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The usage and importance of the rhododendron plant to develop functional food and nutraceuticals

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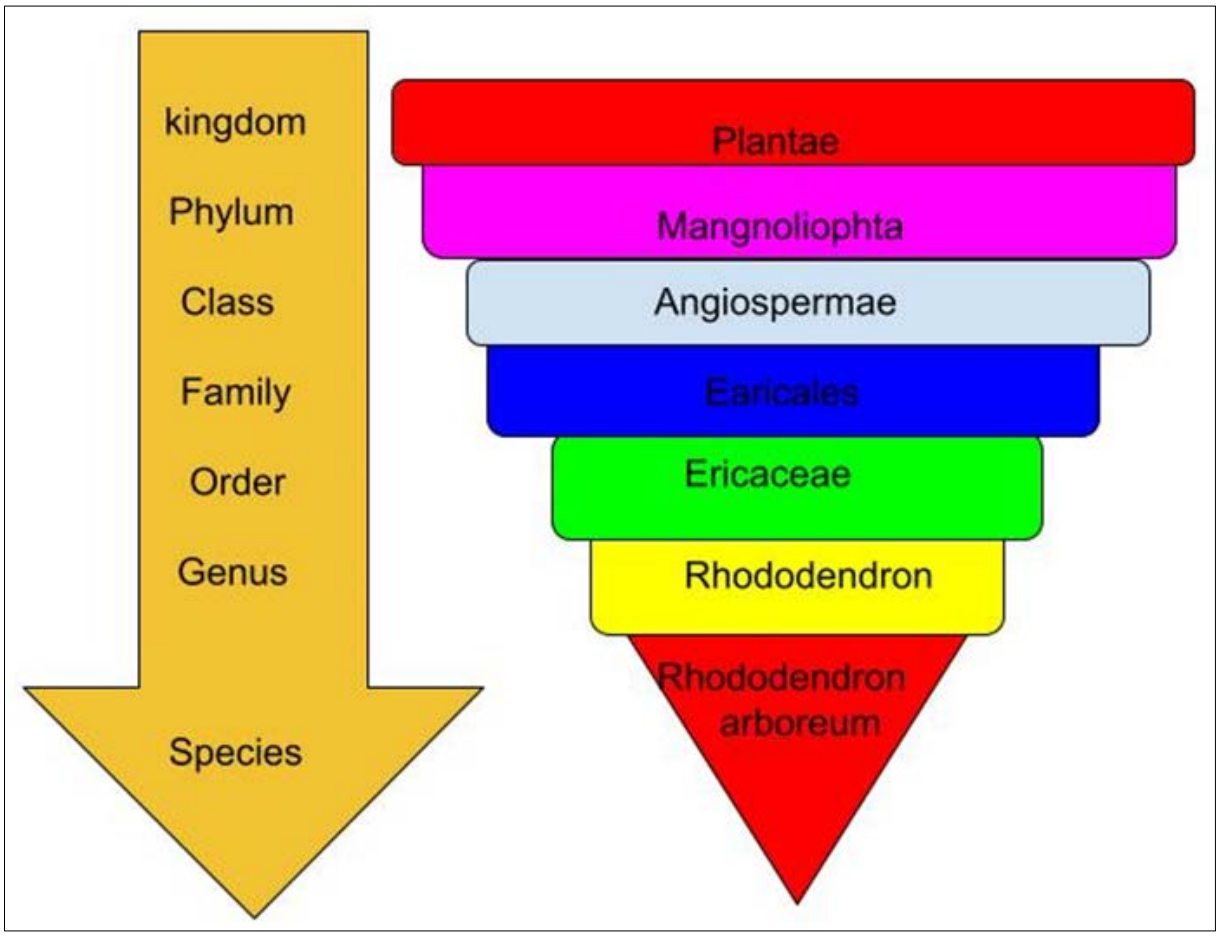
Abstract
The Rhododendron genus has a large number of species around 1024 species. In India, it is found in the trans-Himalayan region, specifically Nepal, it is also founded and awarded as the national flower of Nepal. In Himachal Pradesh Rhododendron is awarded as the state flower. The shrub is 10-40 inches tall. They may be either evergreen or deciduous. In some species, the undersides of the leaves are covered with scales (lepidote) or hairs (indumentum). Some of the best-known species are noted for their many clusters of large flowers. The parts of the rhododendron plant are having phytochemicals. A particular part is carrying particular phytochemical and that phytochemical cures a particular disease. Today that phytochemicals are used to make nutraceuticals and functional foods. Like ursolic acid shows anti-inflammatory properties and is used in nutraceuticals. Nowadays functional foods like cookies are made by using dry flowers of Rhododendrons. It is having pharmacological value and toxicological values. Which gave more value to this plant in the field of Ayurveda. Some species of the Rhododendron genus are used as anti-insecticide. In India, Rhododendron arboretum is used widely for developing new products. Phytochemicals like ursolic acid and Quercetin fight against cancer and show anti-diabetic properties. Other phytochemicals like Quercetin, Columaric acid, tripernoids, and Betulinic acid are the major components found in the rhododendron plant.

Keywords: Anti-inflammatory, rhododendron arboreum, anti-diabetic, anti-oxidant, cardio-protective, ursolic acid

1. Introduction
India is known for its rich traditional medicinal systems (Ayurveda) and great biological diversity, which give a strong platform for the exploration of various plants for use in general healthcare, the rhododendron is one such plant that is assuming a special role in people's cultural and economic lives (Kumar *et al.*, 2019) [10]. Visitors are drawn in by the visual appeal of fully developed flowers during the flowering season. The flower is also rewarded as the "National Flower of Nepal" and the "State Flower of Himachal Pradesh" (India) (Bhattacharyya, 2011) [1]. The Rhododendron genus, which has 1200 species worldwide and 542 species in China, is the most expansive and distinctive genus in the Ericaceae family. (*Inman 2000. Pdf*, N.D.) India's rhododendrons are widely cultivated in a variety of climates and elevations, mostly in the Himalayas. Rhododendrons are essentially non-existent in the Siwaliks, a few may be found in the lesser Himalayas, and the bulk can be found in the larger Himalayas among the four parallel Himalayan ranges. In the Trans-Himalayan area in India's far north-west, which includes the chilly deserts of Jammu and Kashmir and Himachal Pradesh, just one species may be found. Therefore, India's larger Himalayas are the perfect location for rhododendrons. In addition to this, North-eastern India is home to a large number of species, notably in the Naga and Khasi hills. The Western Ghats are home to one Rhododendron arboreum nilagiricum subspecies. Arunachal Pradesh has the most species of any state (67 species), followed by five from Nagaland, five from Manipur, two each from Mizoram Meghalaya, four from Himachal Pradesh, four from Jammu & Kashmir, and four from Uttarakhand. In Tamil Nadu and Kerala, there are just one subspecies. (Bhattacharyya, 2015) [24]. The various species of rhododendron are used in different ways. The current study used Rhododendron dauricum flower extract to create silver nanoparticles (Mittal *et al.*, 2012) [12]. Rhododendron ponticum L. subsp. ponticum, Rhododendron luteum L., Rhododendron Smirnovi L., and Rhododendron caucasicum L show antibacterial activity as the research done in Australia (Ertürk *et al.*, 2009) [3]. The presence of flavonoids (hyperin), tannins, saponins, and other phytochemicals in rhododendron, either singly or in combination, may be the cause of the extract's anti-inflammatory or nociceptive effect.

The substantial degree of anti-inflammatory action of the ethyl acetate extract may be due to the flower's abundant flavonoids. It has several medicinal advantages (Mukhopadhyay & Sciences, 2020) [13]. Researchers have recently started looking at the chemical components of different Rhododendron species. Rhodojaponin-III was shown to be the most effective active ingredient in R. Molle's insecticidal function, according to research. Some species of the rhododendron is having the capability to fight against insects as pest control but arboretum is not among them but this species is chiefly used in nutraceutical products. Nowadays, different types of food products are launched in the market in which rhododendron is used as functional part. The Rhododendron genus established a very good perspective of novel application in nutraceuticals as it is rich in ursolic acid, which is having anti-inflammatory, anti-diabetic, and anti-ulcer properties. (Ghada A Soliman, 2019) [5]. The genus Rhododendron is quite valuable in terms of horticulture. As rhododendron arboreum is a blooming plant, it is grown for its attractive, enticing blooms -decorative foliage and ornamental leaves. In this study we reviewed the one of the most utilised specie of the rhododendron known as "Rhododendron Arboreum". It is found in the Western Ghats Predominantly (Lal & Chauhan, 2019) [11].



1.1 Botanical Description and morphological characters of Rhododendron arboretum

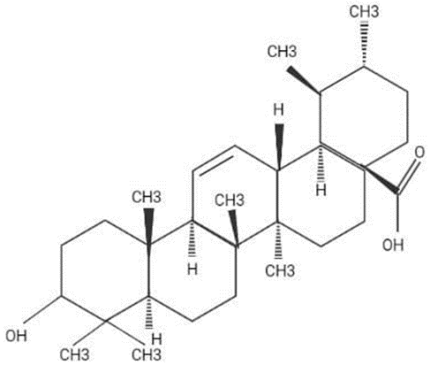
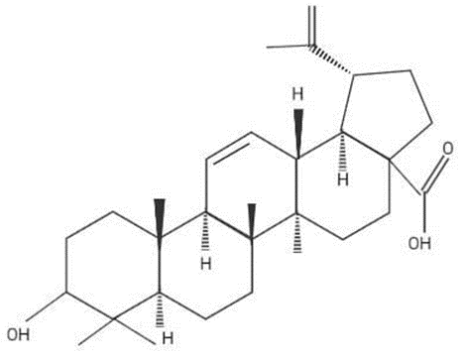
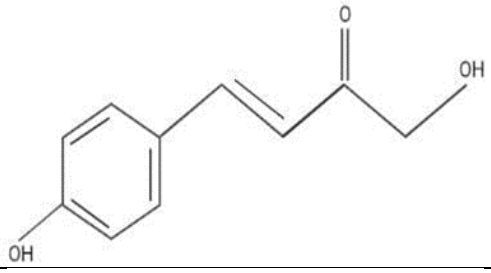
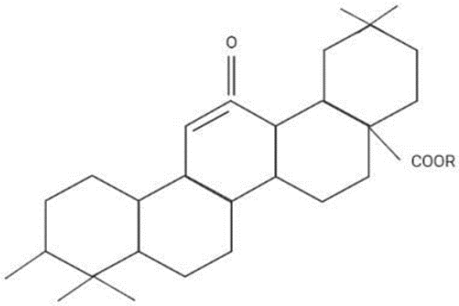
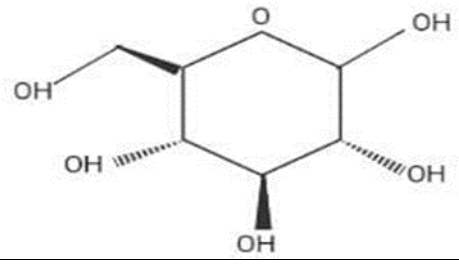
The Rhododendron is a small tree or shrub with an average height of 5 to 10 meters. It is a deciduous plant. The reddish-brown bark is soft, and coarse, and has branches on the trunk. Rhododendron is a deciduous shrub about 5-10 m in height. The leaves of the rhododendron arboreum are monomorphic. The flower is rounded to cuneate at base, acuminate to obtuse at apex, crowded at the end of branches with deeply impressed lateral veins. The flowers are grouped in a raceme. The inflorescence is rarely axillary (Verma *et al.*, 2020) [22]. The flower is having 5-20 stamens and anthers with pores. There is 5-12 locular ovary. The fruit is a capsule, and the seeds can range in form from elliptical to spindle-shaped. (Popescu & Kopp, 2013) [15]. It grows well at altitudes between 4500 and 10,500 feet and may reach heights of 40 to 50 feet. Large often harvests over 100 feet. "Laligurans" and "burans" are other names for Rhododendron (Mukhopadhyay & Sciences, 2020) [13].

2. Phytochemical composition: The rhododendron plant

2.1 Bioactive compounds present in the different parts of the Rhododendron Plant

Sr. No	Part	Bioactive compounds	References
1.	Bark	Triterpenoids	(Sonar *et al.*, 2012) [21]
		Ursolic acid acetate	(Nisar *et al.*, 2013) [14]
		Betulinic acid	
2.	Flower	Quercetin-3-rhanoside	
		Phenolic Compounds	(Kemertelidze *et al.*, 2007) [6]
		Rutin	
		Columaric acid	
3.	Leaves	Glucoside	
		Ericolin	
		Hyperoside	(Kim *et al.*, 2014) [7]
		Ursolic acid	
		Quercetin	
		Flavonoids	

2.2 Stereochemistry of Bio-active compounds of rhododendron

S/No	Bioactive compounds	Structure
1.	Ursolic acid	
2.	Quercetin	
3	Betulinic acid	
4.	Columaric acid	
5.	Tripernoids	
6.	Glucoside	

The rhododendron plant is rich in the phytochemicals and above some structures of phytochemicals are present in the different parts of the plant. All these phytochemicals are specifically utilised against different kinds of diseases. Among all these phytochemicals Ursolic acid is an important one. It is utilised as therapeutic agent. Recently the fresh flowers of rhododendron is used for making functional food as well as nutraceutical. The fresh flower is used to make jam, jellies and cookies. And the presence of these phytochemical in the food products developed by using rhododendron is considered as functional food (Qiang *et al.*, 2011) [16].

Table 3: Bioactivity or medicinal usage of different parts of *Rhododendron arboreum*

Parts	Bio-active Compounds	Reference
Leaves	The leaves include flavonoids and vitamin C, which has been shown to have antioxidant action. Phenolic acids obtained which are reported to anti-HIV, anti-inflammatory, anti-nociceptive activities. They are also useful in the treatment of gout and rheumatoid arthritis, as well as for many other ailments including coughs, colds, fevers, indigestion, headaches, etc.	(Wang *et al.*, 2022) [23]
Flowers	The flower can be utilised as a nutraceutical or functional food for diabetes and its consequences because it has anti-diabetic potential. Its medicinal benefits are enhanced by the phenolic chemicals present, and as a result, it is frequently used to treat a variety of illnesses. Are utilized for treating illness like headache, diabetes, and rheumatism.	(Rhododendron: Species and Traditional Uses 2021, Krishna *et al.*, 2011) [9]
Bark	Alkaloids play a metabolic function in controlling how an organism develops. Tannins have a lowering capacity that guards against liver damage by obstructing lipid peroxides. There are several biological and therapeutic benefits of ursolic acid.	(Sonar *et al.*, 2012) [21]
Stem	The bioactive compounds can improve health and are used to treat numerous disorders. The bioactive substances can promote good health and they are used for healing many diseases like asthma, anticancer, prevents cardiovascular diseases.	(Sharma *et al.*, 2022) [20]
Root	The rhododendron root can be utilised as a medication since secondary metabolites are present in it. Presence of secondary metabolites in roots proves that rhododendron is used as therapeutic agent.	(Nisar *et al.*, 2013) [14]

3. Pharmacological activities

3.1 Anti-inflammatory activity

The rhododendron flower is used in drugs to reduce the inflammation, the anti-inflammatory property of flower is investigated by the animal model. The presence of flavonoids hyperin, tannins, saponins, and other compounds in the Rhododendron arboreum be the cause of its anti-inflammatory effects. This is examined using the cotton pellet granuloma model of inflammation, Freund's adjuvant-induced paw arthritis (P, 0.01), and arachidonic-induced paw edoema (P 0.01), (Sharma *et al.*, 2022) [20]. The presence of phytochemicals might be either singular or combined. The high concentration of flavonoids in the flower may be responsible for its notable degree of anti-inflammatory action (Mukhopadhyay & Sciences, 2020) [13].

3.2 anti-diabetic activity

Rhododendron arboreum phytochemical activities are very powerful and efficient in treating human diseases like diabetes. Due to the presence of quercetin (3 - O-beta-D-galactopyranoside) it shows the antidiabetic activity (Gautam *et al.*, 2016) [4] extracted hyperoside from Rhododendron arboreum flowers that was discovered to have anti-diabetic properties. It was discovered to inhibit gluconeogenesis, which causes diabetes, and boost insulin secretion (Rawat *et al.*, 2020) [17].

3.3 cardio protectivity

Due of the significant amount of quercetin and its derivatives in rhododendron, research has shown that they can lower the risk of cancer and coronary heart disease as well as prevent the oxidation of low-density lipoproteins (LDL) by scavenging free radicals and chelating transition metal ions. (Science, N.D.)

3.4 anti-oxidant activity

It reduces the damage by donating the free radical and considered as stable molecule which neutralizes. The rhododendron is having the extracts of anti-oxidants which act against the ROS produced by the UV rays, sunlight and metabolic process. The reactive oxygen species causes various kind of diseases like atherosclerosis, hypertension, ischemic disease, Alzheimer's disease, Parkinsonism, cancer, diabetes and mellitus. The rhododendron flower extracts have Hydroxyl radical scavenging activity, which is effective than the catechin 840 µg/ml (A Synthetic Antioxidant). The reactive oxygen species damages the cellular membranes. The determination of nitric oxide synthase activity, which promotes the inter-cellular mediator cell functions and act as signal molecule in immune.

3.5 Food Trends

The Rhododendron plant is used to develop cookies, Jam and jellies. The jam and jellies are developed by using the fresh flowers of the plant. Fresh juice is also extracted and it is considered as refreshing. The juice of the rhododendron is extracted by the two methods cold pressing method and hot pressing method. The rhododendron flowers are used to develop dried food products and ready to serve food products. All these food products are considered as functional as these are can be used on daily basis (Qiang *et al.*, 2011) [16]. Functional foods are dietary components that, in addition to supplying nutrients and energy, advantageously affect one or more specific bodily processes, by boosting a particular physiological response and/or by lowering the risk of illness. Functional foods, in the words of the Institute of Food and Information Council (IFIC), "offer health advantages beyond basic nutrition". Fruits, vegetables, herbs, and flowers are all examples of functional food, and each has its unique curative and restorative properties. Rhododendron blooms have been used in several research, and it has been discovered that they contain a variety of helpful and functional chemicals (Krishna *et al.*, 2012) [9]. It is true that rhododendron blossoms have been used historically as a treatment for headaches and joint discomfort. The preventative and curative properties of rhododendron blossoms for treating various ailments are clearly highlighted in the current review. Every component of a rhododendron flower that contains bioactive chemicals has a

therapeutic use. Given that it includes all necessary and useful bioactive components, it is one of the functional flowers (Qiang *et al.*, 2011) [16].

4. Conclusion

Rhododendron plant is utilised to develop different kinds of functional foods. The rhododendron plant is rich in phytochemicals, these phytochemical are used to fight against different diseases. There is some species of rhododendron which are used as insecticides. In this review, we discussed the pharmacological properties of the rhododendron like anti-inflammatory, cardio-productivity and antidiabetic. This review encourages the researchers to develop different kinds of functional foods from the rhododendron.

5. References

1. Bhattacharyya D. Rhododendron Species and Their Uses with Special Reference to Himalayas: A Review. Assam University Journal of Science & Technology. 2011;7(1):161-167.
2. Bhattacharyya D. Rhododendron Habitats in India Rhododendron Habitats in India; c2008 Jan.
3. Ertürk Ö, Karakaş FP, Pehlivan D, Nas N. The antibacterial and antifungal effects of rhododendron derived mad honey and extracts of four rhododendron species. Turkish Journal of Biology. 2009;33(2):151-158. https://doi.org/10.3906/biy-0808-15
4. Gautam V, Sharma A, Arora S, Bhardwaj R. Bioactive compounds in the different extracts of flowers of Rhododendron arboreum Sm. Journal of Chemical and Pharmaceutical Research. 2016;8(5):439-444. Available Online: www.jocpr.com
5. Ghada A Soliman. Dietary Fiber, Atherosclerosis, and Cardiovascular Disease. Nutrients. 2019;11:1155. DOI: 10.3390/nu11051155inman2000.pdf. (N.D.).
6. Kemertelidze EP, Shalashvili KG, Korsantiya BM, Nizharadze NO, Chipashvili NS. Therapeutic effect of phenolic compounds isolated from Rhododendron ungernii leaves. Pharmaceutical Chemistry Journal. 2007;41(1):10-13. https://doi.org/10.1007/s11094-007-0003-8
7. Kim GS, Yoon JS, Kee R, Shin YH, Ko JS, Gwak MS, *et al.* Association between the use of gel pads under patients' knees and the incidence of peroneal neuropathy following liver transplantation. Singapore Medical Journal. 2014;55(8):432–435. https://doi.org/10.11622/smedj.2014102
8. Krishna H, Attri BL, Kumar A. Improvised Rhododendron squash: Processing effects on antioxidant composition and organoleptic attributes. Journal of Food Science and Technology. 2012;51(11):3404-3410. https://doi.org/10.1007/s13197-012-0855-0
9. Krishna H, Das B, Attri BL, Kumar A, Ahmed N. Interaction between different pre- and postharvest treatments on shelf life extension of 'Oregon Spur' apple. Fruits. 2011;67(1):31-40. https://doi.org/10.1051/fruits/2011064
10. Kumar V, Suri S, Prasad R, Gat Y, Sangma C, Jakhu H, *et al.* Bioactive compounds, health benefits and utilization of Rhododendron: A comprehensive review. Agriculture and Food Security. 2019;8(1):1-7. https://doi.org/10.1186/s40066-019-0251-3
11. Lal P, Chauhan D. Journal of Agriculture and Forest Descriptive Study of Burans (*Rhododendron Arboreum* Smith) in the. J Agri Forest Meteorol Res. 2019;2(1):59-62.
12. Mittal AK, Kaler A, Banerjee UC. Free radical scavenging and antioxidant activity of silver nanoparticles synthesized from flower extract of Rhododendron dauricum. Nano Biomedicine and Engineering. 2012;4(3):118-124. https://doi.org/10.5101/nbe.v4i3.p118-124
13. Mukhopadhyay D, Sciences DP. From inception of herbal medicine to an ideal perception of therapeutic Agent; c2020 Nov.
14. Nisar M, Ali S, Qaisar M, Gilani SN, Shah MR, Khan I, *et al.* Antifungal activity of bioactive constituents and bark extracts of Rhododendron arboreum. Bangladesh Journal of Pharmacology. 2013;8:2. https://doi.org/10.3329/bjp.v8i2.14054
15. Popescu R, Kopp B. The genus Rhododendron: An ethno pharmacological and toxicological review. Journal of Ethno Pharmacology. 2013;147(1):42-62. https://doi.org/10.1016/j.jep.2013.02.022
16. Qiang Y, Zhou B, Gao K. Chemical Constituents of Plants from the Genus Rhododendron. Chemistry & Biodiversity. 2011;8(5):792-815. https://doi.org/10.1002/cbdv.201000046
17. Rawat P, Rai N, Kumar N, Waheed SM. Rhododendron: Traditional vs modern, benefits for Himalayan Communities. Ecology, Environment and Conservation. 2020;26:S76–S82.
18. Rhododendron: Species and Traditional Uses. Webology; c2021. https://doi.org/10.29121/web/v18i1/43
19. Science A. (N.D.). Isolation of Quercetin from Flower Petals, Estimation of Total Phenolic, Total Flavonoid and Antioxidant Activity of the Different Parts of. 34–40.
20. Sharma M, Gargi A, Borah A, Author C. Rhododendron arboreum and its potential health benefit: A review. The Pharma Innovation Journal. 2022;SP-11(6):926-933. www.thepharmajournal.com
21. Sonar PK, Singh R, Khan S, Saraf SK. Isolation, Characterization and Activity of the Flowers ofRhododendron arboretum (Ericaceae). E-Journal of Chemistry. 2012;9(2):631-636. https://doi.org/10.1155/2012/872147
22. Verma K, Kumar I, Thakur N. Issue 3 Citation: Kritika Verma *et al.* IJPPR. Human. 2020;19(3):161-176. www.ijppr.humanjournals.com
23. Wang W, Lin J, Zhou X, Wang C, Huang M, Cai S, *et al.* Associations between comorbidities and annual incidence plus frequency of asthma exacerbation hospitalisation during the past year: Data from CARN study. BMC Pulmonary Medicine. 2022;22:1. https://doi.org/10.1186/s12890-022-02038-3
24. Singh B, Ishwarya G, Gupta M, Bhattacharyya SK. Geopolymer concrete: A review of some recent developments. Construction and building materials. 2015 Jun 15;85:78-90.