nisar et al., 2013). These secondary metabolites are important components of plants for survival, and it plays a very important role in the health of humans (Chamberlain and Rae, 1990).

## 5. Utilization prospects of *Rhododendrons*

### 5.1. Aesthetic values:

*Rhododendrons* have caught the interest of botanists and horticulturists all over the world because of their lovely, majestic blossoms and evergreen foliage. Nearly half of the *Rhododendron* species is already under cultivation, and 5000 to 6000 *Rhododendron* hybrids have already been established. These hybrids are expensive and grown for their showy and lovely blossoms in gardens and parks. *Rhododendron* trees can be planted as avenue trees in the slopes between 2000 and 4000 metres, along roadsides and residential areas (Paul et al., 2005).

*Rhododendrons* are frequently used in landscaping, accent planting (area-specific examples), and forest planting (P.O., R.A. and V.A., 2017). The plant, which was one of the first to colonies wasteland, aids in soil erosion prevention and vegetation regeneration. *Rhododendrons* produce more color than any other flowering shrub or tree when placed in a mass. They're great for creating a genuine woodland look and a massed spring color impact (Tiwari and Chauhan, 2006). Moreover, *Rhododendron arboreum* plant's wood can also be used to make products like gunstocks, kukri handles, gift boxes, saddles, and posts for packaging and many more products (Rawat et al., 2018).

### 5.2. Therapeutic applications of *Rhododendron Arboreum* plant

Plant-based medicines are still used by over 80% of the world's population, according to the World Health Organization (WHO). A great number of medicinal plants were employed in Ayurveda, Siddha, and Unani for the treatment of human ailments. Medicinal plants held a special role in human life (Lepcha *et al.*, 2015). It goes through the benefits of using plants or

plant parts as medication. Plant-based medications have received a lot of interest in traditional medicine since they are readily available, less expensive, and have no adverse effects (Baker, 1994), (Kaul, M.K., 2010). As secondary metabolites, plants can manufacture a diverse range of phytochemical substances (Lumbantoruan and Hidayat, 2013). Many phytochemicals have been successfully employed to treat a variety of human illnesses. The World Health Organization has attempted to identify all medical plants used around the world and has compiled a list of over 20,000 species. The majority of medicinal plant parts are employed as raw pharmaceuticals and have a wide range of therapeutic characteristics. Plants have a lot of potential for developing novel medications and for treating chronic and infectious disorders in traditional medicine. Phytomedicine is becoming increasingly important in the treatment of inflammation (Middleton and Kandaswami,1993). There has been a growing recognition of the usefulness of medicinal plants in recent years (Murugesan and Deviponnuswamy, 2014).

*Rhododendron* plant is commonly works as a cure for many diseases in Far-West Nepal and it is known mainly for its various medicinal applications with a less side-effects. Anti-inflammatory, anti-HIV, anti-nociceptive activities have been reported (Bhattacharyya, 2011). Phenolic acids obtained from *Rhododendron* plant twigs, leaves, and flowers are used for the treatment of cancer, diabetes, headache, rheumatism, and various diseases (Jayanthi et al., 2012) (Pathak *et al.*, 2021).

Dried flowers fried with ghee have historically been deemed highly effective in treatment of diarrhea, blood dysentery (Leach, D. G., 1961), (Sonar et al., 2012) and reported to be used in the mental retardation therapy. The anti-inflammatory and cholinergic activity of flowers has also been documented (Murugesan and Deviponnuswamy, 2014). *R. Arboreum* is important component of the Ayurvedic preparation that is "Ashoka Aristha". *R. arboreum* in known to have oxytocic, osteogenic and prostaglandin synthetase inhibiting activities (Sonar et al., 2012). As per Materia Medica of Homeopathic, the essence of dried leaves of *R. arboreum* is beneficial for the Rheumatism and Gout (Sonar et al., 2012), (Dubey S K, et al, 1980).dis

The *Rhododendron* plant has been described as a treasure trove of medicinal and aromatic plant species. A detailed survey on the leaves of 206 *R. Arboreum* species, varieties and subspecies, quantitated different flavonoid types such as coumarins, Myricetin, Gossypetin, Dihydrokaempferol, Azalea tin, Dihydromyricetin, Kaempferol, dihydroquercetin and Carya tin

(Kumar *et al.*, 2019). The distribution of 5-methyl ether flavanol has been studied that in the petals and leaves of the 50 *Rhododendron* plants. As stated by the World Health Organization (WHO, 2000), 65% population of the world integrates this medicinal plant for treatment of various disease. In India, 80% population uses plant products for the treatment of different types of diseases (Prakash, Rana and Sagar, 2016). *R. Arboreum* plant has natural medicinal value, which are beneficial for health and potential to cure the heart-related disease, diarrhea, detoxification, dysentery, inflammation fever, nasal problems, constipation, bronchitis, asthma and many more (Nisar et al., 2013), (Pathak *et al.*, 2021). The *R.arboreum* leaves have the productive activity of antioxidants. Its young leaves are used for headache relief.

**Table 2: Medicinal Uses of Rhododendrons at a glance (Bhattacharyya, 2011).**

| PARTS USED | USES | Components |
|---|---|---|
| Flowers, corolla (Fresh, Dried) | In treatment of hill diarrhea and dysentery. Fried flowers taken with ghee prevent blood dysentery. This medication is also used when fish bones become lodged in the esophagus. | Quercetin-3-rhamnoside, Phenolic compounds: Rutin, Coumaric acid |
| Leaves | Used as poultice for treatment of high fever and headache. Antioxidant activity, anti-inflammatory, gout and rheumatics (dried leaves), alleviate headache and fever, diuretics, fungal infection, to relief toothache, sciatica syphilis, treatment of cold cough, asthma, bronchitis, post-delivery complications, indigestion, lung infection, | Glucoside, Ericolin, Ursolic acid, Quercetin, Hyperoside, Flavone glycosides, Flavonoids |
| Bark | Excellent cold reliever, antimicrobial agent, anti-inflammatory, anti-oxidative, anti-inflammatory, anti-oxidative, anti-carcinogenic, anti-mutagenic, anti-atherosclerotic, anti-hyperlipidemic, and antimicrobial effects | Triterpenoids, Ursolic acid acetate , Betulinic acid, Leuco-pelargonidin |

| | | |
|---|---|---|
| Stem | Hemorrhage, hay fever, bronchial asthma, anticancer, prevent cardiovascular disease. | Alkanoids, steroids, terpenoids, anthraquinones, tannins, glycoside |

### 5.2.1. Medicinal uses of flower

*R. arboreum* has a wide range of flower colors, from deep scarlet to red with white lines, pink to white. When in full bloom, this rhododendron, which can have up to twenty flowers in a single truss, is a sight to behold. The vivid red variants of this rhododendron are often found at lower elevations, according to reports. The flowers are bright red and arranged in thick globose cymes (Srivastava, 2012). As flowers of *Rhododendron* contains the anti-diabetic potential, which are used as functional food or nutraceutical for the diabetes problems and presence of phenolic compounds in flowers increase its medicinal properties and plays very important role for healing or treatment of many diseases worldwide (Pathak *et al.*, 2021), (Srivastava, 2012), Bhattacharyya, 2011), (Manikumar et al., 2011), (Gill, Panthari and Kharkwal, 2015). In addition to anti-diabetic property, which are beneficial against the (DN) diabetic nephropathy, flowers are also having antimicrobial activity, anti-diarrheal activity. Anti-inflammatory, anti-nociceptive, and hepatoprotective properties are also found in these flowers. Flowers are also used for treatment of fungal infections, and it is also effective against anti-allergy problems.

### 5.2.2. Medicinal uses of leaves

The oblong-lanceolate shaped leaves are 10-20cm long and 3.6cm wide. When the petiole is young, it is covered with white scales and crowded at the ends of branches. It's a shiny green felt with strongly embossed veins on the top and a cinnamon or reddish brown felt on the underneath. (Srivastava, 2012). Leaves of *Rhododendron* plant shows anti-inflammatory, antioxidant activity and dried leaves have potential to treat the Gout and Rheumatics (Issn, 2021). Leaves are also used in treatment of fever and headache. It is also used in treatment of fungal infection. These leaves are used to get relief from toothache, treatment of cold cough, bronchitis, asthma, post-delivery complications, lung infection, indigestion, hepatic disorders.

Flavonoids is the compound, which is present in the leaves of *rhododendron* plant, these dried leaves of *Rhododendron* plant are helpful in treatment of diseases such as Gout and Rheumatism

and these leaves are also helpful in healing of many diseases like Fever, Headache, Cough any many various diseases (Srivastava, 2012) (Bhattacharyya, 2011),(Manikumar et al., 2011).

### 5.2.3. Medicinal uses of Trunk

Branched, twisted, or gnarled trunks are common. The bark is a reddish-brown color, soft and scratchy, and it peels off in tiny flakes. (Chauhan, 1999), (Srivastava, 2012). Bark of *Rhododendron* plant is used for cold reliever. It is also very useful as anti-microbial, anti-oxidative, anti-mutagenic, anti-carcinogenic, anti-lipidemic, anti-atherosclerotic effects. In bark of *Rhododendron* plant, alkaloids are present which plays a metabolic role by providing best beneficial properties to treat diseases (Srivastava, 2012), (Nisar et al., 2013), (Gill, Panthari and Kharkwal, 2015).

Stem is used to treat the anti-cancer, hay fever, Hemorrhage, bronchial asthma. It is also used to prevent cardiovascular diseases. The bioactive substances present in stem of *Rhododendron* is beneficial in good health and used in healing and treating various diseases (Nisar et al., 2013).

### 5.2.4. Medicinal use of Root

Presence of the secondary metabolites in plant signifies that root of the *Rhododendron* plant can be used as a therapeutic agent. Root has the properties of Anticancer, Anti-inflammatory, Anti-nociceptive which are used to prevent cardiovascular diseases (Srivastava, 2012) (Nisar et al., 2013).

### 5.2.5. Fruit

Fine lobes, ribbed, up to 3.8 cm long and 1.25 cm wide, make form the capsule-curved central column. (Srivastava, 2012).

### 5.2.6. Seeds

Small, dark brown seeds with an obvolute membrane are compressed, thin, and linear. (Srivastava, 2012).

## 6. *Rhododendron* plant products

Recently, it has been of research interest to utilize *Rhododendron Arboreum* plant to produce beneficial food items, but very few products are available in the market. The proper utilization of *Rhododendron Arboreum* needs to do by carrying out scientific research because of the limited

distribution of *Rhododendron* flowers in limited places. In this review, few of the potential items which are produced from *Rhododendron* flower are suggested here. This opens a new gate for the processors and researcher to use *Rhododendron Arboreum* flower for beneficial purpose.

*Rhododendron* flower juice is believed to have great therapeutic value and used as a refreshing drink. Two methods can be used to extract *Rhododendron* juice, which are (a) hot-pressing method and (b) the cold-pressing method (Figure 2). For the juice extraction the processor typically uses the hot-pressing method resulting in greater yield, but the thermosensitive phytochemical properties are affected at the same time. Therefore, the processor can use the cold-pressing method for solving the problem and which provide customers with a healthy product. For the best marketing plans for the selling of the squash and many other drinks, *Rhododendron* flowers may bring enormous opportunities (Bhattacharjee, S.K, 1998). The researchers are still not investigating other items like: preserve, syrup, appetizer, vinegar, wine, jam, instant juice mix, jelly, probiotic beverages, milk-based products and flavored milk which require more exploration in future time to carry this plant forefront to Indian industries of food (Gill, Panthari and Kharkwal, 2015).

Besides the production of juice-based products and juices, *Rhododendron* flower also used in production of various dried products (like - Chutney, dried-powder, pickle, and many more dried products). *Rhododendron* flowers are traditionally used for production of the chutney it is prepared by crushing the flowers of rhododendron and then adding the salt, mint leaves, tamarind or anadama to give a sour taste to the chutney. However, these various types of products of rhododendron flowers are not studied by researchers yet.

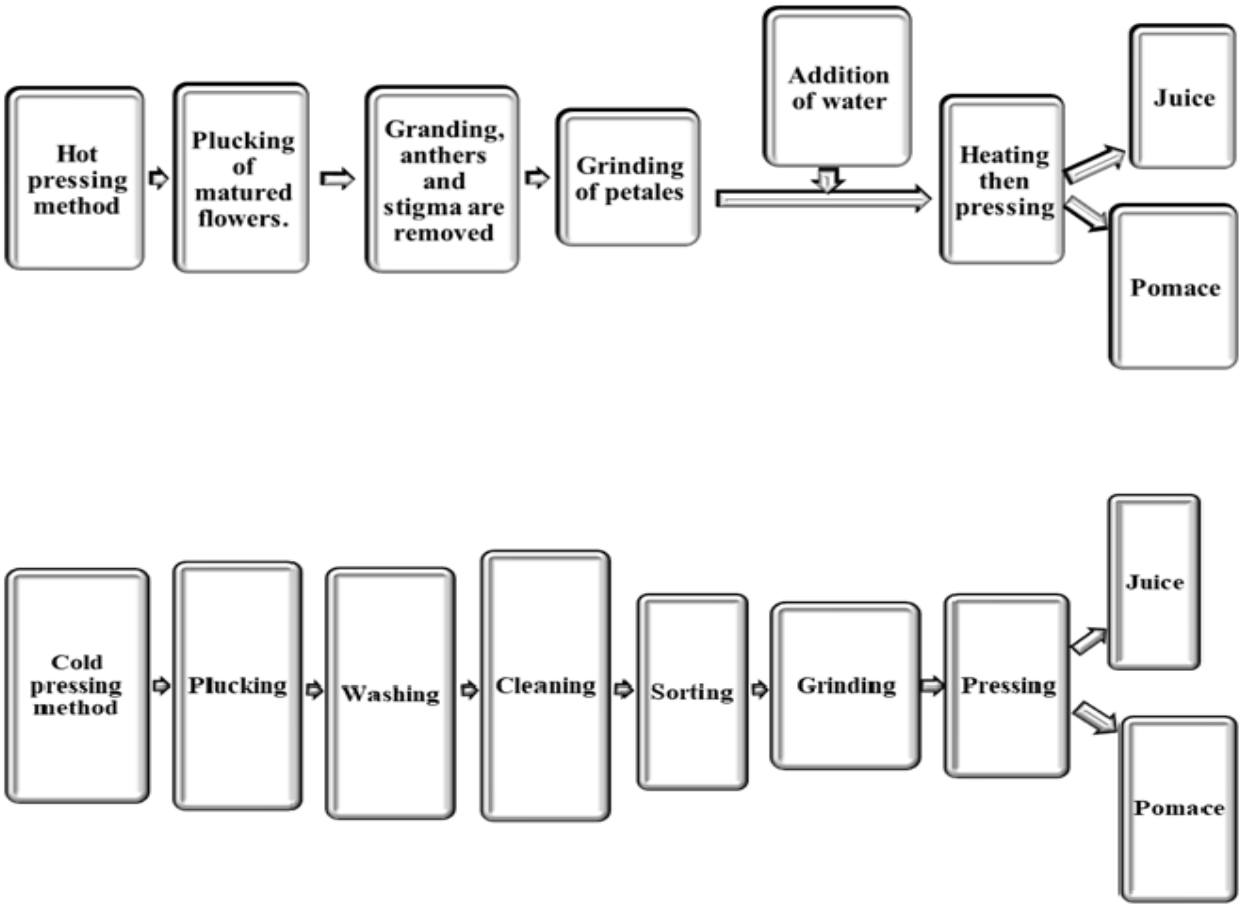


**Figure 2:** Methods of Rhododendron flower juice extraction (hot and cold pressing) (Kumar *et al.*, 2019)

## 7. Prospective Future of *Rhododendron arboreum*

*Rhododendron arboreum* can be used commercially for production of pharmaceutical products and various food products. The availability of *rhododendron* flowers or flowers-based products all over the year helps in development of employment for the rural tribal population. Tremendous opportunities are also present to devise better marketing strategies as the plants of *Rhododendron* can be used for development of various lifesaving medicines. A good prospect for local livelihoods depends on the sustainable use of this plant. Research focusing on the value addition and raising the awareness of its many medicinal and nutritional value among rural, semi-urban and urban consumers, is still needed to address the problems of malnutrition or/and

improving of economy (Pankaj Kumar et al., 2017). Figure 3 illustrates the future prospect of *Rhododendron arboreum* flower for development of food products in worldwide. Researchers need to further explore for the development of novel products targeting the markets and food industries.

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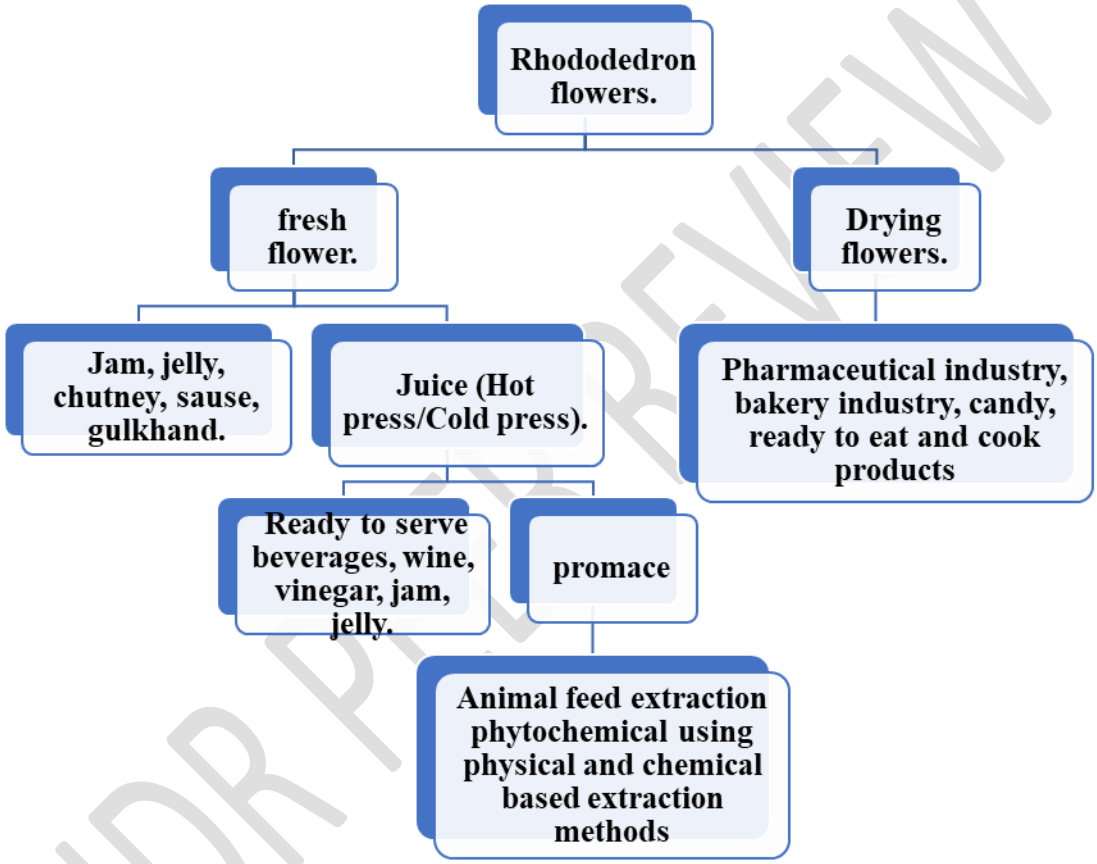


**Figure 3:** Future prospective of *Rhododendron* flower (Source: Kumar *et al.*, 2019).

## 8. Conclusion

In this review we conclude that *R. Arboreum* flower has many applications and benefits in the daily life. Along with antimicrobial activities, rhododendron plants have a range of health benefits and have potential for use in the food and beverage industries. And it has many future prospective also. The researchers should further study this plant as it is still underused and is not adequately stored to make it accessible throughout the year. Exploring new horizons as well as

medicinal properties of *Rhododendron* flowers can attracts the researchers to perform value-added research in this area that can assist in improving the next generation's employment and economy. *R. arboreum* flower is one of the useful and beneficial properties in disease treatment, food industries, and mainly in developing value-added items to boost the livelihoods of the rural tribal community for sustainable growth and it also helps in rural tribal population development with the great possibilities of employment.

**DISCLAIMER:**

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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