

Ethnobotanical Significance of *Picrorhiza Kurroa* (Kutki), a Threatened Species

Isha Kumari¹, Hemlata Kaurav², Gitika Chaudhary³

¹Junior Research Executive, ²Research Associate, ³H.O.D. - Research and Development, Shuddhi Ayurveda, Jeena Sikho Lifecare Pvt. Ltd. Zirakpur 140603, Punjab, India

Corresponding Author: Gitika Chaudhary

ABSTRACT

Herbal plants have been used in the health maintenance customs since the origin of mankind. The herbal products have negligible adverse impacts on the consumer health because they have suitable and beneficial physiological actions on the living systems. Traditional systems of medication primarily use plants in their practices. The market demand of these plant based products has been increased over the past few years. *Picrorhiza kurroa* Royle ex Benth is one of the most established herbal plants with extraordinary medicinal properties. It belongs to Scrophulariaceae family and commonly called as Kutki. *Picrorhiza kurroa* is also called as bitter drug due to presence of Kutkin, principle phytochemical constituent of this medicinal plant. It is used in Ayurveda and folk system for treating liver related disorders and used as a remedy for jaundice, malaria, cut, wounds, snake bites etc. Its main therapeutic properties are antimalarial, antidiabetic, hepatoprotective, anticancer, anti-mutagenic, anti-inflammatory, immunomodulatory etc. The aim of present review is to provide information related to phytochemistry, traditional uses in Ayurveda and folk medicinal system and therapeutic properties of *Picrorhiza kurroa*.

Keywords: Kutki, Kutkin, Rasapanchak, Hepatoprotective, Antimalarial

INTRODUCTION

Mother nature has been fulfilling our requirements since ancient times. It has gifted us a vast variety of important medicinal plants which are being used primarily in traditional medication systems.

The chemical constituents of these plants are served as chemical entities for synthetic drugs. This is the reason why plant kingdom is entitled with “the treasure house of potential drugs [1-7]. These medicinal plants also play a vital role in cosmetic and nutraceutical industry. Herbal nutraceuticals have a great impact on maintaining the health and longevity of life [8,9]. These medicinal plants are the rich source of secondary metabolites like flavonoids, saponins, alkaloids, triterpenes etc. which have a definite, compatible and suitable physiological actions on the human body this is the reason why the drugs derived from herbal plants have negligible side effects [10-12]. The WHO estimation on the utilization herbal drugs revealed that 80% of the world population relies mainly on herbal medicines [13-17]. The continent Asia has a very history of using herbals for the treatment of numerous chronic as well as infectious human diseases [18]. India being the botanical garden of the world and listed among the World biodiversity centers, uses more than 45000 different plant species for health maintenance [19,20]. The traditional medication systems (Ayurveda and folk) of India greatly promote the use of medicinal plants [21]. China has been using herbal plants in their day to day life for many years. Japan, Hong Kong, Korea and Singapore are known primary importers of Traditional Chinese Medicine which are taking almost 66% share of China’s total herbal drug export [22-24]. As per the historical reports, various different plant

species of plants were used by Amerindians [25]. It is believed that many American plant species were introduced by the Spanish and the Portuguese to many parts of the world [26]. Balkan Peninsula, the most important biodiversity center of Europe, comprises of 6340 different vascular plant species [27]. The plant diversity of Turkey comprises of 10,500 different plant species among which 30% are the native plants of Turkey [28,29]. In African continent it is a very common practice of using traditional medicines [30]. A large proportion of Nigerian population use traditional medicines in their daily routine [31]. The ancient practices of using medicinal plants are gaining popularity and being continually adapted by many populations [32]. There are so many important medicinal plants around the world which are of great significance in traditional medication systems and one such significant plant is *Picrorhiza kurroa* Royle ex Benth (figure 1). It is a member of Scrophulariaceae family and commonly called as Kutki in Hindi and many other languages. It is a native plant of western Himalayas. The word *Picrorhiza* is made up of two words "picross", Greek word which indicates a meaning bitter while the word "rhiza" indicates roots. The Punjabi name of the plant "Karu", indicates the same meaning as that of "rhiza" [33]. Scrophulariaceae family consists of 200 genera and 3000 species which are mainly found in the northern temperate regions of the world. Popular garden plants (including tiny alpines) and aesthetically important plants such as Penstemon, Mimulus and Calceolaria are some members of this family [34]. It is an esteemed medicinal plant in traditional medication systems especially in Ayurveda. In ancient Ayurvedic literature by Jivek, Charak and Vagbhata *Picrorhiza kurroa* is mentioned as an important remedy. Also this medicinal plant is listed as an official drug in Indian Pharmacopoeia [35]. In Ayurveda and other traditional systems, it is used against a variety of diseases such as liver and respiratory tract problems, dyspepsia, chronic diarrhea,

scorpion sting, fever and dyspepsia, dropsy, asthma, leprosy, arthritis, stomachic troubles, wounds, cuts etc. [36,37]. It has diverse phytochemistry composed of iridoids, acetophenones and cucurbitacins, apocynin. Kutkin is the major active principle phytochemical constituent present in this plant which is used in a number of herbal formulations due to associated extraordinary therapeutic properties [38,39]. The root of *Picrorhiza kurroa* is therapeutically important. They act as laxative in small doses and cathartic in large doses. They are also used against gastrointestinal and urinary disorders, leukoderma, snake bite, scorpion sting and inflammation [40,41]. It is a plant of great pharmacological and therapeutic significance. It is associated with properties like antimalarial, antidiabetic, hepatoprotective, anticancer, anti-mutagenic, anti-inflammatory, immunomodulatory etc. *Picrorhiza kurroa* is listed under highly threatened plant species thus for its conservation conventional and biotechnological approaches have been initiated so that maximum benefit can be derived from this wonder herb in the future also [42]. Vernacular names and taxonomic classification of *Picrorhiza kurroa* is given in table 1 and 2 respectively.



Figure 1. *Picrorhiza kurroa*

Table 1: Vernacular Names of *Picrorhiza kurroa*

English	Hellebore
Sanskrit	Kutki
Hindi	Tikta, Tiktrohini, Kaurohini, Kavi, Sutiktaka, Kauka, Rohini
Assamese	Katki, Kutki
Gujrati	Kadu, Katu
Kannada	Katuka rohini,
Malyalam	Katuka rohini, Kaduk rohini
Marathi	Kutki, Kalikutki
Oriya	Katuki
Punjabi	Karru, Kaur
Tamil	Katuka rohini, Katuku rohini, Kadugurohini
Telugu	Karukarohini
Urdu	Kutki

Table 2: Taxonomy of *Picrorhiza kurroa* [43]

Taxonomic Rank	Taxon
Kingdom	Plantae
Division	Dicotyledonae
Class	Asteride
Order	Scrophulariales
Family	Scrophulariaceae
Genus	<i>Picrorhiza</i>
Species	<i>kurroa</i>
Common Name	Kutki

Morphological Description of *Picrorhiza kurroa* [44-46]

It is a small perennial herb which attains height up to 10-20 cm. A small leafy weak creeping stem is present which is erect at flowering. This plant contains 6-10 inches long hard roots which are wrinkled and grayish to brown in color. Rhizomes are 2.5–12.0 cm long, 0.3–1.0 cm thick, cylindrical which are curved in irregular manner with the branching and rooting at the jointed nodes. The rhizomes are externally greyish-brown in appearance. Numerous aerenchymas are present in leaf, aerial stem and rhizome. The basal alternate leaves present in this plant are 5 to 15 cm in length. Leaves are oval in shape and are acuminate, serrate, stalked, winged, oblanceolate or narrowly spatulate and are coarsely toothed. Two kind of glandular hair are present over the leaves. *Picrorhiza kurroa* has white or pale purple colored bisexual flowers which are present on long terminal spikes. Calyx has equal 5 parts with 4-5 lobbed corolla. Lobes are actinomorphic. Slightly didynamous stamens which are 4 in number are inserted on corolla tube. Capitulate stigma is present. *Picrorhiza kurroa* has acute ovoid and swollen fruits/capsules which are 6-10 mm in size, tapered at top, split up into 4 valves.

Numerous pale brown seeds are present in this plant. Seeds are almost 1 x 0.8 mm in size and ellipsoid in shape. A very thick and transparent seed coat is present over the seeds.

Geographical Distribution of *Picrorhiza kurroa* Kutki

It is an indigenous plant of western Himalayan at 3000-5000 m of elevation [47]. Western Himalayan range includes Jammu and Kashmir, Himachal Pradesh and Uttarakhand. In Kashmir, it is mainly found in Gurez, Lolab, Karna, Sindh and Lidder Valleys. In Uttarakhand it is found in areas of Badrinath, Kedarnath and Chamba. In Himachal Pradesh it is widely found in hilly districts such as Chamba, Pangi, Kullu, Shimla, Kinnaur and Lahaul valleys [48]. *P. kurroa* grows well in moist, sandy clay loam textured soils which have high in organic matter present in them [49]. It is found in Pakistan, Nepal, Bhutan, China [50].

Phytochemistry of *Picrorhiza kurroa*

The study reports on its phytochemistry revealed that it contains complex mixture of phytochemicals. It mainly consists of iridoids, acetophenones and cucurbitacins. The active phytochemical constituent present in *Picrorhiza kurroa* is kutkin (a bitter phytochemical constituent) which is made up of picrosides and kutkosides. The major picrosides present in kutkin are picroside I and II which are ideally iridoid glycosides. The kutkoside and picroside are present in fixed proportion of 1:2. Kutkins are associated with hepatoprotective activity. Picroside III, V and pikuroside, 6-feruloylcatalpol, minecoside are present as a minor iridoid glycosides constituent. Triterpenes are included in cucurbitacins. Major cucurbitacins are cucurbitacin B, D and R. Stuppner et al., discovered six novel cucurbitacin form this plant. Cucurbitacins are associated with cytotoxic and antitumorous activities. Other constituents present in this plant are, minecoside, picein, 4-hydroxy-3-methoxy acetophenone,

apocyanin, vanillic acid, cinnamyl veronicoside acid, D-mannitol, kutkiol, kutkisterol and a ketone and phenolic glycosides like picein and androsin.

Apocynin (catechol) is anti-inflammatory in nature and prevents oxidative burst of neutrophil. It is believed that androsin exhibits anti-asthmatic properties [51-58].

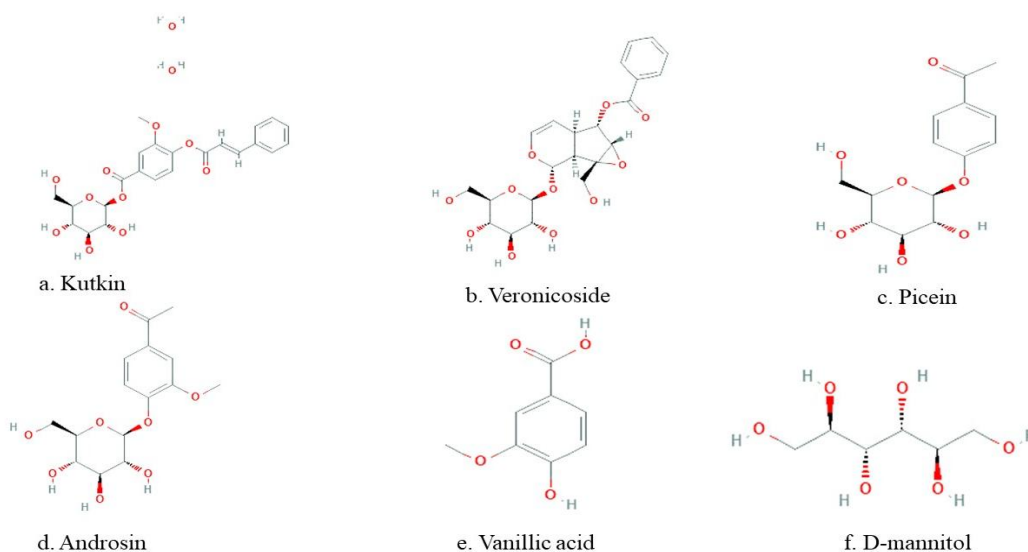


Figure 2. Chemical Structures of some of phytochemical constituents of *Picrorhiza kurroa*

Traditional and Modern View

a. Ayurvedic View of *Picrorhiza kurroa*

Ayurveda mainly focus on maintaining the equilibrium of our three body components/doshas of the body i.e. kapha (water&earth), pitta (fire) and vata (space &air) [59,60]. *Picrorhiza kurroa* is a well-known medicinal plant which has a very rich history of its use in Ayurvedic medicine system. Its medicinal value has been mentioned in many Ayurvedic literatures like Nighantu, Caraka Samhita, Susruta Samhita, Astang Samgraha. It is useful in maintaining the kapha, Pitta dosha of the body. It is mainly used for treating digestion related problems, bilious fever, urinary discharge, hiccup, blood troubles, burning sensations, leucoderma, and jaundice [61-64]. Rasapanchak of *Picrorhiza kurroa* is given in table 3.

Table 3. Rasapanchak of *Picrorhiza kurroa* as per Ayurveda

Sanskrit/English	Sanskrit/English
Virya/Potency	Sheeta/Cold
Vipak/Metabolic property	Katu/Pungent
Guna/Physical property	Laghu/Light, Ruksha/Dry
Rasa/Taste	Tikat/Bitter

Properties and Uses of *Picrorhiza kurroa* as per Ayurveda [65,66]

Paachan sansthan: It acts as an appetizer and digestion enhancer when used in low dose. Also acts as an anthelmintic. It is used to treat anorexia and weak metabolism, liver related disorders and jaundice. It cleans the bowel. It treats constipation and bloating when used in high amounts. It stimulates the secretion of digestive juices. It softens the hard stool.

Rakatwah sansthan: It is used for heart related problems. It helps in regulating blood pressure. Also acts as a blood purifier. It reduces edema.

Shwasan sansthan: It has ant mucolytic properties. It is used to treat cough and asthma.

Mootrawah sansthan: It is antidiabetic agent.

Prajannan sansthan: It works on problems related to lactogenesis.

Twacha: It is useful in treating skin disorders.

Taapkram: It has antipyretic properties. It is used to treat malarial fever.

Saatmikaran: It provides nourishment when taken in small dose. It scrapes the endotoxins and fats out from the body. It is used to treat malnutrition and obesity.

Ayurvedic Formulations of *Picrorhiza kurroa*

Arogyavardhini gutika, Tiktaka ghrita, Laghumanjishthadi kwatha, Sarvajvarahara lauha are some important Ayurvedic formulations of *Picrorhiza kurroa* [67].

- Arogyavardhini gutika is pitta shamak which works on secretion of bile. It improves the digestion and functioning of liver [68].
- Tiktaka ghrita is a polyherbal formulation made up many medicinal plants like *Trichosanthes dioica*, *Azadirachta indica*, *Picrorhiza kurroa*, *Alhagi pseudalhagi*, *Fumaria indica*, and *Gentiana kurroo*, *Cyperus rotundus*, *Andrographis paniculata*, *Holarrhena antidysenterica*, and *Piper longum*. This formulation is effectively used against skin diseases, wounds, inflammation, piles, sinus, etc. [69].
- Laghumanjishthadi kwatha is another important polyherbal formulation made up of Manjishtha, Triphala, Kutki, Vacha, Daruhaidra, Haridra, Gudduchi and Nimba which is used as ablood purifier and kaphaghna and kledaghna [70].
- Sarvajvarahara lauha is an efficient Ayurvedic iron formulation which is used to treat iron deficiency anemia. It significantly increases the Hb regeneration [71].

Folk View

There are so many different cultures around the world which use variety of plants in their own way to treat several diseases. Medicinal plants are of great importance in folk cultures and they are associated with rich ethnobotanical uses. Ethnobotany is the term related with the association of human cultures with the plants. Plants are used for so many purposes like for food, shelter, medicine, divination etc. There are some strong cultural beliefs associated with many plants due to which they are worshiped [72]. *Picrorhiza kurroa* L, Kutki is one such plant which is used for health maintenance purpose by many folk cultures. For instance,

it is used as a traditional remedy for fever by Bhotiya tribal communities of Niti valley in Central Himalaya [73]. The Gaddi and Gujjar tribes of Himachal Pradesh, use kutki roots as an appetite enhancer. They use the kutki decoction along with ajwain as a remedy in skin infection to purify blood [74]. The rhizome powder of *Picrorhiza kurroo* L kutki is used traditionally in Hamirpur district of Himachal Pradesh as a cure to liver related problems and jaundice [75]. The roots, rhizome and flowers of kutki are used to treat fever and are used as blood purifier in North region of Himachal Pradesh especially in Lahaul and Spiti [76]. In Pangi Himachal Pradesh, people use rhizomes in the treatment of cold and cough where as they use decoction as a blood purifier and dried powder as a pain killer [77]. In Kashmir, the tribal people of Kupwara district use kutki rhizomes and roots as a tonic, laxative and stomachic when their powder form is boiled in water [78]. In Gurez region of Kashmir, the root powder is used traditionally for treating liver related problems like jaundice [79]. In Grahwal Himalayas, this plant is traditionally used to cure chronic dysentery, asthma, dyspepsia, hepatic derangement, and jaundice. It also used as diuretic antipyretic, muscle relaxant, antistress, anti-inflammatory, analgesic, and CNS depressant [80]. In West Sikkim, the root paste of kutki is used traditionally to cure cuts, injuries and wounds [81]. The traditional practitioners, Jhankri, Bijuwa and Phedangma in Darjeeling Himalaya use rhizome of kutki against fever, cold and snake bite [82,83]. In Rawain valley, Uttarkashi people use roots of this plant in treating fever, typhoid, jaundice, stomachache [84]. In Gharwal Himalayas, root powder mixture of *Cassia angustifolia* Vahl, *Picrorhiza kurroo* L, *Trachyspermum ammi* is used traditionally as a remedy for itching. People also used paste of sarson oil and boiled fruits of Kutki externally against itching [85]. The dried roots are traditionally used to treat malarial fever chronic fever, and problems related to respiration in Rangit

Valley, South Sikkim [86]. In some areas of Sikkim, people use extract of fresh leaves to treat jaundice and they use root decoction as an appetizer [87]. In Uttarakhand, the decoction of dried roots of kutki with black pepper and honey is used traditionally for the treatment of fever, dysentery, jaundice, stomachache [88,89]. In Devikund, the fever is treated by root extract of *Picrorhiza kurru* [90]. People of Arawali Hills, use rhizome powder of this plant to kill pinworms [91]. In Asi Ganga sub-basin, Western Himalaya, people administer roots extract or powder orally to treat fever, jaundice, pain, and dysentery [92]. The tribal people of Sikkim and Darjeeling use *Picrorhiza kurru* rhizome to treat diabetes [93]. In North Sikkim people use rhizome either its decoction or powder to treat heart related issues, urinary disorders, piles, malarial fever, body ache. They use it as a tonic in anemia and constipation [94]. In folk medicine practices of some regions of Sikkim, roots and rhizomes of *Picrorhiza kurru* are being used to treat fever, cough and asthma [95]. In Ladhak, roots of kutki are used against stomachache [96]. The Sherpas of Helambu, Central Nepal use kutki roots against fever. They also used roots as an appetizer and a bitter tonic [97]. The traditional healers of limboo tribe in south-west of Khangchendzonga biosphere reserve, Sikkim use dried rhizome of kutki against variety of diseases like fever, dysentery, cough, cold, dysentery, headache, throat pain, stomachache [98]. The traditional healers of Parvathi Valley, use roots of this plant as a remedy to abdominal pains. They use leaf drops against nose bleeding [99]. In Tungnath - Chopta region, kutki is used to treat fever [100]. People use extract of dried root of *Picrorhiza kurru* in the treatment of fever, dyspepsia in Darjeeling district of West Bengal [101].

Modern View of *Picrorhiza kurroa*

The global and domestic markets of herbal drugs are growing increasingly nowadays because people have inclined more towards herbal products [102]. But due

to great market demand, these natural products are getting adulterated or contaminated directly or indirectly in order to derive maximum benefit [103]. Adulteration and contamination directly affects the quality of herbal drugs [104]. Species adulteration in the global herbal drug industry has been observed for a long time [105,106]. For instance, *Picrorhiza kurroa* is being adulterated with many other plants such as *Gentiana kurroo* Royle (trayamana), *Plectranthus amboinicus*, *Helleborus niger* L., *Neopicrorhiza scrophulariiflora*, *Actaea spicata* L., *Cimicifuga foetida* L., *Coptis teeta* Wall., *Coscinium fenestratum*, *Sorbus cashmiriana* Hedl., *Delphinium zalil*, *Delphinium saniculifolium* Boiss., *Ficus heterophylla* L.f., *Thalictrum foliolosum* DC., *Gentianella moorcroftiana*, *Lactoris cashmiriana* (Royle ex Benth.). These plants are sold out in the market samples of the *Picrorhiza kurroa* [107,108]. These adulterated herbal products have adverse effects on the consumer health [109]. These alterations should be detected by proper standardization and quality analysis techniques. WHO guidelines for standardized of herbal products must be implied to ensure the quality, safety and efficacy of drugs herbal medicines [110].

Therapeutic Uses of *Picrorhiza kurroa* Anti-microbial

Antimicrobial potential of *Picrorhiza kurroa* was evaluated by Usman et al. They conducted an *in-vitro* study on bacterial strains i.e *Bacillus subtilis* and *Staphylococcus aureus* gram positive bacteria and *Pseudomonas aeruginosa* and *Escherichia coli* gram negative bacteria and *Aspergillus niger*, *Candida albicans* and *Malassezia furfur* fungal strains. It was observed that ethanolic extract of this plant showed efficient action against all the used strains of microbes which suggests its use as an anti-microbial [111]. Antimicrobial activity of *Picrorhiza kurroa* was also investigated by Sharma et al. It was observed that methanol extract showed more potent actions against bacterial strain

(*E. coli*, *B. subtilis*, *S. aureus*) than antibacterial drug ciprofloxacin and aqueous extract was found to be more effective against fungal strain (*A. niger*, *C. albicans*) than Fluconazole which is a standard antifungal drug [112].

Anti-asthmatic

As per the report of Sehgal et al., *in-vivo* and *in-vitro* study, *Picrorhiza kurroa* is associated with anti-asthmatic properties. They used guinea pig models for the study. For *in-vivo* study histamine was used to induce broncho-constriction in the models. It was revealed from the study that ethanolic extract of the roots showed protective actions. Whereas for *in-vitro* study same extract was studied on isolated guinea pig ileum. Protective actions of ethanolic extract were observed which demonstrated that *Picrorhiza kurroa* is associated with anti-asthmatic properties [113].

Anticancer

Rajeshkumar et al., conducted an *in-vivo* study on BALB/c mice models for the evaluation of anti-cancer activity of *Picrorhiza kurroa*. Sarcoma was induced by 20- methylcholanthrene (20- MC) in models and papilloma formation was initiated by 7,12- dimethylbenz[a]anthracene (DMBA) in the models. The oral administration of picroliv (100 and 200 mg/kg, p.o) showed inhibitory actions against 20- MC and DMBA by decreasing sarcoma and papilloma. This study suggested that picroliv is a potent anti-cancer agent [114].

Anti-oxidant

Kalaivani et al., conducted an *in-vitro* study to evaluate the anti-oxidant and free radical scavenging potential of *Picrorhiza kurroa*. It was observed that ethanolic extract of this plant showed significant anti-oxidant properties due to the presence of flavonoid and phenolic compounds [115].

Anti-mutagenic

As per the reported study conducted by Zabeti et al., hydroalcoholic extract of *Picrorhiza kurroa* is associated with anti-mutagenic actions. It was found that hydroalcoholic extract exhibited inhibitory actions against *Salmonella typhimurium* MTCC 1251 and MTCC 1252 strains by direct acting mutagen of sodium azide [116].

Immunomodulatory

As per the Hussain et al., *in-vivo* study report *Picrorhiza kurroa* is associated with immunomodulatory activities. The study was carried out on immunosuppressed mice models. Cyclophosphamide was induced in the models for immunosuppression. The study concluded that the alcoholic plant extract is significantly works on enhancement on immunostimulant activities [117].

Anti-inflammatory

An *in-vivo* study carried out by Kumar et al., on rat models to evaluate the Anti-inflammatory activities of *Picrorhiza kurroa*, suggested that this plant is a potent source of anti-inflammatory drug. In the study models were administered with carrageenan for inducing paw edema and implanted with cotton pellet for inducing granuloma formation. Rhizome extract of *Picrorhiza kurroa* in a dose dependent manner effectively worked on the inhibition of carrageenan-induced paw edema and cotton pellet-induced granuloma formation. It was also observed that there was reduction in levels of inflammatory cytokines (TNF- α , IL-1 β , IL-6) which is accompanied with increase in anti-inflammatory cytokine (IL-10) level in the serum and peritoneal macrophages [118].

Hepatoprotective

Hepatoprotective activity of *Picrorhiza kurroa* was investigated by Shetty et al., on male Wistar rat models. Models were fed with 30% high fat diet for 2 weeks for inducing non-alcoholic fatty

liver disease (NAFLD). The administration of hydroalcoholic extract for 4 weeks at the dosage of 200mg/kg and 400 mg/kg b.i.d., p.o. showed potent hepatoprotective actions by restoring all the changes in the liver induced in the liver^[119].

Anti-diabetic

Hussaain et al., conducted an *in-vivo* study on rat models to investigate the anti-diabetic potential of *Picrorhiza kurroa*. The models were administered with streptozotocin nicotinamide to induce diabetes mellitus. The oral administration of standardized aqueous extract effectively helped in restoring all the changes induced by streptozotocin nicotinamide which suggests *Picrorhiza kurroa* use as an anti-diabetic agent^[120]. Some reported pharmacological studies are summarized in table 4.

CONCLUSION

Medicinal herbs are the significant segment of healthcare systems. They are being used to treat various ailments. Medicinal plants are the promising source of discoveries of new drugs. *Picrorhiza kurroa* is a well-known perennial medicinal plant which is used in Ayurveda for as a remedy for liver and digestion related problems. It is used as main ingredient in many Ayurvedic polyherbal formulations. It commonly used plant in folk systems around the world for curing malaria, jaundice, typhoid, stomache, itching etc. It is used as a blood purifier in some folk practices. The active principle constituent of this plant exhibits many therapeutic properties. His plant is associated with therapeutic properties like antimalarial, antidiabetic, hepatoprotective, anticancer, anti-mutagenic, anti-inflammatory, immunomodulatory etc. The phytochemical constituents of this unique plant can be served as chemical entities for the new drugs in future.

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