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REVIEW ARTICLE **OPEN ACCESS**

Rhodiola rosea: A Drug of Pivotal Importance in Traditional and Modern Medicine

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ABSTRACT
Rhodiola *species, belong to the family Crassulaceae comprises more than 100 perennial plants are mentioned in ancient and other official Pharmacopeias have long being used as Adaptogeneic, Antifatique, Antimountain sickness, Antioxidantor functional foods.* Rhodiola *species is also found in Ladakh region of India locally called Solo. A detailed summary of* Rhodiola rosea *which include its biological source, geographical distribution, cultivation, collection, macroscopy, microscopy, chemical constituents, pharmacological activities, safety and uses are mentioned. The review is designed to attract research interest in this important Himalayan, Siberian mountaneous plant.*
Keywords: *Rhodiola rosea, Traditional, Pharmacological, Modern medicine.*

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INTRODUCTION

COMMON NAMES

- Botanical name: *Rhodiola rosea*
- Botanical synonyms: *Rhodiola roanensis*, *Sedum rosea*, *Sedum roseum*, *Sedum rosea* var *Roanensis*
- English name: Rose Root, Stone carp
- Chinese name: Hong Jing tian
- Ladakh local name: Solo var *Rhodiola quadrifida*
- Other name: Arctic root, Golden root, Rosavin, Rhidola, Rhodiola rhizome.

TAXONOMY

Rhodiola rosea (R. rosea) was first mentioned by Pedanius Dioscorides in the Materia Medica. The current taxonomical classification of the genus Rhodiola is diverse and complex. Before 1945 some taxonomist classified Rhodiola to the subfamily Sedoidae. It was again reclassified as subgenus Sedum and in 1963, it was re-established in separate genus Rhodiola by Hegi [1].

SCIENTIFIC CLASSIFICATION

Kingdom: Plantae
Sub kingdom: Viridiplantae
Infra Kingdom: Streptophyta
Super Division: Embryophyta
Division: Tracheophyta
Subdivision: Spermatophyte
Class: Magnoliopsida
Super order: Saxifraganae
Order: Saxifragales
Family: Crassulaceae

- Genus: *Rhodiola*
- Species: rosea
- Bionomial name: *Rhodiola rosea* Linn.

BIOLOGICAL SOURCE

It consist of dried roots of a perennial flowering plants *R. rosea* - stone carp family Crassulaceae, Figure 1 [2].

FIGURE 1. *RHODIOLA ROSEA* LINN. PLANT

GEOGRAPHICAL DISTRIBUTION

Rhodiola may have originated in the mountainous location of great Himalayas and Southwest China in Asian continent. Genus is distributed from Altai Mount across Mongolia into many parts of Siberia. In Europe, the genus extends from Iceland and the England across Scandinavia to southward including the Pyrenees, the Alps, the Carpathian Mountains and other Balkan countries. It is also distributed in Arctic region. In ladakh, genus is found in khardung la, Changla and Pezilla areas. In ladakh, India, genus is called by the local name solo. The three species of solo are found whose names are Solo carpo (white), Solo marco (red) and Solo sarbu (yellow). *Rhodiola rosea* is found in the North America –Canada, part of USA, Siberia, Norway, Sweden , Iceland and Balkans countries. *Rhodiola crenulata* is found in the Tibet and southwest China. *Rhodiola sachalinensis* is found in the Canada, West America, East America, Norway, Siberia, Sweden, Iceland, East China and Balkan countries. *Rhodiola sacra* found in the Siberia, Southwest China. *Rhodiola kirilowii* is found in southwest China and in parts of Siberia. *Rhodiola quadrifida* is found in the southwest China, Nepal, India. *Rhodiola dumulosa* is found in parts of eastern India and southwest China [3].

CULTIVATION AND COLLECTION

R. rosea prefer well-drained soil especially alkaline soil. It cannot grow in the shade, prefer dry or moist soil and can tolerate the drought. The plant can resist maritime exposure and can grow naturally where temperature is below the freezing point. Rhodiola cultivation take place through the seed germination in Russia. The cultivation is the only solution to obtain raw material. Field culture is established by transplantation of seedling .five year is the cultivation period from planting to harvesting.

MACROSCOPIC CHARACTERS [4]

STEM

It is tall, fleshy 15 to 35 cm stems growing from a short scaly root stock. It is perennial with a thick rhizome.

FLOWER

The flowers are yellow to greenish yellow in color some time with reddish tip and dioecious. The flower consist of four sepals and four petals. The Corolla is regular yellow and measures about 0.5 to 1 cm broad. Petals measures 3.5 millimeter (mm) long on a staminate flower 2.5 mm long on pistillate flower. The calyx is fused with four yellow lobed and lobe is 2.5 mm long. It is staminate flower with stamens.

LEAVES

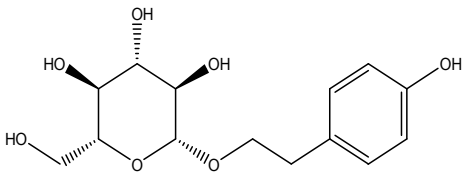
They are alternate and stalkless. Lowest leaves can be scale like stem. Leaf blade are elliptic– obovate, sharp tipped, blunt toothed, flat, glabrous, slightly fleshy and bluish.

MICROSCOPY

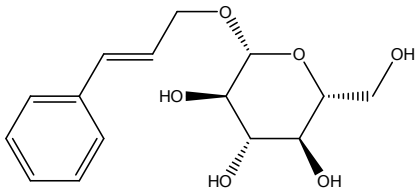
Microscopy of dried rootstock, on the rootstock crosscut is seen a schistous periderm. Root stock structure is of fascicular type. Duct fascicles are open, collateral fusiform, ringshaped, root stock periphery-oriented by phloem and centre oriented by xylem. Root stock parenchyma consists of large cells filled by starch. Starch grains are simple round or oval, 220 micron meter in diameter.

CHEMICAL CONSTITUENTS

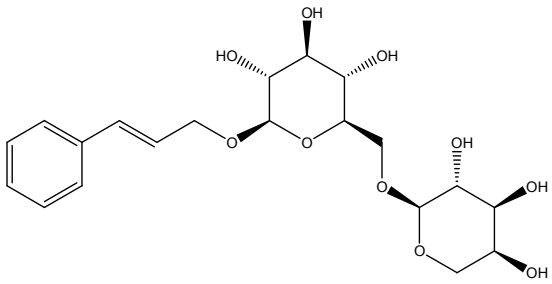
Root of *Rhodiola rosea* consists of phenylpropanoid compounds (Prosavin, Rosin, Rosarin), Phenylethanol derivatives (Salldroside, Tyrosol), Flavanoids (Rodiolin, Rodionin), monoterpines (rosiridol, rosaridin), Triterpines compounds (daucosterol) and various phenolic acids such as chlorogenic, hydroxycinnamic acid, gallic acids. Salidroside (Rhodioloside) is responsible for the pharmacological activities of *Rhodiola rosea* root [5,6]. Proanthocyanidins from Rhodiola extract (30% of the 70% acetone dry crude extract) is responsible for antioxidant, anti-aging, anti-inflammatory, anti allergic & antimutation activities. Root contains three cinnamyl alcohol vicianosides-rosavin, rosin, rosarin. The term Rosavins can be used to include rosavin, rosinand rosarin that are specific to species *R. rosea*.



Rhodioloside



Rosin



Rosavin

PHARMACOLOGICAL ACTIVITIES

EFFECT ON CENTRAL NERVOUS SYSTEM

R. rosea stimulate various neurotransmitters such as norepinephrine, dopamine, serotonin (5-HT) in small and medium doses. It increases the permeability of blood-brain barrier to dopamine and 5-hydroxytryptamine [6-7].

EFFECT ON PHYSICAL WORK CAPACITY

It is shown that *R. rosea* can cause an increase in the physical work capacity and shorten the recovery time between bouts of high-intensity exercise.

ADAPTOGEN

It is observed that *R. rosea* increases the resistance to a variety of chemical, biological and physical stressor by influencing the activity of monoamines and opoid peptides such as beta endorphin.

EFFECT ON CARDIAC ACTIVITY

It's extract prevent the degrees in cardiac contractile for secondary to environmental stress in the acute cooling and contribute to stable contractility.

ANTICANCER ACTIVITY

R. rosea extract given with the other anticancer agents, it shows good pharmacological activity.

Rhodioloside and Salidroside shows many pharmacological activities such as neuroprotection, hepatoprotection, stress prevention, immune protection, neuro endocrine protection through various mechanism/functions operating as-

- They protect from oxidative damage in fatigue.
- They cause protection of hepatic tissues from paracetamol induced oxidative damage.
- They protect liver against tacrine-induced cytotoxicity in liver derived hepG2 cells.

- They promote recovery of hematopoietic functions of the bone marrow depressed anemia.
- They causes protection of the cultured neuronal cells PC-12 cells against hypoglycemia and serum limitation induced cytotoxicity possibly through modulation of apoptosis related gene expression.
- They result in protection of cultured neuronal cells from sodium azide and glutamate induced injuries.
- They offers protection of cultured myocardial cells from anoxia and reoxygenation induced injuries of cell membrane, endoplasmic reticulum and mitochondria.

MECHANISM OF ACTION OF *RHODIOLA ROSEA*

a) It increases heat shock protein HPS 70. (Amsterdam, Panossian 2016)
b) It helps in increasing BDNF. (Yang et al 2014)
c) It causes inhibition of Monoamine oxidases receptor A, B. (Von, Diermen et al 2009)
d) It decreases stress response and increase beta endorphins. (Lishmanov et al)
e) It stimulates noradrenaline, serotonin,d opamine and acetylcholine receptors. (Mao et al 2015)
f) It decreases SAPK/JNK. (Amsterdam, Panossian 2016)

BIOLOGICAL ACTIVITIES OF DIFFERENT CHEMICAL CONSTITUENTS OF *RHODIOLA spp*. [8-10]

ANTIOXIDANT ACTIVITY

Out of sixteen phenolic compounds of *R. crenulata*, eleven compounds showed scavenging activity against ABTS –free radical. They are methyl gallate, 2-(4-Hydroxylphenyl)ethyl ester-3,4,5-trihydroxy-benzoic acid, kaempferol, pollenitin, kaemferolderivative, rhodionin, ternatumoside, crenuloside, rhodiosin, luteolin and flavones derivative.

IMMUNOMODULATORY EFFECTS

The effect is shown by two compounds rhodiocyanoside A and rhodiocyanoside B from Rhodiola quadrifida. Eight compound from *R. kirilowii* are kenposide A, sacranoside B, rhodiooctanoside, phenethanol beta-vicianoside, rhodiocyanoside D, heterodendrin, lotaustralin, and sacranoside A.

HEPATOPROTECTIVE EFFECTS

The effect is shown by salidroside, kaempferol, trans caffeic acid, rhodiosin, sachaloside III, and sachaloside IV.

ANTICANCER ACTIVITIES

Salidroside inhibit the growth of bladder cancer. Anticancer activity is also shown by crenulatanoside B and C.

ANTIVIRAL EFFECTS

Salidroside is effective against coxsackievirus B-3. Rhodisin, epicatechin-3-o-gallate,3,3-digalloyl procyanidinB-2, epigallocatechin-3 gallate.

SAFETY & TOXICITY

Studies in both animal and human says that it is non-toxic drug. *Rhodiola* can cause mild dizziness and gastrointestinal discomfort [11]. Animal studies done using *R. rosea*, *R. heterodonta, R. fastigiata, R. sacra, R.hodiola kirilowii* shows no acute and chronic toxicity.

DRUG- DRUG INTERACTION

- Rhodiola constituents such as the rhodiosin and rhodionin are potent inhibitors of cytochrome P450 enzymes and P-gp transporter.
- Rhodiocyanosides and Lotaustralin shows antiallergic histamine release inhibitory effects.

RHODIOLA USED AS TRADITIONAL MEDICINE

- The Greek physician Dioscorides had analyzed medical application of *Rodia riza* in 77 C.E. in Materia Medica. Linnaeus renamed it *R. rose* with rose like fragnance while cutting it.
- In Mountanious Siberia Village, roots are given to couples before marriage to enhance the fertility thus having better offspring
- In middle Asia *R. rosea* tea was given for the treatment of the cold and flu in winter season.
- Linnaeus explain the preparation of astringent for the treatment of hernia, vaginal discharge, hysteria and headache [12].
- German researchers described the benefits of *R. rosea* for pain, headache, scurvy, haemorrhoids as a stimulant and as an anti-inflammatory agent [13].
- It protects animals and humans from mental stress, physical ailment, toxin, cold and flu. In Himalayan rhodiola (*R. sacra*) root is an excellent rare herb and Tibetian considered as sacred herb. It is used by Tibetian and other Himalayan people as powerful adaptogenic tonic herbs

since the beginning of Tibetian civilization. Rhodiola by Buddhist monk is used to increase their concentration, spiritual power and mood as it increases a person's capacity to absorb and utilizemore oxygen.

- It prove to be more powerful than Ginseng in term of physical endurance, memory enhancement and energizing ability. Local people of Ladakh India make a special dish from solo called Tangathur for various health benefits.
- The first appearance of Rhodiola in traditional Tibetan medicine can be dated back to 1000 years ago. In Tibet monograph like four medical code (rGyud-bzhi in Tibetan, Si Bu Yi Dian in Chinese 800 AD) [14].

RHODIOLA IN MODERN MEDICINE

- The pharmacological and pharmacoepial committee of Soviet ministry of health has included *R. rosea* in official Russian medicine in 1969. In 1975 the health Ministry of Soviet approved the registered preparation number 75 / 933/14 as medicine.
- In Sweden, *R. rosea* was approved as herbal medicinal product in 1985 and has been described as an anti-fatigue agent in the textbook of "Phytomedicine for Pharmacist" [15].
- In Sweden, *R. rosea* is described as a plant with a stimulant function. In addition to this, the pharmaceutical book (Lakemedelsboken 97/98) detail its role. *R. rosea* as one of the most commonly used Psychostimulant [16].
- In Denmark, it is registered as a medical product of Botanical drug.
- *R. rosea* has been documented by Europian medicine agency for the temporary relief of stress related symptoms, beside this *R. rosea, R. crenulata* has been incorporated by US pharmacopeia convention.
- *Rhodiola* was first incorporated in Chinese pharmacopeia in 1977 [17].

CONCLUSION

This Himalayan Siberian mountains plants called by the various names such as *R. rosea* solo, Arctic root etc proved to have many dynamic therapeutic activities. Rosavins are the major chemical constituents are specific to this species. The immunomodulation properties of the plant are protecting the hilly people since ancient times and as the new researches are going on the plant which may not less than a miracle for the mankind.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

HUMAN AND ANIMAL RIGHTS

Not applicable.

RESEARCH INVOLVING PLANTS

Not applicable.

CONSENT FOR PUBLICATION

Not applicable.

CONFLICT OF INTEREST

No conflict of interest.

SOURCE OF FUNDING

None

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