

Pharmacological Activities, Evaluation and Therapeutic Significance of *Rhododendron arboreum*

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Abstract: *Rhododendron arboreum* is an evergreen shrub or small tree with a showy display of bright red flowers. The name „RHODODENDRON“ is derived from the Greek word „RHODO“ means rose & “DENDRON” means tree. *Rhododendron* is the national flower of Nepal & is known as (*Laligurans*) & the state tree of Uttarakhand. It is called „Burans“, *Bras*, *Buras* or *barah ke Phool* market popularity as *Rhodo juice/sharbat* and the plant is found in the Himalayas from Kashmir eastwards to Nagaland. Cardiovascular diseases (CVDs) remain the main cause of death worldwide and increased production of reactive oxygen species (ROS) may be a unifying mechanism in CVDs process and plants are naturally loaded with distinctive secondary metabolites. HEPATOPROTECTIVE activity shown by leaves of *Rhododendron arboreum* possibly because of its reported antioxidants activity and this property may be attributed to the quercetin related flavonoids, saponins, and phenolic compounds present in the leaves of *Rhododendron arboreum*.

Keywords: - *Rhododendron*, *arboreum*, *Burans*, Pharmacognosy, Cardiovascular, Hepatoprotective.

I. INTRODUCTION

One of the valuable non-timber forest products (NTFPs) in Garhwal Himalaya is the *Rhododendron arboreum*, also mentioned to as "Burans" in the local dialect, which produces beautiful blossoms. For the local people, these blooms provide a reliable source of cash and aid in subsistence. If possible, gathering is done sustainably, *R. arboreum* flowers can assist the local community in improving their standard of living (A.K., 2021).[1] Phytochemicals that acquire the potential to control SARS-CoV-2 replication or bind to host receptors in a viable manner could be effective as COVID-19 adjuvant treatments. By using petals of *Rhododendron arboreum*, we profiled and examined the phytochemicals of the petals, conducted in vitro experiments, and discovered that the plant was a suitable candidate to fight against SARS-CoV-

2. Our decision to evaluate SARS-CoV-2 was driven by reports from multiple scientific studies that the phytochemicals function against a variety of viruses both in vitro and in vivo. (et al Masakapalli, S.K., 2023).[2]



[Fig. No.1]



The antioxidant effect of *Rhododendron arboreum* flowers was assessed using the identification and quantification of anthocyanins, flavonoids, and phenolic acids (et al Bhandari, P., 2022).[3] In this project, we used an aqueous flower extract from *Rhododendron arboretum* to examine a green technique of synthesizing zinc oxide (ZnO) nanorods (NRs) doping with chromium. In this case, chromium-doped ZnO NRs ranging in chromium doping concentration from 2–10% were formed. Using scanning electron microscopy (SEM), ultraviolet spectroscopy (UV-Vis), and X-ray diffraction (XRD), the green synthesized compounds were subjected to extensive investigation (et al Sharma, S 2024).[4]

II. HISTORY OF RHODODENDRON ARBOREUM:

The genus *Rhododendron* is one of the largest and most diverse genera in the family Ericaceae, comprising more than 1,000 species distributed mainly across Asia, Europe, and North America [5,6]. The name “*Rhododendron*” originates from the Greek words *rhodon* (rose) and *dendron* (tree), meaning “rose tree.” However, the species *Rhododendron arboreum* was later classified and named by James Edward Smith in 1802 [9].

Historically, *R. arboreum* has held cultural, ornamental, and medicinal importance in Himalayan societies [11,12]. Indigenous people of Nepal, India, and Bhutan have long revered this plant for its vivid red flowers, symbolizing beauty, vitality, and spiritual purity [7]. In the early 19th century, British botanists and explorers, including Sir Joseph Hooker, collected and documented various *Rhododendron* species from the Eastern Himalayas, introducing them to Europe as ornamental plants [6,10].

In India, historical records suggest that *R. arboreum* was traditionally used in local medicine systems such as Ayurveda and Unani, though it was more regionally prominent in Himalayan ethnomedicine than in classical Ayurvedic texts [19]. The local hill tribes of Garhwal, Kumaon, and Sikkim have for centuries prepared Buransh flower juice as a natural remedy for fatigue, inflammation, and heart ailments [9,13].

During the colonial period, British botanists in India established several herbaria and botanical gardens—such as the Royal Botanic Garden, Calcutta—where specimens of *R. arboreum* were preserved and studied for taxonomy and morphology [10]. The earliest formal herbarium record of *R. arboreum* in India dates back to 1820, collected from the Nilgiri and Himalayan regions [11].

In modern times, *R. arboreum* has gained renewed attention not only as an ornamental plant but also as a pharmacologically active species [14,15]. Early phytochemical investigations began in the 1960s, identifying phenolic compounds, flavonoids, and glycosides [17]. Later, during the 2000s, research on antioxidant and antimicrobial activities expanded, highlighting the plant’s potential in nutraceutical and pharmaceutical industries [8,14].

III. CLASSIFICATION AND DISTRIBUTION OF RHODODENDRON ARBOREUM:

Based on morphological data (flowers, leaves, hair, etc.), taxonomists have made different classifications. due to distinct species of their kind. *Rhododendron* is the largest genus of the Ericaceae family with 1200 species, which is distributed throughout Northeast Asia and Eurasia Western Europe and North America. *Rhododendron*, a well-known horticulture plant, has turned into one of most popular plants in the garden and as avenue tree. It has also been widely cultivated in different part of the world because of its ethical uses, commercial and medicinal principles. It occupies a vast region of South-eastern Asia between the north –western Himalaya through Nepal, Sikkim, Eastern Tibet, Bhutan, Arunachal Pradesh and upper Burma to western and central China.

3.1 Taxonomic Classification

Rhododendron arboreum Sm. belongs to the family Ericaceae, one of the most important families of flowering plants adapted to acidic soils and temperate climates [5,6]. The genus *Rhododendron* comprises more than 1,000 species distributed mainly in Asia, with a few in Europe and North America [10]. Taxonomically, *R. arboreum* is the type species of the subgenus *Hymenanthes*, section *Arborea*, characterized by large, leathery leaves and bell-shaped red flowers [11].



3.2 NOMENCLATURE

Kingdom: Plantae Order: Ericales Family: Ericaceae Genus: *Rhododendron* Species: *R. arboreum*

3.3 COMMON NAME, HABIT AND HABITAT.

English: Rose tree, *Rhododendron* Tamil: billu

Punjabi: adrawal Altitude 1200-3600m

Mean annual temperature 12-17 degree C Mean annual rainfall 200-1800 mm

Soil type: The plant prefers light (sandy), and medium (loamy) soils require well drained soil. The plant prefers acid soil and can grow in very acid soil. It can require moist soil.

3.4 Ecological and Environmental Conditions

The ecological distribution of *R. arboreum* is largely determined by altitude, soil acidity, and rainfall [9,11]. It prefers acidic soils (pH 4.5–6.0), 5–20 °C temperatures, and 1,500–2,500 mm rainfall annually [12]. It thrives in temperate broad-leaved forests with *Quercus*, *Pinus wallichiana*, and *Cedrus deodara* species [11]. Ecologically, it plays a vital role as a pollinator-attracting species and prevents soil erosion on mountain slopes [9].

3.5 Conservation and Ecological Significance

Due to overharvesting, habitat fragmentation, and climate change, *R. arboreum* populations have shown local decline in several Himalayan regions [11,12]. The IUCN Red List classifies it as a species of Least Concern but recommends ongoing monitoring [9]. Conservation initiatives in Uttarakhand and Sikkim promote community-based cultivation and eco-tourism to preserve its cultural and medicinal value [11,12,20]

IV. MACROSCOPIC IDENTIFICATION:

4.1 Leaves

Leaves are glossy green, oblong-lanceolate, 10–20 cm long and 3–6 cm wide, crowded towards the tips of branches. Petioles are covered with white scales when young [21].



[Fig. NO. 4.1.2]

4.2 Flowers

The flowers of *Rhododendron arboreum* range in colour from deep scarlet to pink or red with white markings, bearing up to twenty blossoms in a single truss. The bright red forms occur at lower elevations. Morphologically: calyx – five-cleft; corolla – tube-spotted, funnel-shaped; stamens – hypogynous, declinate; filaments – filiform; anthers – ovate; style – capitate [22, 23].





[Fig. NO. 4.1.3]

4.3 Seeds

Seeds are minute, dark brown, compressed, thin, and linear with an obvolvate membrane [24].



[Fig. No.4.1.4]



[Fig. No.4.1.5]

V. PHYTOCHEMISTRY OF RHODODENDRON ARBOREUM

Overview

Rhododendron arboreum (Ericaceae) contains diverse secondary metabolites including phenolics, flavonoids, terpenoids (especially triterpenoids), alkaloids, glycosides, tannins, and saponins. Different plant parts (flowers, leaves,



bark, buds) show varying chemical profiles; floral parts exhibit the highest phenolic–flavonoid content, underlying antioxidant and other pharmacological properties [25–27].

1. Phenolics and Flavonoids

Phenolic acids (gallic, p-coumaric, ferulic) and flavonols (quercetin, rutin, kaempferol) are abundant in flower and leaf extracts [25, 26]. HPTLC and spectrophotometric assays reveal high total phenolic content correlating with antioxidant assays such as DPPH and FRAP [27]. These phenolics contribute to free-radical scavenging, vascular protection, and enzyme regulation.

2. Terpenoids and Triterpenoids

Leaves and bark yield pentacyclic triterpenes—ursolic acid, betulinic acid, taraxerol, and α/β -amyrins—implicated in anti-inflammatory, hepatoprotective, and cytoprotective actions [28]. These compounds are typical of the Ericaceae family and contribute to membrane stabilization.

3. Glycosides and Arbutin

Phenolic glycosides, particularly arbutin and related O-glycosides, are reported from floral tissues [29]. They influence flavour, antioxidative properties, and contribute to anti-inflammatory and anti-diarrhoeal activities noted in ethnomedicine.

4. Alkaloids, Tannins, and Saponins

Qualitative phytochemical analyses consistently detect alkaloids, condensed tannins, and saponins in flowers and leaves [30]. These compounds impart astringency and antimicrobial activity; saponins also support cytoprotective and haemolytic balance.

VI. PHARMACOLOGICAL ACTIVITY OF RHODODENDRON ARBOREUM

1. Antioxidant Activity

Several studies demonstrate robust antioxidant potential of different parts of *R. arboreum*. For example: a study on leaf extracts from Uttarakhand, India reported high total phenolic and flavonoid contents; the aqueous leaf extract of *R. arboreum* inhibited ~60.12% proliferation of HeLa cells at 31.25 $\mu\text{g}/\text{mL}$ and showed free-radical scavenging and reducing-power activity [31]. A more recent integrative study using leaf and flower methanolic extracts from the eastern Himalayas reported GC-MS profiling and found that leaf extracts showed superior antioxidant capacity (DPPH, ABTS, hydrogen peroxide scavenging, FRAP) compared to flower extracts [32].

In Nepali material, the ethyl-acetate extract of *R. arboreum* showed high total phenolic content (~128.36 $\mu\text{g GAE}/\text{mg}$) and flavonoid content (~107.3 $\mu\text{g QE}/\text{mg}$) and an IC_{50} of ~34.97 $\mu\text{g}/\text{mL}$ in DPPH assay [33].

Mechanistic note: The antioxidant potential is attributed to phenolic and flavonoid compounds (e.g., quercetin, rutin) which can donate hydrogen/electrons, chelate metals and thereby reduce oxidative stress [32, 34].

Gap: Most studies are in vitro; few link the antioxidant effect to in-vivo oxidative-stress biomarker modulation.

2. Anti-inflammatory and Antinociceptive Activity

R. arboreum has been documented for anti-inflammatory and pain-relief (antinociceptive) activities: A study on the bark methanolic extract evaluated crude extract and fractions (n-hexane, chloroform, ethyl acetate, n-butanol) in mice using acetic acid-induced writhing and carrageenan-induced paw oedema. The ethyl acetate fraction (200 mg/kg i.p.) produced ~82% analgesic effect in writhing; a time-course anti-inflammatory effect was observed (1–5 h) in the paw oedema model [35]. Flower extracts: A hydro-alcoholic and aqueous extract of the flower was studied for anti-inflammatory potential in vitro; results indicated the presence of tannins,



flavonoids, phenols, triterpenes, steroids and carbohydrates and demonstrated dose-dependent anti-inflammatory activity [10].

Mechanistic note: Evidence indicates inhibition of lipoxygenase, reduction of prostaglandin-mediated inflammation, and analgesic effect likely via central and peripheral mechanisms (though detailed mechanistic studies are limited).

Gap: More in-vivo models of chronic inflammation (arthritis etc) and mechanistic biochemical marker studies (e.g., cytokines, NF- κ B, COX-2) are needed.

3. Antidiarrheal / Gastrointestinal Motility Effects

A standardized ethyl acetate fraction of *R. arboreum* flower (EFRA) was evaluated in rats: at 100, 200, 400 mg/kg it significantly inhibited castor-oil and magnesium-sulfate induced diarrhea, reduced intestinal transit (charcoal meal test) and enteropooling (intestinal content volume/weight) [13]

Mechanistic note: The antidiarrheal effect may result from flavonoids/tannins reducing intestinal fluid secretion and motility, though exact pathways (e.g., effects on gut smooth muscle, chloride channels, prostaglandins) are not clarified.

Gap: No studies yet on human GI models; dose-response and chronic use data are lacking.

4. Antidiabetic and Enzyme-Inhibitory Activity

A study of leaf extracts of *R. arboreum* showed porcine α -amylase inhibition: methanol extract at 1 mg/mL inhibited ~51.10% of α -amylase activity, acetone and aqueous extracts showed lower inhibition (~44% and ~35% respectively) in the same study [36]. A review article also mentions antidiabetic potential of *R. arboreum*, attributing the effect to presence of quercetin derivatives, hyperoside etc which can inhibit gluconeogenesis and enhance insulin secretion [15].

Mechanistic note: Enzyme inhibition (α -amylase) reduces carbohydrate breakdown; flavonoids may also exert hypoglycaemic activity via insulin secretion modulation, antioxidative stress effects in pancreatic β -cells.

Gap: Controlled in-vivo diabetic model studies are limited; human clinical data are absent; pharmacokinetic data on active compounds are scarce.

5. Antimicrobial / Antibacterial / Antifungal Activity

In Nepal, the ethyl acetate extract of *R. arboreum* showed antibacterial activity: zones of inhibition against *E. coli*, *K. pneumoniae*, *P. aeruginosa*, *A. baumannii*, *S. aureus* and *E. faecalis*; lowest MBC values reported for some extracts [18]. A study on bark extracts reported antifungal activity of the bark fractions and isolated compounds [37].

Mechanistic note: Likely due to phenolic compounds, terpenoids, flavonoids that disrupt microbial cell walls/membranes, interfere with microbial enzyme systems or nucleic acid synthesis.

Gap: Most antimicrobial assays are preliminary (agar diffusion/broth microdilution). Mechanistic studies (e.g., microbial spectrum, synergy, resistance profile) are minimal.

6. Anticancer / Cytotoxic Activity

The leaf extracts (aqueous) of *R. arboreum* inhibited proliferation of HeLa cells (~60% inhibition at ~31.25 μ g/mL) and also down-regulated HIF-1 α and VEGF (pro-angiogenic factors) in the same study [31].

Mechanistic note: Suggests possible anti-angiogenic and antiproliferative mechanisms via suppression of angiogenesis markers; flavonoids and triterpenoids may be key responsible.

Gap: Very limited number of cancer-cell models; no animal tumour model data reported; isolation of specific active cytotoxic compounds is minimal.



7. Adaptogenic / Antidepressant / Neuro-behavioural Activity

A 2023 study assessed the ethanolic extract of flower of *R. arboreum* in rodent models: adaptogenic activity (anoxia stress and swimming endurance) and antidepressant activity (tail suspension test, elevated plus maze) were observed at doses of 200 mg/kg and 400 mg/kg [38].

Mechanistic note: The study authors attribute adaptogenic activity to flavonoids such as rutin and quercetin, and antidepressant effect possibly to terpenes. They also measured biochemical, hematological and organ-weight parameters to support adaptogenic effect.

Gap: Mechanistic neurochemical studies (e.g., monoamine levels, BDNF, receptor binding) are lacking; clinical translation remains remote.

8. Antiviral / SARS-CoV-2 Related Activity

A study on Himalayan *R. arboreum* petals reported that extracts produced ~80% inhibition of SARS-CoV-2 viral load in Vero E6 cells at 1 mg/mL ($IC_{50} \approx 173 \mu\text{g/mL}$). The phytochemicals (5-O-feruloyl-quinic acid, 3-caffeoyl-quinic acid, etc) were profiled and subjected to molecular docking and molecular dynamics studies showing strong binding affinity with SARS-CoV-2 main protease and human ACE2 receptor [39].

Mechanistic note: Suggests that the extract may interfere with viral entry (ACE2) and replication (M^{pro}) but this is in-vitro/in-silico only.

Gap: No in-vivo antiviral data; safety/toxicity and specificity (virus vs host) need evaluation; the relevance to human infection is speculative.

9. Cardioprotective, Hepatoprotective & Immunomodulatory Activity

Review summaries mention cardioprotective potential (via flavonoids preventing LDL oxidation) and hepatoprotective/immunomodulatory effects, though primary experimental data specifically in *R. arboreum* are sparse [40].

Gap: These are more hypothesized than well-documented for this species; experimental animal studies for hepatoprotection and immunomodulation are needed.

10. Traditional and Ethnomedicinal Uses

Rhododendron arboreum Sm. has been revered for centuries in traditional medicine systems of the Himalayan region, where it holds immense ethnomedicinal, nutritional, and cultural significance. Indigenous communities of India, Nepal, and Bhutan have long utilized different parts of the plant—particularly the flowers, leaves, and bark—for treating a wide range of ailments [11, 12]. In Ayurveda, *R. arboreum* is regarded as a “Rakta Pushpaka Dravya”, or red-flowered plant, traditionally believed to strengthen the heart, purify blood, and enhance circulation [19]. The flowers are most commonly used in traditional remedies; they are crushed or juiced and administered orally to alleviate headaches, diarrhoea, dysentery, inflammation, and fatigue. In many Himalayan villages, a refreshing drink known as “Buransh juice” or “Buransh squash” is prepared from the petals and consumed as a cardiac tonic, coolant, and antioxidant-rich health beverage, reputed to reduce hypertension and oxidative stress [12]. The petal extracts are also used to relieve stomach disorders, ulcers, and menstrual pain, while dried flower powder is mixed with honey or water for the management of diabetes and high blood pressure in Nepalese folk medicine.

The leaves of *R. arboreum* possess significant medicinal value and are traditionally employed to treat rheumatism, gout, headaches, and skin diseases. Poultices made from crushed leaves are applied externally to relieve joint inflammation, muscle pain, and wounds, reflecting the plant’s anti-inflammatory and healing potential [9]. The bark is occasionally used in decoction form to manage liver disorders, coughs, and dysentery, while bark paste is applied topically to soothe dermatitis and insect bites. In some tribal communities of Uttarakhand and Himachal Pradesh, flower infusions are consumed during seasonal transitions as a natural immunity booster and energy restorative, believed to protect against mountain-fatigue and altitude sickness [12]. In Sikkim and Bhutan, both flowers and leaves are incorporated into



traditional herbal mixtures used to treat diabetes, digestive issues, and circulatory ailments, often in combination with other local herbs.

Culturally, *R. arboreum* holds ritual importance across the Himalayas. The bright red flowers are offered in religious ceremonies and folk festivals, symbolizing vitality, purity, and renewal. In Nepal, where it is the national flower (*Laligurans*), it represents love, passion, and strength, and is often used in decorative garlands and temple offerings [8]. Ethnobotanical surveys reveal that rural healers (*Vaidyas* and *Amchis*) prepare polyherbal formulations containing *R. arboreum* extracts as natural tonics and cardiovascular supports [12]. The petals are also fermented or sun-dried for later medicinal use, and the flower paste is sometimes applied to the forehead to relieve sunstroke and dizziness.

Overall, the traditional uses of *R. arboreum* encompass a broad pharmacological spectrum—ranging from gastrointestinal, hepatic, and cardiovascular disorders to inflammatory and metabolic diseases—reflecting deep indigenous knowledge and experience accumulated over generations. These folk practices form the foundation for modern pharmacological research, which has begun to validate many of these traditional claims through experimental and biochemical studies [5]

VII. MATERIALS AND METHODS

Plant materials, pathogen isolates, and sampling In the study "Nova Zembla" rhododendron leaves were lacerated using a sterile scalpel tip. 30 μ l of zoospore suspensions at a concentration of 1×10^4 ml⁻¹ was dropped into the wound to start the inoculation process. As a control, deionized water was used. For each phytophthora species, ten leaves were used. The inoculated leaves were placed on trays with plastic nets and sterile, wet blotting paper covering them. The trays were then sealed in polyethylene foil and incubated at 22°C for 12/12 hours of light and dark. Every day, sterile distilled water was gently sprayed on the inoculated leaves Following a 14-day period, the leaves were cleaned using deionized water, and portions of the leaves comprising approximately three-fourths diseased and one-fourth healthy tissue were crushed in a mortar with a liquid nitrogen pestle. Next, samples of 100 or 200 mg of infected tissue were taken for DNA extraction in accordance with the isolation methodology. Placing 5 \times 5 mm of necrotic tissues onto the PARP (*Pimaricin* + *Ampicillin* + *Rifampicin* + *Pentachloro nitro*) allowed for the confirmation of infection.

7.1 Procedure and Extraction

The four DNA extraction methods are contrasted below based on quantity and quality:

- I. The extraction procedure outlined by Aljanabi and Martinez (1997) (AM) was used with the exception that, rather than homogenizing the tissue in a Polytron Tissue Homogenizer, 100 mg of fresh weight of tissue was crushed in liquid nitrogen using a mortar and pestle.
- II. The extraction process followed the manufacturer's instructions (www.qiagen.com) and used a commercial DNA extraction kit, the DNeasy Plant Mini Kit (Qiagen) (Q), with 100 mg of fresh weight of tissue.
- III. Using the unmodified Doyle and Doyle (1987) technique, 200 mg of fresh tissue weight and CTAB (*Cetyltrimethylammonium bromide*) buffer were utilized.



Fig.:- Extract

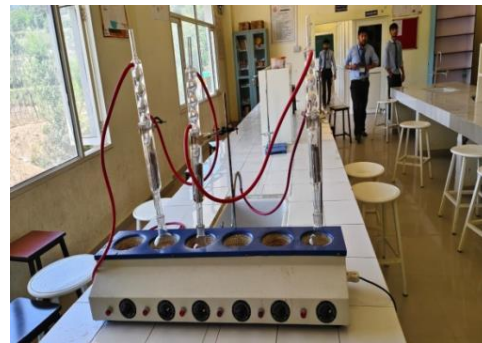


Fig.:- Extraction assembly



Comparing the CTAB buffer amount to the original, which used five hundred–1,000 mg of fresh tissue, it was proportionately less.

The following changes were made to the Doyle and Doyle (1987) (DDm) protocol:

- (i) 200 mg of fresh weight of tissue was used to extract DNA, rather than 500–1,000 mg;
- (ii) 500 μ l of CTAB buffer was used;
- (iii) nucleic acid precipitation was done at -20°C rather than room temperature;
- (iv) precipitation time was one hour rather than several hours;
- (v) nucleic acid washed with 70% ethyl alcohol rather than a wash buffer containing 76% ethyl alcohol and 10 mM ammonium acetate without centrifugation but only gently pipetted.

Following extraction, methods I, III, and IV incubated for one hour at 37°C with RNase A added to a final concentration of $10\ \mu\text{g}\cdot\text{ml}^{-1}$.

7.2 Phytochemical Tests

1. Flavonoids: 2ml extract+2-3 drops of conc. HCl= Red/Pink colour.
2. Phenolic: 2ml extract+ 2-3 drops of 5% FeCl_3 = Dark Blue/Green Colour
3. Tannins: 2ml extract+few drops of FeCl_3 = Dark Blue/Green Colour
4. Saponins: 2ml extract+5ml water shake for 1 min wait for 30 sec persistent foam = presence of saponins
5. Alkaloids: 2ml extract+Dandruff's reagent = Orange/Red precipitates



Fig.:- Test results

7.3 Toxicity and Antimicrobial activity

Substantial cytotoxic effects were observed in the leaves, with moderate toxicity from the stem and roots and minimal relevance from the bark. The biological activity of the extract may be attributed to its glycosides, alkaloids, and flavonoids. The *R. arboreum* flower, leaf, stem, and root methanolic crude extracts showed considerable efficacy against *B. subtilis*, *Salmonella typhi*, and *S. aureus*. According to Prakash, leaf extract surpassed floral extract in terms of effectiveness. The zone of inhibition for *S. aureus*, *Klebsiella pneumoniae*, *Streptococcus pyogenes*, and *E. coli* in methanol and aqueous leaf extracts. According to Sharma, ethanolic floral extract shows remarkable efficacy against *Escherichia coli*, *B. subtilis*, *S. aureus*, and *Salmonella typhi*. The minimum effective concentrations of ethanol, methanol extract, and isolated quercetin were found against *S. Aureus* and *E. Coli*. In another study, water extract demonstrated significant results against *Candida albicans*, *Aspergillus parasiticus*, and *Aspergillus flavus*, while the ethanolic flower extract demonstrated significant role against *E. coli*, *S. epidermidis*, and *S. aureus*, respectively, and showed antifungal activity against *Aspergillus flavus*, *Candida albicans*, and *Aspergillus flavus*. Effective antifungal activity against *Fusarium solani*, *Aspergillus niger*, *Microsporum canis*, *Cantharellus flavus*, *Candida albicans*, and



Candida glabrata was demonstrated using methanol and the ethyl acetate extract. The hydrophilic nature of betulin and 3-acetoxyurs-11, 12-epoxy-13 β explain their high activity.

7.4 Traditional use of rhododendron

Historically, *Rhododendron arboreum* has been used as *Rhododendron arboreum*'s exquisite blossom is used in various cultural and industrial contexts. Blooms are extensively used in bridal bouquets, as well as offered as offerings in hill temples. The bark and flower extract are extracted and utilized as an ingredient in skin conditioner and other commercial cosmetic treatments.

7.5 Medicinal uses of rhododendron

There are reports of minimal side effects and medical benefits for *Rhododendron arboreum*. Every part of rhododendron is used to treat a variety of illnesses and possesses its own therapeutic and beneficial qualities. Rhododendron includes a wide variety of bioactive chemicals in each of its regions. The plant's stem holds compounds such as alkaloids, steroids, terpenoids, tannins, glycoside, and reducing sugar that can help alleviate hay fever, bronchial asthma, and bleeding. The bioactive ingredients are used to treat illnesses and help to maintain excellent health. This plant's roots have alkaloids, tannins, lowering sugar, steroids, and saponins that aid in the prevention of cancer and cardiovascular illnesses. The presence of secondary metabolites suggests that rhododendron root has potential medicinal uses for anthocyanidins. They will assist in relieving lung infection, cough, fever, headache, and toothache. The phenolic compounds such as steroids, quercetin, rutin, coumaric acid, saponins, and tannins found in *Rhododendron arboreum* flowers are beneficial against diabetic nephropathy, diarrhea, and microbes. Additionally, because these flowers have an antidiabetic factor, they can be used as functional foods or nutraceuticals for people with diabetes.

7.6 Utilization of rhododendron as food and drink

Rhododendron arboreum is utilized to produce a wide variety of high value food products. This small tree has multiple sections that are useful for therapeutic purposes. Due to the sweet and sour taste of plants, a wide variety of food products are made, such as local brew, squash, chutney, jam, jelly, juice, and preserves. Rhododendron has gained market value and appeal because of its frequently consumed juice, which is made from flowers. It exhibits hepatoprotective, anti-inflammatory, anti-incontinence, and antidiarrheal properties. Fresh petals are used in mountainous regions to make "Buransh Ki chutney," a chutney made with mint and other regional spices. This flower's dried powder is prescribed as a medication to treat "blood dysentery." Three closely related varieties of *Rhododendron* produce the herbal tea known as "Labrador Tea."

7.7 Utilization of rhododendron as functional food

Functional foods are dietary items that, apart from providing nutrients and energy, beneficially modulate one or more targeted functions in the body, by enhancing a specific physiological response and/or by reducing the risk of disease. The Institute of Food and Information Council (IFIC) asserts that functional foods "provide health benefits beyond basic nutrition. Functional food can be fruits, vegetables, herbs and flowers and they have its own medicinal and beneficial effect. Burans belongs to the Ericaceae family which consists 1200 species among which China has the highest number of species that is 571 species. It is a national flower of Nepal and state tree of Uttarakhand. Moringa, the genus *moringa* belong to the Moringaceae family, the genus comprises of thirteen species, and it is commonly known as "drumstick," "horseradish.

VIII. CONCLUSION

The *Rhododendron arboretum* "a medicinal herb" was Collected, dried and extracted. The study of phytoconstituents found in this plant rebels that the plant is having an immense potential for utilization as a medicine, the active



ingredient found in the plant is already having a wide medicinal value and the study on this plant showing the scope of the plant as medicine in further prospects.

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