Annals of Phytomedicine 6(1): 63-67, 2017
DOI: 10.21276/ap.2017.6.1.9 ; Print ISSN : 2278-9839 and Online ISSN : 2393-9885
Ann. Phytomed., 6(1):63-67 (2017)

Original article

Picrorhiza kurroa Royle ex Benth. A plant of diverse pharmacological potential

Phalisteen Sultan, Shahid Rasool* and Qazi Parvaiz Hassan
Microbial Biotechology Division, CSIR-Indian Institute of Integrative Medicine, Sanatnagar, Srinagar-190005, Jammu and Kashmir, India
**Genetic Resources and Agrotechnology Division, CSIR-Indian Institute of Integrative Medicine, Canal Road, Jammu-180001, Jammu and Kashmir, India*

Received May 1, 2017: Revised June 6, 2017: Accepted June 11, 2017: Published online June 30, 2017

Abstract

Amongst many useful herbs, *Picrorhiza kurroa* Royle ex Benth. is considered a bitter drug, used in treating liver disorders since antiquity. A bitter extract of *P. kurroa*, rich in iridoid glycosides has hepatoprotective, anticholestatic, antioxidant, anti-inflammatory and immune modulating activities. In an effort to explore possibilities for future use of some useful herbal formulations, often some important herbs are ignored, one such plant is *P. kurroa*. Thus, an effort has been made in reviewing the available literature about the plant in the most common texts which would provide an insight for the use of this herb against various diseases like disorders of the liver, upper respiratory tract and more recently against hyperlipidemia. Hyperlipidemia mostly contributes to the prevalence and severity of coronary heart diseases and treatment of these diseases using herbal formulations is cheap and easily available. The possible mechanism suggested and proposed for this hypothesis demonstrates that *P. kurroa* improves gall bladder secretions, thus helping in the digestion and metabolism of fats and it thus becomes very effective in regulating fat metabolism in the liver.

Key words: *Picrorhiza kurroa* Royle ex Benth., ayurveda, therapeutic, herbal sources

1. Introduction

Picrorhiza kurroa Royle ex Benth. (Scrophulariaceae), commonly known as 'Kutki", is high value medicinal plant that grows in the north western Himalayan region from Kashmir to Kumaun, Garhwal and Sikkim regions in India at an altitude of 3000-4500 above mean sea level (msl). The name, *Picrorhiza* is derived from the bitter root, where "picros" means bitter, while "rhiza" means root. The *Picrorhiza* species belongs to the genus, *Picrorhiza* are characterized into two species, *P. kurroa*, found mainly in dry western Himalayas and *P. scrophulariflora* found in the moist eastern Himalayas (Bantawa *et al*., 2011). The genus has attracted great interest in the recent past and the possible role of *P. kurroa* formulations in many chemical and pharmacological investigations has been revealed. Medicinal plants play a leading role in hypolipidemic activity and various herbal formulations are investigated. The major advantages of herbal treatment are effectiveness, safety and acceptability.

P. kurroa is highly threatened plant species, not cultivated largely being endemic to alpine Himalayan mountains. In view of high pharmacological impotance and lack of proper cultivation strategy of such useful medicinal plant, which yields clinically proven hepatoprotective and immune modulating glycosides in its underground parts (Anonymous, 2007; Gupta *et al*., 2006), an effort has been initiated for its conservation by conventional and biotechnological approaches.

Figure 1: *Picrorhiza* cultivation in natural habitat and IIIM gene bank.

Author for correspondence: Dr. Qazi Pervaiz Hassan
Senior Scientist, Microbial Biotechnology Division, CSIR-Indian Institute of Integrative Medicine, Sanatnagar, Srinagar-190005, Jammu and Kashmir, India.
E-mail: qphassan@iiim.ac.in; pervaizqazi@yahoo.com
Tel.: +91-9596050105

P. kurroa contains 'kutkin' which is mixture of gylycosides such as picroside I and II (Kumar *et al*., 2001). Iridoids are the major class of compounds found in *P.* kurroa. Iridoid found in medicinal plants, are responsible for some of their pharmacological activities. Iridoids are found mainly in plant subclass like Ericaceae, Rubiaceae, Scrophulariaceae, Valerianaceae, and Menyanthaceae. In the plants of the genus, *Picrorhiza*, kutkoside and kutkin are present which are known to be the mixture of picroside I and picroside II (Tiwari *et al*., 2012). Iridoids exhibit a wide range of biological activities like cardiovascular, hypoglycemic, antihepatotoxic, analgesic, choleretic and anti-inflammatory activities. In the present communication, we have described detailed botanical description, growth, distribution, phytochemical and pharmacological importance and conservation efforts done in this high value medicinal herb, *P. kurroa* and its effective role in treatment of various diseases like hepatoprotective disorders.

1.1 Description of the plant

P. kurroa is a perennial herb (Rasool *et al*., 2016). The roots of *P. kurroa* are hard, about 6-10 inches in length. The leaves are 5 to 15 cm long, oval in shape, coarsely toothed. The flowers are white or pale purple on a long spike, blooming in June through August. Flowers are about 8 mm, 5 lobed in the middle and with much longer stamens. The fruit is small 1.3 cm long, pale or purplish blue in colour and oval in shape .

1.2 Seed production

A breakthrough was achieved with regard to viable seed production at relatively lower elevation (1300 above msl) at IIIM Srinagar gene bank under protected conditions in polyhouse (Figure 2). Time of planting was standardized so that seed development took place before onset of summer which is not favourable for seed development under the subtropical conditions.

1.3 Origin

In India, It is found mainly in Himalayan region from Kashmir to Sikkim.

1.4 Parts used

The main part which is generally used is the root/rhizome.

1.5 Main uses of kutki is referred in liver diseases

Liver is the largest gland of our body which carries about 500 functions of our human system. But due to our sedentary lifestyle and dietary habits, our liver gets affected by several diseases like cirrhosis of liver, jaundice, hepatitis B, gall bladder stones, *etc*. Kutki is mainly known for its hepatoprotective properties, jaundice, bile disorders and other ailments of liver (Lee *et al*., 2008).

1.6 Morphology of the plant

The plant is small (about 10-20 cm in height), hairy, perennial herb and its flowering time is from July-August. Leaf surface is covered with two kinds of glandular hair, and the stoma is anomocytic type. Moreover, the leaf is isolated and different from most of alpine plant. Leaves are basal, alternate, acuminate, serrate, stalked, winged, oblanceolate or narrowly spathulate, each leaf is 2-6 cm long and 0.5-1.2 cm wide, usually 10-20 per rosette; serrate in upper half; surfaces glabrous or sparingly short-glandular-hairy. The rhizome of this perennial herb is long, externally grayish brown, surface rough due to longitudinal wrinkles and bitter taste (Anonymous, 2007). Stem is small, weak, creeping, erect at flowering, leafy and slightly hairy (Anonymous, 2008). Rhizomes are joined and zigzag, cylindrical, irregularly curved with branching and rooting at the jointed nodes. The roots are wrinkled, grayish to brown in appearance (Kar, 2007). Root stacks are irregularly curved and thick as the little fingers (Kirtikar and Basu, 1999). Large numbers of aerenchymas are distributed widely in leaf, aerial stem and rhizome (Liu *et al*., 2010).

Leaves are basal and alternate with terminal spikes 6-10 cm in length. In the flower, calyx generally 5 in number with 10 mm long corolla. Flowers are dark blue purple, the flowering time is July-August. The flowers are found in a dense terminal spikes arising from a rosette of conspicuously toothed leaves, flowering occurs in one or two phases depending upon altitude of the growing site. Under relatively lower elevation of 2500-3500 above msl, the first phase starts in 1st week of May and continues up to 3rd week of June and the second flowering begins in August and continues up to end of September. In alpine regions (>4000 m), flowering occurs only once in July-August and seeds develop in September. Flowers are purple coloured, bisexual and having convex thalamus. Fruits are capsule and 6-10 mm in size, and ovoid, swollen. Seeds are pale brown in colour, and reniform and 1 x 0.8 mm in size, the fruiting time is October-November. The extremely small sized seed is 1.3 x 1 mm in size.

1.7 Microscopic characteristics of *P. kurroa*

The rhizome consists of cork cambium, cortex, primary cortex persists in some cases having one or two small vascular bundles and secondary xylem having vessels, tracheids, xylem fibers.

1.8 Distribution of *P. kurroa*

This plant is mainly found in the Himalayas from Kashmir to Sikkim at an elevation of 2700-4500 above msl. Its rhizome are generally used in the Tibetan and Chinese traditional medicine to treat various ailments like liver disease, fever, asthma, jaundice and also have pharmaceutical properties as hepatoprotective, anti-asthma activities (Chin *et al*., 2006; Bantawa *et al*., 2011). CSIR-Indian Institute of Integrative Medicine has developed a germplasm base of this medicinal plant at our farms for standardization of agrotechnology protocols. Germplasm collections from different high altitude geographical regions of Kashmir Himalyas have been made. The plants were transplanted for establishment of a germplasm base of these core collections at our plant gene bank at IIIM Experimental field station, Bonera, IIIM experimental field station, Yarikha (Gulmarg) and IIIM, Srinagar.

1.9 Roots and rhizomes

Young roots generally have single layered epidermis, some epidermal cells are elongate forming unicellular hairs, hypodermis single layered, cortex is 8-14 layered, oval to polygonal, thick walled, parenchymatous cells, primary stele tetrarch to heptarch, enclosed by single layered pericycle, thick-walled cells of endodermis, mature root shows 4-15 layers of cork, 1-2 layers of cork cambium, secondary phloem poorly developed, secondary xylem consisting of vessels, tracheids, parenchyma and fibers, vessels have varying shape and size, some cylindrical with tail like, tapering ends, some drum shaped with perforation on end walls or lateral walls, tracheids are cylindrical with tapering pointed ends, fibers aseptate, thick-walled, lignified with tapering blunt with pointed ends (Figure 2).

Figure 2: Vigorous growth of roots of *P. kurroa* plants.

1.10 Active constituents of *P. kurroa*

It contains a 'bitter principle' which is a mixture of two molecules, the irioid glycosides known as picroside I and picroside II (picroside II also being called kutkoside) and the mixture overall is then called kutkin, used in various herbal drug formulations, mainly as strong hepatoprotective and immune-modulatory compound. Iridoid glycosides having an epoxy moiety present in the cyclopentane ring. *P. kurroa* is used mainly for the treatment of liver disorder, gastrointestinal and urinary disorders.

1.11 Herbal formulations of *P. kurroa*

Arogyavardhini gutika is a formulation mainly used for skin diseases and blood disorders like jaundice, anemia and useful in poor appetite. Mahatikataka ghrita is a formulation used for all chronic skin diseases that are deep in the plasma, blood and muscle tissue with red eruptions and itching.

1.12 Applications and uses of *P. kurroa*

1.12.1 Traditional uses

This plant is used as Svasa, Daha, Jvara, Kamala, Kustha and Arocaka (Elizabeth, 2002).

1.12.2 Modern uses

The dried roots and rhizomes are used as hepatoprotective, anti-asthemic, immunomodulatory agent particularly for liver disorders and jaundice, fever, dysentery and diarrhea (Anonymous, 2007). It is also useful in epilepsy, cough, swollen piles, leucoderma, ascites (Rasool *et al*., 2016).

1.12.3 Scientific studies done on genus *Picrorhiza*

Transverse section of *Picrorhiza*, rhizome shows important parts like cork, cambium, cortex, endodermis, xylem, phloem, pith, starch grains, pigment cells, and cortical parenchyma by microscopic studies (Meena *et al*., 2010) .

1.12.4 Quantitative study

The two iridoid glycosides kutkoside and picroside-I found in *P. kurroa* are the main active principles. In *P. kurroa*, picroside I and II are the active ingredients responsible for its different medicinal properties. These chemical constituents vary according to different plants at different altitudes and this is analyzed by HPLC studies. The plants collected from the lower altitude contains less picroside content as compared to plants collected from higher altitude (Katoch, 2011). For the quantification of these phytoconstituents, a precise and rapid thin-layer chromatography (TLC) method was developed.

1.12.5 Pharmacological studies

1.12.5.1 *Immunomodulatory activity*

The effect of an ethanolic extract of each drug was studied on delayed type hypersensitivity, humoral responses to sheep red blood cells, skin allograft rejection, and phagocytic activity of the reticuloendothelial system in mice.

1.12.5.2 *Antiarthritic activity*

Open-label studies conducted in India show a preliminary benefit for persons with primarily rheumatoid arthritis.

1.12.5.3 *Hypolipemic activity*

A hypolipemic activity of *P. kurroa* was observed in a high fat diet feeding mouse. Liver weight, serum aspartate transferase (AST), alanine transferase (ALT), low density lipoprotein (LDL),

triglyceride and total cholesterol levels were significantly reduced by the treatment. On the contrary, serum HDL level seems not affected by *P. kurroa* water extract (Lee *et al*., 2008).

1.12.5.4 *Anti-inflammatory activity*

Apocynin concentration dependently inhibited the formation of thromboxane A2, whereas the release of prostaglandins E2 and F2α was stimulated. Apocynin inhibited arachidonic acid induced aggregation of bovine platelets, possibly through inhibition of thromboxane formation. The rhizome of *Picrorhiza* is used to treat inflammatory diseases as a traditional medication (Singh *et al*., 1993).

1.12.5.5 *Hepatoprotective activity*

Plant is a potent immuno-stimulant of both cell mediated and hormonal immunity. *P. kurroa* is also useful in treatment of asthma. Isolated compounds from *P. kurroa* have also been shown to have hepatoprotective activity. Non-alcoholic fatty liver disease (NAFLD) in rats was cured by giving standard hydro-alcoholic extracts of *P. kurroa*. It reduced the lipid content of liver significantly at the dose of 400 mg/kg (Shetty, 2010).

1.12.5.6 *Antidiabetic activity*

Extract of *Picrorhiza* was found to lower blood glucose in laboratory animals. Chronic administration of the extract significantly reduced blood sugar in alloxan-induced diabetic rats for 10 days. The extract was also used to reduce the increased blood urea nitrogen and serum lipid peroxides in alloxan-induced diabetic animals and to inhibit the body weight reduction and leukopenia induced by alloxan administration (Joy and Kuttan., 1999).

In the streptozotocin induced diabetic rats, treated with a gavage of ethanol extraction of *Picrorhiza* herbal formulation. It reduced NADPH - oxidase dependent superoxide generation and decreased expression of malondialdehyde and advanced oxidation protein products in diabetic kidney. So, extraction of *Picrorhiza* improves diabetic nephropathy through inhibition of redox sensitive inflammation (He *et al*., 2009).

1.12.5.7 *Toxicity study*

Picrorhiza is not readily water soluble but soluble in ethanol. The bitter taste makes tinctures unpalatable. So, it is usually given as kutkin encapsulated powder extract. In India, no adverse effects of *Picrorhiza* root extracts have been reported.

1.12.6 Therapeutic uses, benefits and claims of *P. kurroa*

The traditional uses of *P. kurroa* include treatment of a wide range of conditions, including fevers, chronic diarrhea, constipation, dyspepsia and jaundice. Animal studies have shown that *P. kurroa* has a powerful antioxidant and anti-inflammatory effect. *P. kurroa* is thought to be helpful as a remedy for a number of auto-immune diseases such as vitiligo and psoriasis. Research also indicates that *P. kurroa* may be of therapeutic value in treating viral hepatitis and that some constituents of *P. kurroa* may protect against liver damage due to Amanita mushroom poisoning. Studies have shown that the curcubitacins in *P. kurroa* are highly cytotoxic and have antitumor actions and that it may reduce blood cholesterol levels and reduce coagulation time. Furthermore, studies of the rhizome was shown to boost the immune system and to have a specific action against the parasite, *Leishmania donovani*, which causes the tropical parasitic disease called leishmaniasis.

1.12.6.1 *Side effects and possible interactions of P. Kurroa*

Picrorhiza root extracts are widely used in India with no adverse effects being reported. Keep in mind that herbs may still produce side effects or may carry some element of risk (although side-effects and risks are generally less common and serious than in synthetic drugs). It is essential to consult your health care professional when altering medications and you should thoroughly investigate how your medications may interact with each other. Any applicable precautions and contraindications should be clearly understood. The nodal explant segments and callus with induced buds from 2.5 mg^{-l} BAP and 2,4-D treated media, respectively were excised after 10-12 days and sub-cultured thrice in the same media for large regeneration under aseptic conditions.

1.12.6.2 *Preparation of extracts*

The rhizomes and leaf samples were taken from all the seven accessions, grown at three different locations, *viz*., gene bank, IIIM, Srinagar, field Station Bonera (Pulwama) and Yarikha (Gulmarg), Jammu and Kashmir, India. The air dried plant material was finely powdered and stored at 4^0C. A known quantity of finely powdered sample was weighed into a 250 ml conical flask and subjected to sequential cold extraction using methanol and water in the ratio of 1:1 as extraction solvents while stirring at room temperature. Contents of the flask were squeezed through muslin cloth and the filtrate from aqueous extract was filtered using Whatman filter paper. The extraction process was repeated thrice (two to three hrs. stirring each time). The extracts from each of the sample were evaporated under reduced pressure to give residues in different amounts.The yield of the extract was approximately 10%. Extract was suspended in HPLC grade methanol in preparatory tubes (5 ml) and used for all experiments (Sultan *et al.*, 2016).

2. Discussion

The prime objective of the study was to highlight the pharmacological properties of *P. kurroa*. Although, iridoid glycosides are potential chemical markers in *P. kurroa* apparently but they occur sporadically within each genus.Many reports highlight, *Picrorhiza kurroa* due to its use in the Ayurvedic and Chinese system of medicine. Roots of *P. kurroa* have given a number of iridoids of which the main are I and II. Plant samples from different regions were analyzed and the occurrence of the iridoid compounds was confirmed by a combined set of criteria including retention time, mass spectra of both positive and negative mode. All major peaks that could be recognized as iridoids were taken into consideration. The results were summarized and compared with the previous reports for isolation and spectral identification of iridoids from the studied species. Keeping in view the high importance of this species in a traditional and modern system of medicine, efforts must be taken to safeguard its diversity and genetic base using both conventional and biotechnological approaches.

Conflict of interest

We declare that we have no conflict of interest.

References

Anonymous, (2007). The Ayurvedic Pharmacopoeia of India. Part-I, Government of India, Ministry of Health and Family Welfare Department of Ayush, **2**:91-93.

Anonymous, (2008). Agrotechniques of some selected medicinal plants. National Medicinal Plants Board, Department of AYUSH, Ministry of Health and Family Welfare, Government of India.

Bantawa, P.; Ghosh, S,K.; Bhandari, P.; Singh, B.; Mondal, T. and Ghosh, P.D (2011). Micropropogation of an elite line of *Picrorhiza scrophulariiflora*, Pennell: An endangered high valued medicinal plant of the Indo China Himalayan region. Medicinal and Aromatic Plant, Science and Biotechnology, **4**(1):1-7.

Chin, Y.W.; Balunas, M.J.; Chai, H.B. and Kinghron, A.D. (2006). Drug Discovery from Natural Sources. AAPS Journal, **28**:132.

Elizabeth, W.M. (2002). Major herbs of Ayurveda. The Dabur Research Foundation and Dabur Ayurvet Limited, pp:220-222.

Gireesha J., and Raju, N.S. (2016). Phytochemical analysis, antibacterial and antioxidant potential of *Acronychia pedunculata* (L.) Miq. Ann. Phytomed., **5**(2):147-151.

Gupta, A.; Khajuria, A.; Singh, J., Bedi, K.L.; Satti, N.K.; Dutt, P.; Suri, K.A.; Suri, O.P. and Qazi G.N. (2006). Immunomodulatory activity of biopolymeric fraction RLJ-NE-205 from *Picrorhiza kurroa*. Int. Immunopharmacol., **6**:1543-1549.

He, L.J.; Liang, M.; Hou, F.F.; Guo, Z.J.; Xie, D. and Zhang, X. (2009). Ethanol extraction of *Picrorhiza scrophulariiflora* prevents renal injury in experimental diabetes *via* anti-inflammation action. Journal of Endocrinology, pp:347-355.

Joy, K.L. and Kutten, R. (1999). Antidiabetic activity of *Picrorhiza kurroa* extract. Journal of Ethnopharmacology, **67**(2):143-148.

Kar, A. (2007). Pharmacognosy and Pharmacobiotechnology. New Age International Publishers, pp:196-197.

Katoch, M.; Fazil, I.S.; Suri, K.A.; Ahuja, J. and Oazi G.N. (2011): Effect of altitude on picroside content in core collections of *Picrorhiza kurroa* from the north western Himalayas. Journal of Natural Medicine, **65**:578-582.

Kirtikar, K.K.; Basu, B.D. (1999). Indian Medicinal Plants, 2nd Edition. International Book Distributors, pp:1824-1826.

Kumar, S.; Devaki, T. and Kumar, M. (2001). Cardioprotective effects of *Picrorhiza kurroa* against isoproterenol - induced myocardial stress in rats. Fitoterpia, **72**:402-405.

Lee, H.S.; Yoo, C.B. and Ku, S.K. (2008). Hypolipemic effect of water extracts of *Picrorhiza kurroa* in high fat diet treated mouse. Fitoterapia, **77**(7-8):579-84.

Liu, X.L.; You, C.; Yang, Y.W.; Zhang, L. and Qian, Z.G. (2010). Anatomy and adaptation to environment study of endangered alpine medical plant, *Neopicrorhiza scrophulariiflora* Zhong. Yao. Cai., **33**(4): 507-510.

Meena, A.K.; Rao, M.M. and Krishna, C.M. (2010). Evaluation of phamacognostic and physicochemical parameters of *Picrorhiza kurroa* Royle ex Benth. International Journal of Ayurvedic Medicine, **1**(1):41-47.

Mulliken, T. C. (2008). Review of the status, harvest, trade and management of seven Asian CITES- listed medicinal and aromatic plant species. Federal Agency for Nature Conservation, pp:61-64.

Rasool, S.; Khan, M.H.; Hamid, S.; Sultan, P.; Qazi, P.H. and Butt, T (2016). An overview and economical importance of few selected endangered medicinal plants grown in Jammu and Kashmir region of India. Ann. Phytomed., **5**(2):27-37.

Singh, G.B.; Bani, S.; Singh, S.; Khajuria, A.; Sharma, M.L.; Gupta, B.D. and Banerjee, S.K. (1993). Anti-inflammatory activity of the iridoids Kutkin, Picroside-1 and Kutkoside from *Picrorhiza kurroa*. Phytother. Res., **7**:402-407.

Sultan, P.; Jan, A. and Qazi, P. (2016). Phytochemical studies for quantitative estimation of iridoid glycosides in *Picrorhiza kurroa* Royle. Botanical Studies, **57**:7.

Shetty, N.S.; Mengi, S.; Vaidya, R. and Vaidya. A.D. (2010). A study of standardized extracts of *Picrorhiza kurroa* Royle ex Benth in experimental non alcoholic fatty liver disease. Journal of Ayurveda and Integrative Medicine, **1**(3):203-210.

Tiwari, S.S.; Pandey, M.M. and Rawat, A.S. (2012). TLC densitometric quantification of picroside (picroside-I and picroside-II) in *Picrorhiza kurroa* and its substitute *Picrorhiza scrophulariiflora* and their antioxidant studies. Biomedical Chromatography, **26**(1): 61-68.