

# Nutraceutical Aspects of *Rhododendron* (Burans): Certainly a Need to Include Some Other Species for Food and Beverage Production

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**Abstract:** *Rhododendron* species belongs to dicotyledonous family Ericaceae with small shrub to tree bearing pink to orange yellow, deep red clusters of flowers. Flowers and other plant parts of some species are used medicinally and for preparations of other food items, although few species in the genus are poisonous. The species are rich in phytoconstituents, acclaiming their medicinal attributes. The flowers of *R. arboreum* are widely used to prepare a squash locally in India and offers health promoting activities as are rich source of antioxidants. The present review focuses on the different *Rhododendron* species found in India highlighting their photochemistry, traditional uses, pharmacognostic features and their valuable novel nutritional aspects. However, only the detailed investigation and nutritional aspect of *R. arboreum* are acclaimed. There is a need to explore more about the other *Rhododendron* species so as to utilize them at a larger scale. Seven species of *Rhododendron* have been identified as medicinal from India which needs to be studied in depth for their nutraceutical attributes. The assessment of nutritional contents of carbohydrate, fat, protein, fibers and micronutrients will help to establish their nutritional values. There is also a need for conservation of *Rhododendron* species by establishing *Rhododendron* gardens through Village Forest Management committees.

**Keywords:** *Rhododendron*, nutraceutical, burans, flower, phytoconstituents, India

## 1. Introduction

The ethnic communities are well versed and knowledgeable enough to sustain life and livelihood with locally available limited bio resources. These ethnic communities utilize their surrounding flora and fauna for food, medicine, socioeconomic purposes etc. The traditional knowledge acquired within these ethnic groups is passed from one generation to another over centuries and today has become the basis for many scientific investigations resulting in the formulation of new product each day. Since ancient times *Rhododendron* species are known for their medicinal and nutritive values. The use of the species is mentioned in the preparation of 'Asoka Aristha' an Ayurvedic formulation<sup>1</sup> and described as Kurabaka place in "Kashaya" group<sup>2</sup>. Besides this for years, some *Rhododendron* species have been applied in traditional medicine to treat various diseases in Asian, North American and European traditional medicine mainly against inflammation, pain, skin ailments, common cold and gastro-intestinal disorders. In Chinese folk medicine flowers, dried stems and leaves, of *R. spinuliferum* are used to get relief from cough, eliminate phlegm and also as an anti-asthmatic drug. The dried leaves of *R. dauricum*, known in China as *Manshanhong*, were used as an expectorant, and to treat acute and chronic bronchitis<sup>3,4</sup>. Both flowers and fruits of *R. molle* have been recorded in ancient and modern monographs as analgesics and not only in India and China the other species of *Rhododendron* such as *R. ponticum*, *R. chrysanthum*, *R. ferrugineum*, *R. molle*, *R. cinnabarium*, and *R. collettianum*

, are also used against pain and other inflammatory conditions. In an extensive study the isolation and characterization of approximately 208 active phytoconstituents including secondary metabolites as monoterpenoids, sesquiterpenoids, diterpenoids, triterpenoids, steroids, coumarins, and flavonoids, as well as others, with the majority of flavonoids, followed by diterpenoids have been elucidated<sup>4,5</sup>. Worldwide, around 1200 species of *Rhododendron* have been estimated, amongst which China has the highest number of species *i.e.*, 571 species of total species in the world<sup>6,7</sup>.

### Distribution and acclaimed uses of *Rhododendron* species in India

The genus name '*Rhododendron*' is derived from Ancient Greek word 'ρόδορρόδον' for "rose" and 'δένδροδένδρον' for "tree"<sup>8</sup>. It belongs to family Ericaceae and mainly inhabit the northern hemisphere growing from alpine shrubs to subtropical forest ranging from dwarf shrubs to large trees. The smallest are *R. nivale* and *R. pumilum* only 10- 50 cm however the tallest species, *R. arboreum* grows over 40 meters. In India it is mainly distributed between 1200-4000 m a.s.l. in Himalayas and was first recorded by Captain Hardwick in Jammu and Kashmir in 1776 where he spotted the *R. arboreum* Sm. but it was British botanist Joseph D. Hooker who during his visit to Sikkim between 1858 and 1850 revealed the *Rhododendron* wealth of the region. The Northeastern states are the treasure house of maximum *Rhododendron* *i.e.* the house of 97% of the *Rhododendron* species and sub-species of India. Various studies and records

emphasize the availability of 132 taxa (80 species, 25 sub species and 27 varieties) of *Rhododendron* found in India, from which 129 are found in the north-eastern India alone<sup>9,10</sup> and 36 species with 45 other variants from Sikkim Himalaya. In Arunachal Pradesh highest number of *Rhododendron* taxa i.e. 119 taxa with 74 species, 21 sub species and 24 varieties are in occurrence. Sikkim is endowed by 42 taxa i.e. 25 species, 11 sub-species and 6 varieties while 10 in Manipur, 04 in Mizoram and 11 species in Nagaland are found. There is a need to protect and conserve several varieties of *Rhododendron* with 18 species endemic to India. 27 species of *Rhododendron* are reported from Upper Subansiri and Kurungkumey districts of Arunachal Pradesh. *R. arboreum* Sm., *R. formosum* Wall. *R. arunachalense* D.F. Chamb, S.J. Rae., *R. ciliatum* Hook. f., *R. cinnabarium* Hook. f., *R. eclectum* Balf. F. & Forrest, *R. exasperatum* Tagg., *R. falconeri* Hook. f., *R. formosum* Wall., *R. grande* Wight, *R. griffithiana* Wight, *R. kendrickii* Nutt., *R. keysii* Nutt., *R. lanatum* Hook.f., *R. lepidotum* Wall. ex G. Don, *R. leptocarpum* Nutt., *R. crassum* Franch. *R. megeratum* Balf. F., *R. neriflorum* Franch., *R. pumilum* Hook. f., *R. sanguineum* Franche, *R. sinogrande* Balf. F. & W.W. Sm., *R. succothii* Davidian, *R. thomsonii* Hook.f., *R. trilectorum* Cowan, *R. vaccinioides* Hook. f., only three taxa i.e. *R. arboreum* and *R. arboreum* sub sp *nilagiricum* (Zenker) Tagg are recorded from South India and *R. colletianum* Aitch. & Hemsl and *R. rawatti* I.D. Rai & B.S. Adhikari from the western Himalayas which could not be recorded from North-eastern states<sup>11,12</sup>. In Uttarakhand, the plant *R. arboreum* Sm., is known as Burans (Buransh), with its common name *Rhododendron* and it is designated as the 'State Tree of the State' [Fig 1,2]. Out of all the known species of *Rhododendron* only 2 species have been included for nutritional and a few for medicinal purposes which is used by the natives (Table 1). *R. campanulatum* grows at high altitudes and thus very few collectors collect its parts. Only on demand, leaves are collected by the collectors for commercial purpose as used at an indiscriminate amount by temporary settlers in the high altitude areas [Fig 3,4]. However, other species are indiscriminately cut for military establishments, construction as well as very commonly for firewood by the local people as are commonly occurring tree species found in those areas. These factors contribute to the increasing rate of disappearance or extinction of these taxa from the natural habitat. The frequent forest fire during the dry season is another factor which threatens the species survival. In an extensive survey by different scientist it has been found that states of Manipur, Nagaland, Meghalaya and Mizoram the rhododendron species have become rare and threatened are only found in few pockets in these states. However, in Arunachal Pradesh and Sikkim the distribution of rhododendron is much more. Besides used medicinally some *Rhododendron* species like *R. anthopogon* D. Don yields incense. The decorations of houses and temples is done using munja grass fitted with flowers, leaves of *R. arboretum*<sup>10,13</sup>. Fresh leaves in combination with Thuja / Pine/ Juniper leaves are burnt for making smoke that is believed to be holy and help in purifying surrounding air<sup>14</sup>. *R. barbatum* Wall. ex G. Don and *R. falconeri* Hook. f. is used as fish poison<sup>15,16</sup>. The fresh and dried corolla is advocated when fishbone get stuck in

gullet, possibly due to the acid helping in dissolving the bone naturally. The leaves of *R. cinnabarium* Hook.f., are considered -poisonous to cattle and goats. However, the fresh petals are used for making jam jelly and local brews<sup>17</sup>. Several methods of detoxification of poisonous medicinal plants including *Rhododendron* (*R. campanulatum*) have been described by Lama *et al.*<sup>18</sup>, where the rhizome is boiled with the extract of *Terminalia chebula*, however the boiling period of extract depends upon the toxicity of plant and it differs from species to species. In Sikkim the leaves of *R. falconeri* are used for packaging of apples by local people, similarly leaves of *R. kesangiae*, *R. hodgsonii*, *R. grande* and *R. falconeri* are used for packing mashed pulp of *Arisaema griffithii* for yak butte, bread, cheese etc<sup>14</sup>. The hard close grained, unsplitting and smooth wood of *R. hodgsonii*, *R. arboreum* and *R. falconeri* are used to make pack saddles, Khukri handles, gift boxes, ladles and posts by local people<sup>9</sup>.

### Pharmacological activities of *Rhododendron* species

The pharmacological activities of different *Rhododendron* species vary depending upon geographical location as the species shows great variation in their botanical description as well as their phytoconstituents. The life forms vary depending on elevation and species: they occupy the shrub and small tree understory of forests at lower and middle elevations, and occur as shrubs or dwarf shrubs depending upon altitude of the region. In Arunachal Pradesh, *R. maddenii* grows as terrestrial plant in West Kameng and Tawang districts, whereas in Lower Subansiri district it mostly growing as epiphytes on big tree trunks showing great variation in flower and leaf morphology. Looking at the pharmacological investigations of the *Rhododendron* species the leaves of *R. arboretum* Sm., *R. campanulatum* D. Don show antifungal activities and the petroleum ether and chloroform extracts of leaves, stems and flowers lower blood pressure in cats and inhibit intestinal movements in rabbits<sup>29,34</sup>. The flowers and leaves of *R. barbatum* contain andromedotoxin which resembles with protoveratrine, and tertiary amine veratrum alkaloids, in its pharmacological action as in intact animals produces vasopressor response. It also presents stimulation effect on the barostatic-pressor-reflex-mechanism, emetic actions and respiratory effects similar to that of protoveratrine. It also produced, both indirect and direct and, positive inotropic effects, the former being more pronounced. Intravenous administration of andromedotoxin to dogs resulted in 20–40% reduction in blood pressure. The petroleum ether extract of the leaves and stems of *R. falconeri* Hook. f., lowers blood pressure in cats and inhibits the intestinal movements in rabbits. In Punjab the leaves of *R. lepidotum* commonly known as Taalisfur and in Bhutan that of *R. setosum* known as Tsalluo possess properties similar to those of *R. anthopogon*<sup>16</sup>. The leaves of *R. arboreum* are rich in flavonoids, and hold potent antioxidant property<sup>35</sup>. The ethanolic extract of leaves of *R. arboreum* shows preventive effect on lipid peroxides, cardiac markers, and antioxidants in isoproterenol-induced myocardial necrosis in rats and also the leaf extract exhibited potent dose-dependent analgesic activity against central and peripheral analgesic models<sup>36</sup>. *In vivo* and *in vitro* testing of plant extracts and isolated compounds determined diverse

biological activities including anti-inflammatory, analgesic, anti-microbial, anti-diabetic, insecticidal and cytotoxic activity. *R. ungerii* extract and isolated compounds could be a promising antioxidant for food and pharmaceutical industries<sup>37</sup>. The flower juice significantly reduces the various cholesterol parameters and hss CRP significantly increase the HDL levels<sup>38</sup>. Although it has been reported that *Rhododendron* spp., can cause intoxications in humans following intake of rhododendron honey or medicinal preparations. The common toxic principle gyranotoxin is found in plants of Ericaceae family including *Pieris* species, *Kalmia* species, *Azaleas* along with *Rhododendrons*. This compound is resistant to thermal degradation and more than 25 different isoforms of it have been isolated from *Rhododendron*<sup>39</sup>. The concentration of this toxic glycoside varies in different species of *Rhododendron*. *R. flavum*, *R. luteum* and *R. ponticum* are known to possess high concentrations of this compound. The molecules is present in leaves, stems, pollen, flowers and nectar of the plant, and thus becomes available in secondary plant products like Labrador tea, honey, herbal medicines etc. This glycoside affects sodium channels in cell membranes leading to cardiovascular, gastrointestinal and neurological dysfunction in body. The clinical signs of its poisoning include diarrhea, vomiting, abdominal pain, hypotension, shock, cardiopulmonary arrest, seizure and even death depending upon the amount of toxin consumed<sup>40</sup>. The research on pharmacological activities on different *Rhododendron* species validates its use in traditional medicine. However, the focus should be also on the determination of its active phyto-constituents along with the nutritional attributes of different species so that its high dose intake in form of traditional formulations becomes without any risk for consumptions<sup>4</sup>.

### Nutritional attributes of Rhododendrons

The high levels of phenolic acids in *Rhododendrons* highlight the species to be a prominent antioxidant and free radical scavengers resulting to be a key player for health development<sup>41</sup>. The Indian species of *Rhododendron* can bring value addition products and the industries using the flowers can manufacture things like squash and sauces in the name of Burans. Krishanaihet al.<sup>42</sup>, reports that buransh is considered as the best as it reduces the oxidation process in the body and help us to keep protected against reactive oxygen species. The squash is rich in vitamin C, total phenols, flavonoids, tannins, saponins, anthocyanins, reducing sugars and other phytoconstituents which make it a perfect drink as well as is also antidiabetic in nature acting against diabetic nephropathy. In a study conducted the edible portion in inflorescence was found to be  $67.63 \pm 3.37$  % edible portions. The petals contain  $89.28 \pm 0.56$ ,  $8.5 \pm 1.60$ ,  $2.69 \pm 0.12$ ,  $0.80 \pm 0.03$  and  $0.68 \pm 0.04$  %, moisture, TSS, acid, ash and pectin, respectively and  $250.5 \pm 3.5$  mg/100g ascorbic acid and  $214.35 \pm 3.56$  mg/100g anthocyanins. The content of reducing, non-reducing and total sugars was  $5.16 \pm 0.09$ ,  $5.46 \pm 0.79$  and  $10.91 \pm 0.86$  %<sup>43,44</sup>. The squash is slightly bitter in tastes and not as much liked by customers irrespective of its high medicinal and nutritional values. The lack of uniform preparation process and variance

in its organoleptic properties also make it less approachable to the customers<sup>45</sup>. Besides this it is also used as medicinal drink for different diseases<sup>46</sup>. The leaves and flowering tops of *R. lapponicum* are used as infusion and drunk as tea, and generally the white flowers are used to prepare jellies<sup>47</sup>. Various Government and Private organizations are using the fresh petals of *Rhododendron* (Burans) in the preparation of sauces and jelly on commercial basis. The first squash processing unit for *Rhododendron* was established in 2009 in Arunachal Pradesh by Delhi based NGO INSPIRE and Sri Ratan Tata Trust. The unit produces over 4000-5000litres of *R. arboreum* juice in the flowering season<sup>9</sup>. The wine prepared from it when consumed freshly helps to prevent altitude sickness<sup>48</sup>. Almost all part of the plant is used however medicinal and nutritional properties of flower are highly acclaimed<sup>46</sup>. In the Himalayan region of country, the harvest of flowers of *Rhododendron* for its edible purpose brings economic benefits for the local people as well as brings employment for them. Not only flowers but the tree is also utilized for non-timber forest products in this region<sup>49</sup>. However, out of total 80 species 25 sub species and 27 varieties only 2 species i.e. *R. andropogon* and *R. arboretum* have been reported to be used as an ingredient in the manufacture of squash and sauces or other dietary preparations and 07 could be recorded for their medicinal values<sup>11,12</sup>. A brief set up for manufacture of squash and different products from burans is given in diagram 1 and 2. In Sikkim, petals of *R. arboreum* are used in local wines to prevent from seasonal cold in the name of 'Gurans Ko Raksi' why others are neglected from the inclusion for the purpose. Further local people in Sikkim, Darjeeling as well as Arunachal and other Northeastern stated need to be encouraged towards the use of these petals in supplementary food items like jelly and sauces instead of beverages. The petals of *R. cinnabarium* is eaten by local children in Nepal as it is sweet sour in taste, also the people fry petals to a tasty delicacy, and also jam is made by the Tibetan aristocrats and head Lamas<sup>6,48</sup>.

### Scope for the natives of Himalayan regions based on Rhododendron.

*Rhododendron* is one of the most fascinating genus with horticultural importance and presents great opportunity to utilize the maximum benefits from the species. The leaves and bark can be more extensively used in medicinal formulations by the pharmaceutical industries and creates platform for crude drug markets. Flowers and petals in a synchronized way can be used for various types of domestic nutritional formulations like jelly, sauces and soft drinks. The research should be focused more on processing of flowers and petals so as to prepared dried food products as flowers appear for short duration of periods. Establishment of horticultural nurseries as well as focus should be kept to bring maximum involvement of conservation management of *Rhododendron* through Village Forest Management Committee. Among all the species of *Rhododendron* maximum scientific investigations have been carried out on *R. arboreum* as it is a very common species throughout Himalayas and used since ancient times. Several studies have been conducted to establish a link between nutritive and medicinal properties of different

*Rhododendron* species, however most commonly highlighted are of *R. arboretum* as presented in table 1. The minerals like iron, zinc, manganese, selenium, copper, molybdenum functions as important cofactors for different enzymatic reactions and also found in the structural composition of certain enzymes and are indispensable in numerous biochemical pathways. Sodium is important in maintaining the osmotic balance between cells and interstitial fluid<sup>50</sup>.

There are only few reports about the scientific investigation on flowers of *Rhododendron* species and also on utilization of it probably due to perishable nature of flower as well as its limited availability for short duration. *Rhododendron* flowers could offer enormous opportunities for better marketing strategies for the sale of squash and other beverages. Other products such as preserve, appetizer, syrup, wine, vinegar, jam, jelly, instant juice mix, probiotic drinks, flavored milk and milk-based products are still not explored by the researchers. In a recent research the wheat flour was supplemented with *Rhododendron* and an increase value of protein, iron and fiber was found on these biscuits as compared to that of only wheat four biscuits<sup>53</sup>. There is an urgent need to explore other uses of *Rhododendron* species besides juice and jams. The research should focus on the production of nutritious food including some ready to eat dried products, including dry chutney mix or pickle. In the manufacturing process the retaining of all the nutrient components should be an essential parameter so as to get maximum health benefits of the species. It is traditionally being used for making chutney by crushing the flowers and adding mint leaves, salt, Anardana or tamarind for imparting a sour taste although its flavor and aroma are refreshing. There are many health benefits also as it is rich in antioxidants, ascorbic acid and is good for pain and aches and heart problems also<sup>54</sup>. However, these products have not been studied by the researchers still. The investigations are carried out to highlight the nutrients in different *Rhododendron* species. The leaves and flowers of *R. ponticum* and *R. luteum* were found to be rich in palmitic acid, the n-hexane fraction was rich in iso-fatty acids<sup>55</sup>. Since ancient times *Rhododendron* honey was used however commonly known as toxic, wild or mad honey as when used in excess resulted in toxicity due to presence of grayanotoxin and andromedotoxin. Grayanotoxin present in it can cause severe vertigo, arterial hypotension and bradycardia if consumed in large amount. Although it is reported to treat several disorders *i.e.* in rats with diabetes mellitus it lowered lipid levels as well as blood glucose level. It has also been reported to impart anti-bacterial, antifungal, antioxidant and antimicrobial activities<sup>40,56</sup>. In a study 12 *Rhododendron* and 8 multi-flower honeys from Black Sea Region of Turkey were screened for their nutraceutical attributes. 14 trace elements such as Cu, Cd, Pb, Co, Cr, Ni, Al, Se, Zn, Mn, Fe, K, Ca and Mg were present in the samples. It was observed that *Rhododendron* honeys exhibited higher concentrations of Cu, Co, Cr, Ni, Se, Zn, Ca and Mg but lower concentrations of Al, Mn, Fe and K as compared to in the multi-flower honeys. Trace element levels in analyzed honey samples were generally lower than literature values. Antiradicals antioxidant and antimicrobial activities of

*Rhododendron* honey has also been screened<sup>57,58</sup>.

### Need of the hour

Plants of *Rhododendron* have number of health benefits along with different pharmacological attributes and most of the species are having novel potential for its proper utilization by the food and beverage industries. In India seven species from India are reported to be medicinally important and are useful in curing respiratory problems, headache, pain etc., and use of these valuable species as food supplement and beverages are undoubtedly gives better results to the health hazards. In present days' emphasis is given towards use of herbals in our daily need based items for food, soaps, shampoos, beverages etc. Several species of *Rhododendron* are already in use as food supplements *viz.* *R. anthoogon*, *R. arboretum*, *R. lepidotum* etc, and if other species are included in such food supplements it will give on one hand utilization of the products and encouragement towards cultivation and conservation of those species which are added in this stream. Though the useful parts of several species have been reported to be poisonous to animals but the process for the purification of such parts have also been described and are under practice for the detoxification of highly poisonous plant parts *viz.* *Abrus precatorious* and *Aconitum* species<sup>58</sup>. Before going to the process of inclusion of the other species there is need of the assessment of nutritional values and toxicity of the parts to be taken under process as done in case of *R. arboreum*. Leaves and flowers of several species *viz.* *R. barbatum* and *R. cinnabarium* are recorded to be toxic to be used for fish poisoning whereas the fresh petals of *R. cinnabarium* are used for making jam jelly and local brews<sup>17</sup>. There is need of thorough screening of these plant parts. Similarly, the seven species from Indian *Rhododendrons* also presents some toxicity in leaves and the others used in the treatment of various ailments *viz.* in rheumatism, cough as purgative, needs to be tested for nutritional value and toxicity so that can be used easily for the preparation of jelly and sauces. The nutritional values of the flowers of *R. arboretum* which is commonly found in western and Eastern Himalaya and used in the preparation of sauces, jelly and squashes have been reported. The juice from the fresh flowers of several species of *Rhododendron* are used after extraction are sold in the regional markets for the preparation of various value addition products or direct consumption wherein there is need of identifying the species and its commercialization as several species are said to be poisonous. Secondly the screening of maximum species for nutritional and toxicity along with screening of medicinal properties may enable the increase in the list of nutritional and medicinal plants<sup>60</sup>. It was also found that the nutritional and antioxidant activity of the dried products of flowers of *Rhododendron* are also affected by the methods of drying them and also a slight variation in the nutritional content of proteins, carbohydrates, flavonols, phenolics can also be observed<sup>61</sup>. Besides these other types of studies are required to establish *Rhododendron* gardens in Western Himalaya and other hilly part of the Country to introduce maximum species of *Rhododendron* basically for the purpose of extending the *Rhododendrons* for ornamental purposes along with use of flowers for commercialized health

benefits food supplements. However, after thorough screenings on the basis level of toxicity in different parts and nutraceutical values like assessment of proteins, aminoacids sequencing, sugar, fat contents, phenolic contents and other phytochemical screenings as well as the pharmacological applications on animals should be conducted as most of the species of *Rhododendron* have not been studied in these aspects.

The different NGOs and Government Food Processing Centers are fully harnessing the potential of bio-prospective of *Rhododendron* species for economic benefits, thereby, preparing,

the value added products such as sauce and squash. These products are rich in phenolic compounds thus anti-oxidant and free radical investigation activities may be utilized for developing healthy products<sup>41,59</sup>. This work will enhance the scope of Buransh by adding other admissible species of *Rhododendron* for the preparation of jelly, jam, sauces, juice and local wine made from *Rhododendron* species other than *R. andropogon*, *R. arborea* and *R. lepidotum* and through this the nutritional scope of *Rhododendron* will be enhanced and the species with rare occurrence will be undertaken for domesticated cultivation.

**Table 1:** Few important *Rhododendron* species used medicinally

Species	Botany	Phytoconstituents	Medicinal uses	References
<i>Rhododendron anthopogon</i> D. Don	Small deciduous shrub, up to 1.5 m tall. Leaves aromatic, obovate, elliptic, base round, apex obtuse, adaxially dark green, abaxially covered with scales. Inflorescence short racemes with 4-5 flowers. Calyx lobes elliptic, persistent corolla infundibulum, pink or yellowish white.	Leaves contain quercetin, myricetin, taxifolin, kaempferol derivatives, ursolic acid and its acetate, epi-friedlinol, beta-sitosterol, betulinic acid and rutin	Leaves administered as an errhine to produce sneezing. cold, cough, chronic bronchitis, asthma and mucus formation in the nose and throat; leaves and flowers are used to cure indigestion and lung infection by Tibetans and Lamas ; leaves and flowers in form of tea is used as purgative .The leaves of <i>R. anthopogon</i> with those of <i>Abieswebbiana</i> is used for respiratory diseases.	15,19,20
<i>Rhododendron arboreum</i> Sm.	Evergreen tree to 15 m tall. Bark pinkish brown rough; young twigs white or brown pubescent. Leaves oblong-lanceolate, crowded towards the end of branches, narrowed at both ends, entire, dark-green, glabrous above, white or rusty-brown tomentose beneath; petioles short. Inflorescence large, globose, terminal, compact corymbse. Flowers many, crowded, deep red or pink, in; calyx small, lobes pale-yellow, widely ovate, scarious; corolla bright, red-pink, campanulate; 5 lobed, fringed, recurved; stamens 10, with white filaments; ovary 6-10 celled, ferruginous woolly. Capsules cylindrical, ribbed, curved; seeds many, ellipsoid.	Stem wood contain utanoic acid, 4-heptanoic acid and pentanoic acid .Flowers are rich in amino acids.	Young leaves- applied to forehead for headache. Dried flowers for bloody dysentery and diarrhea; fesh flowers for healing wounds; flower petals and leaves for treatment of headache, nose bleeding , fever, dysentery, wounds rheumatism ; bark juice for treatment of cough ,diarrhea, dysentery, piles ,diabetes, skin diseases, liver disorder, and worms. Consuming its root decoction cures early stage of cancer diseases	17,21,22,23, 24,25,26,27
<i>Rhododendron barbatum</i> Wall. ex G. Don	Large shrub or a small tree up to 6 m tall. Peeling bark smooth greyish, young shoots with bristles. Leaves elliptic-lanceolate, shining adaxially, woolly haired abaxially when young, smooth later; petiole with long glandular bristles, in a barbed appearance. Inflorescence compact umbels. Flowers blood-red, tubular-bell-shaped; stamens 10,	Leaves contain campanulin, ursolic acid, hyperoside , alpha-amyrin, epi-friedelinol . Leaves and flowers contain andromedotoxin		28
<i>Rhododendron campanulatum</i> D. Don	Tall shrub to 1.4 m tall. Leaves ovate to elliptic, large, hairs yellowish to rusty brown. Inflorescence with 4-6 flowers. Flowers widely campanulate, white to pale pink or lavender.	Leaves contain andromedotoxin; quercetin, ericolin, ursolic acid, campanulin, alpha-amyrin, friedelin, epi-friedelinol. pigments of flowers contain quercetin and myricetin	Leaves-mixed with tobacco and made into a snuff used in colds and hemicrania; used in chronic rheumatism, sciatica and syphilis; dried twigs and wood-used in phthisis and chronic fevers in Nepal	4,15,29
<i>Rhododendron cinnabarium</i> Hook. f.	Tree, evergreen. Leaves broadly narrow to cordate at base, adaxially green, abaxially glaucous. Flowers terminal clusters of 2-9 pendulous bell shaped, petals cinnabar red, fleshy, ovary densely lepidote. Capsules cylindrical.	Plant contains andromedotoxin. Leaves contain campanulin, alpha-amyrin, triterpenes friedelin, epi-friedelinol, ursolic acid, and quercetin.		15

<i>Rhododendron falconeri</i> Hook. f.	Tree to 5-12 m tall. Bark reddish- brown, young shoots fulvous, -tomentose. Leaves thickly coreaceous, crowded at stem apex, broadly elliptic ovate, apex round, adaxial surface rough, rusty tomentose abaxially. Inflorescence compact with 15-20 flowers; corolla campanulate, creamy white – pale yellow	Stem and leaves contain andromedotoxin; leaves also contain quercetin, ursolic acid, alpha-amyrin, campanulinfriedelin ;flowers contain 3-galactoside of quercetin and 3-rhamnoside;bark contains quercetin taraxerol and betulinic acid.	16
<i>Rhododendron lepidotum</i> Wall ex G.Don.	Shrub or small tree to 5 m tall. Stem branched, scabrid, scaly glandular, blackish brown. Leaves ovate- obovate, or lanceolate, base cuneate, apex obtuse. Flowers orange or yellow or purple yellow calyx elliptic ovate; corolla lobed; stamens 8 or 10; ovary oblong, rough, seeds oblong, brown.	Aerial parts contains 7-O-D-Glucopyranosyl-8-methoxybenzopyranone and 7-Hydroxy-8-O-glycosylbenzopyranone	12,16,18,30, 31,32,33

**Table 2:** Nutritional and Minerals value of *R. arboretum*<sup>21,51,52</sup>

S. No.	Attributes (%)	Content Value
1	Moisture (%)	79.4
2	Ash(%)	2.30
3	Crude fat (%)	1.52
4	Crude fibre(%)	2.90
5	Total Nitrogen(%)	0.58
6	Total proteins (%)	1.68
7	Carbohydrates(%)	12.20
8	Organic matter(%)	97.70
9	Insoluble ash(%)	1.29
10	Soluble ash(%)	1.15
11	Ascorbic acid(mg/100 ml)	11.5
12	Total carotenoids (µg/100 ml)	2685.0
13	Flavanols(mg/100 ml)	288.7
14	Total flavonoids(mg/100 ml)	1276.5
15	Total anthocyanins(mg/L)	154.8
16	Total phenols (mg/100 ml)	956.5
17	Total antioxidant capacity(mMTrolox equivalent /L)	70.4
<b>Mineral Content(ppm)</b>		
1	Iron	405
2	Zinc	32
3	Copper	26
4	Sodium	385
5	Chromium	08
6	Cobalt	<0.5
7	Molybdenum	<1
8	Nickel	<0.5
9	Lead	2
10	Arsenic	3
11	Manganese	50.2



*Rhododendron campanulatum*



*Rhododendron arboreum*



Buds of *Rhododendron campanulatum*



Flowers of *Rhododendron arboreum*

Figure 1: Rhododendron Sp

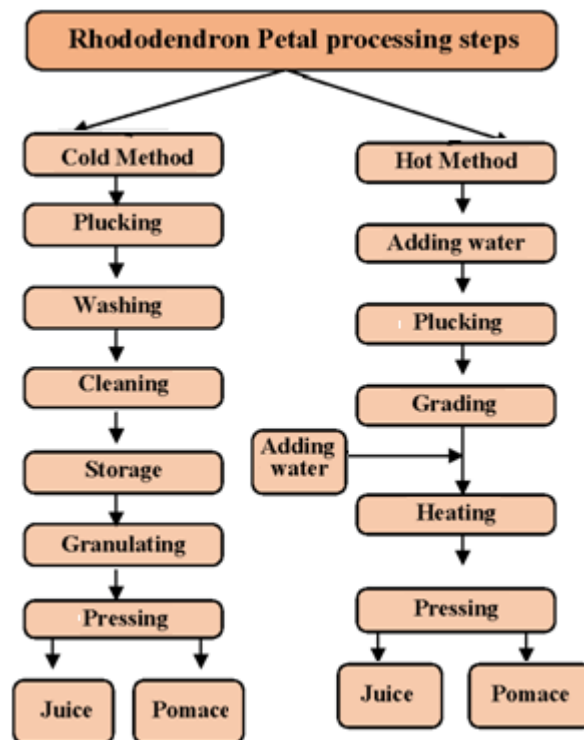
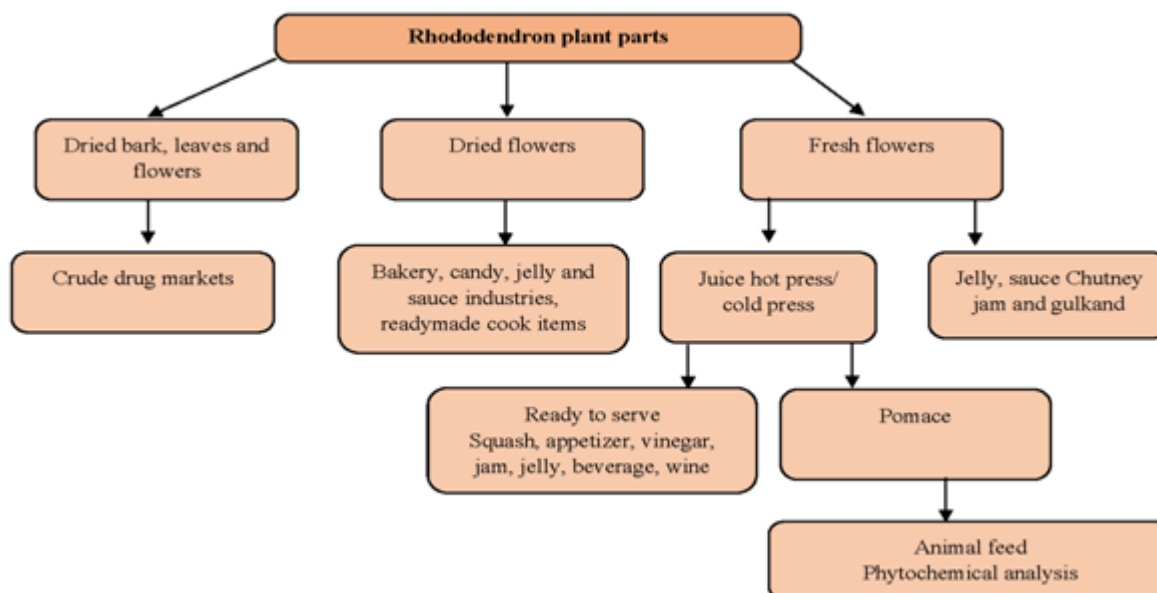


Diagram 1: Flowchart showing a brief set up process for the manufacture of juice of *Rhododendron arboreum*



**Diagram 2:** Flowchart for preparation of different products from Rhododendron

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