DISTRIBUTION AND COLLECTION PATTERN OF *PICRORHIZA KURROOA* MEDICINAL PLANT SPECIES OF NEPAL

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ABSTRACT

Medicinal flora is one of the important natural resources of Nepal. *Picrorhiza kurrooa* (Kutki) is a well-known medicinal herb found in high mountain of Nepal. The Kutki rhizomes have been widely used to cure indigestion problems in traditional medication systems. Very less information is available on its distribution and collection patterns, particularly from high mountain of mid-western of Nepal till date. The present research aimed to explore the distribution of Kutki and assess its collection pattern in Nepal. Primary data were collected through direct field survey and key informant interview. A total of 63 plots with each plot size of 5m×5m were laid out in the field to collect data. The stratified systematic sampling with sampling intensity 0.01% was adopted for distribution survey. The results revealed no significance difference in mean number of Kutki with respect to aspect ($p>0.05$), whereas there is significance difference in mean number of Kutki with respect to elevation ($p<0.05$). The distribution of Kutki was recorded between 3750m lower plot and 4831m at higher plot. The Important Value Index of Kutki was found 113.59 with relative frequency of 34.44%. The highest density of Kutki (7476.92 per hectare) was found on eastern aspect. Male participation was found higher than the female for collection of Kutki. Scientific harvesting technique should be adopted for sustainable management of Kutki in the study area.

Keywords: Important Value Index, medicinal flora, high mountain, Nepal, *Picrorhiza kurrooa*.

INTRODUCTION

Nepal's biodiversity is a reflection of its unique geographic position and variations in altitude and climate. The country's 35 forest types and 118 ecosystems are home to over 2% of the world's flowering plants, 9 percent of the world's bird species, 4 percent of the world's mammalian species, and an estimated 7,000 species of higher value plants-making Nepal the twenty-fifth most species-rich country in the world (Bhuju *et al.*, 2007; MoFSC, 2009). In Nepal, most of commercially used herbs from the country are wild, organic and natural, though not certified. About 3000 species of the MAPs are traded internationally, among which 2000 of them are particularly traded in the European country like German, Switzerland and France. Global import of the MAPs is raised by +3% since 2010

and reached in 2014 a volume of 673,564 tones that cost valued US\$ 2,724 million. The international market for MAPs is dominated by China, France, Italy, Germany, Japan, Spain, UK and USA (Schippmann *et al.*, 2006). The importance of MAPs is even higher in recent years with the expansion of global herbal market, as Vasisht *et al.*, (2016) estimated the annual trade of MAP materials to be US\$ 33 billion in 2014. Nepal's position in the center of the Himalaya enables it to host thousands of medicinal plants and is one of the major suppliers of MAPs to India since time immemorial. However, the quantification of trade had started few decades ago when Edwards (1996) estimated 10,000 tons of MAPs from more than 100 species was harvested from Nepal. Few years later, Olsen (2005); based on 1997/98 survey, estimated the export of 14500 tons of

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crude MAPs worth US\$ 16 million to India and China. Recently, using the UNCOMTRADE data, Ghimire *et al.*, (2015) estimated the export of 10770 tons of MAPs worth US\$ 60.09 million from Nepal.

Picrorhiza kurrooa Royle ex. Benth (family Scrophulariaceae) locally known as 'Kutki' is a medicinally revered perennial herb, distributed in the Himalayan region (Pakistan, India, Nepal, Bhutan and southern China) at an elevation ranging from 3000-5000m (Chettri *et al.*, 2005; Sah and Varshney 2013; Sah *et al.*, 2015). It has a long, creeping rootstock that is bitter in taste marked on its outer part with scaly leaves and cork exfoliates exposing in the black cortex and grows in rock crevices, moist and sandy soil, stony and grassy slopes and on the turf of glacial flats (Dutta *et al.*, 2007). *Picrorhiza kurrooa* is listed in Appendix-II of the Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES). This species is protected for reduction of *P. kurrooa* according to Protection act and its Regulations (Health Canada, 2015). The maximum richness of medicinal plants was found at an elevation of 1100m but the maximum numbers of protected areas were found at elevations between 3000-3500m. This plant is uprooted from its natural habitat mature roots and rhizomes. More than 90% of its annual demand is fulfilled from the wild sources. Total 300 to 400 individual plants should be uprooted to get 1 kg dry weight of underground parts from this plant (Uniyal *et al.*, 2011). Now the size of the wild population has been declining and being critically endangered as a result of overexploitation, habitat fragmentation, lack of organized cultivation practice, which reckless exploitation continues, therefore, this species has been listed as endangered species by international Union for Conservation of Nature and Natural Resources (Nayer and Sastri, 1990; Bantawa *et al.*, 2011). It has also been categorized among the 37 identified as top priority species for conservation and cultivation in Western Himalaya because of narrow distribution range, small population size and high use value.

Picrorhiza kurrooa is among one of the topmost traded 15 plant species in India in relation to their economic value and more than 10,000 kg of their marketing takes place only in the Delhi market. The prices of *P. kurrooa* varied in range of IRs. 220-340 /kg during 2007-10 which is hiked up to IRs.475/kg in 2016 in Indian market (Shitizet *et al.*, 2013; Anonymous, 2016). India contributed only about 70 tons of *P. kurrooa* supply in

context to global supply of 375 tons (excluding China and Pakistan) in their actual demand of 5000 tons annually which is mainly collected from Himachal Pradesh, Jammu and Kashmir, Uttarakhand and Sikkim to satisfy the demand of drug industries (Shitizet *et al.*, 2013). Hence, to fulfill the actual demands of 5000 tons and this is also going up year by year the study and conservation of *P. kurrooa* has become essential. A perusal of literature revealed that although *P. kurrooa* is very well known for its medicinal importance, but information regarding variability in active content (chemo-types) is scanty. Such information is essential in isolating better strains in terms of active content, understanding and further refinement of propagation. The perennial herb plant Kutki is used as official medicine and indigenous medicinal purpose. Nowadays, there is a revival of interest with herbal-based medicine due to the increasing realization of the health hazards associated with the indiscriminate use of modern medicine and the herbal drug industries is now very fast growing sector in the international market (Arya *et al.*, 2013). *P. kurrooa* has been demonstrated to possess multiple pharmacological activities such as Antiasthma-tic, Antioxidant, Anti-inflammatory, Anti-ulcer, Immunomodulatory, Anti-allergic, Anaphylactic, Antibacterial, Hepatoprotective, Immunomodulatory and Antidiabetic activity. (Vaghela *et al.*, 2015).

It has been estimated that about 90 percent of non-timber forest products (NTFPs)/MAPs are harvested from the wild. About 80 percentages of the value and volume in trade is occupied by 20 high demand and high value products, most of the wild origin. Further, half the traded amount is covered by the transaction of five highly-traded NTFPs (Olsen *et al.*, 2005). NTFPs are among the major exports of Nepal. Nepal itself is consuming herbal products on an annual increment of 20 percent (Ghimire *et al.*, 2008). Therefore, proper management, production and diversification of NTFPs and its derivatives in rural areas of Nepal can help alleviate poverty by creating income generating opportunities locally (Pyakurel *et al.*, 2011). Nepal is rich in terms of NTFPs resources with many products having industrial uses and potentials of exporting various levels of value added products. Medicinal plant has an important role in primary health care for local people livelihood whereas majority of household use medicinal plant for treating disorder and disease in Nepal. The fact that a wide range of such plant was collected at household levels mostly for domestic

consumption, some for sale (Hesaret *et al.*, 2013). Most of the rural populations are partially or fully dependent on traditional medicines prepared from locally available herbs. On the other hand, the non-timber forest products of Nepal are declining rapidly due to the unscientific and unsustainable exploitation of the forest products. In the absence of proper management and control in collection and trade, NTFPs are going to be vulnerable, endangered and even extinct (Acharya *et al.*, 2000). Practice of using plants and plants parts for medicinal use is decreasing because youngsters show less interest in traditional practices mainly due to less recognition of traditional healers and easy availability of modern medicines and instant effect (Acharya, *et al.*, 2012). Most of the NTFPs from Jumla are collected by shepherds and other lower caste people for make handsome money. And the upper cast groups normally own more livestock comparing lower caste (Paudelet *et al.*, 2007). The survey also revealed that all the traditional healers have strong faith on ethno-medicines although they were less conscious about the documentation and preservation of medicinal plants (Singh *et al.*, 2012).

Map 1: Location of Patch of Lamtali CF, Patarashi VDC, Jumla.

Methodology

The following tasks were completed for the study area:

- The preliminary list of vegetation types expected to occur in the study area was reviewed and refined.
- The altitudinal range of study area was determined through Digital Elevation Model (DEM).

Thus, the present study aimed to assess the distribution of *P. kurroa* (Kutki) at different geographical elevation and study about its pattern of collection. Besides, it was also aimed to find the distribution of Kutki in a patch at Lamtali Community forest (CF); to assess the frequency, relative frequency, density, relative density and IVI of Kutki; and to identify collection pattern over different geographical elevation (range).

MATERIALS AND METHODS

Study area

The study was conducted in Lamtali CF, which lies in Jumla district of mid-western region Nepal. It is surrounded by the boarders KhadiBijaura at east side, Gadi kola and Phurke CF at west side, Buda Budi Lake at north side and south side is ending with the Chakkhola and the side of PatarasiHimal. Within Lamtali CF area contain all kind of medicinal plant. LamtaliCF covers the 2800 ha area of the patarshi VDC. Within this CF There are three VDC (3,4 and 5) which joined together as a form of CF. Study was carried out within 1602 ha with sampling intensity 0.01% was taken for fixing sampling plot. Total 63 plot were sample in study area.

Map 2: Aspect map of Lamtali CF, Patarashi VDC, Jumla

- The stratified systematic sampling was overlaid at the spacing of 500m through GIS analysis applying 0.01% of sampling intensity, total plot 63 made in the study area.
- The designed plots were identified by X and Y coordinates into GPS. The plot to plot distance was 500m.
- The plot size 5m×5m was measured by tape to collect the rhizomes of Kutki.

- The qualitative data were analyzed by descriptive measurement and were presented in results and discussion part (Table 1). **Sampling Design**

Table 1: Tabulated flowchart of the procedure adopted.

S. No.	Research objectives	Field data collection	Process	Remarks
1.	To find the distribution of Kutki in a patch at Lamtali Community forestry(CF).	1. Reconnaissance survey 2. Participatory resource mapping 3. Direct field observation Area delineation	<ul style="list-style-type: none"> • Survey area • Collect data by counting each number of herbs of species. 	<ul style="list-style-type: none"> • Researcher and research assistant
2.	To assess the frequency, relative frequency, density and relative density of Kutki.	1. Collect data from field. 2. Calculate data according to formulae.	<ul style="list-style-type: none"> • Using various software like SPSS V22, R V 3.2.1 Software, MS excel 2016 etc. 	<ul style="list-style-type: none"> • Researcher and research assistant
3.	To identify collection pattern over different geographical elevations (range).	1. Key informant interview	<ul style="list-style-type: none"> • 237 hhs (20 % of the total hhs in the study area) include local collector, old age people.a 	<ul style="list-style-type: none"> • Researcher and research assistant

Sampling Design

Stratified transect survey was carried out for the field observation of *P. Kurrooa* by making different strata according to elevation class (range). Within the strata sampling, plots were located made with transect line using the GIS at fixed distance. Sampling plot was carried out on different elevation ranges. Kutki is an herbal plant thus the plot of 5m*5m was laid for the herb to collect sample. Herb (Kutki) was collected during the period from September to November, following the Government of Nepal Non-timber Forest Guidelines 2012 (NTFPs Guideline, 2069) for herb collection. Finally, the available plants (herb) were identified and their number were counted and recorded.

Primary data collection

A) Key informant survey: Key informants (i.e. FUGs Chairman, VDC leaders and collector) survey was carried out to gather the data regarding distribution of medicinal plants as well as pattern of collection.

Interviews were informal but also consisted of guided questions and close end questions.

B) Group discussion: Group discussions with the farmers were carried out to gather the information regarding the resource status, pattern of collection of Kutki at different elevations and problems related to it.

Secondary Data collection

Secondary data were collected from different published and unpublished journals, articles, district forest office and concerned community forest of Jumla.

Data analysis

Data obtained from the field were processed and analyzed manually with the help of Microsoft Excel to find out frequency, relative frequency, density, relative density and Importance Value Index (IVI). The parameters for the distribution and availability of the plants were species richness and abundance while density and frequency were used as indicators. The

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Frequency = (No. of sample plot in which species occurred / Total Number of sample plot studied) *100
Relative frequency is frequency of a species in relation to other species.

Relative frequency % = (Frequency of individual species / Total frequency of all species) *100

Density /ha = (Total number of plant of any species / Total number of plot taken * area of sample plot) *1000

Relative density is the density of a species with respect to the total density of all species.

Relative Density % = (Density of individual species / Total density of all species) *100

Importance Value Index = Relative density + Relative frequency + Relative ground cover

RESULT AND DISCUSSION

From the study in the field, it was observed that the species remained primarily in association with the Padamchal, Panchaule, Jamasi species etc. The other associated species were Pakhanbed, Satuwa etc. Altitudinal range was observed 3000-5000m.

Geographical distribution of *P. Kurrooa*

Data pertaining to Table 2 shows that *P. kurrooa* has highest frequency (82.54%) and *D. hatagirea* has the lowest frequency (7.94%). *P. kurrooa* has highest relative frequency and the *D. hatagirea* has lowest relative frequency. The *P. kurrooa* has highest density (7263.492/ha) than the other associated species. The *D. hatagirea* shows that the lowest density (241.2698/ha). The relative density of *P. kurrooa* is higher (47.93/ha) than the other associated species. The relative density depends upon the occurrence of individual species. *D. hatagirea* possesses lowest relative density (1.59/ha). The higher IVI value of Kutki than other associate species (113.59) gradually followed by Jatamashi (88.51), Nirmashi (41.91), Padamchal (24.3), Bikh (16) and ultimately Panchaule (15.69).

Aspect-wise distribution of Kutki

Parametric F test were applied based on one-way ANOVA for the significance test of Kutki with respect to the elevation at 5% level of significance (Figure 1). The result revealed that there was no significance difference between species with respect to aspect ($p>0.05$). Table 3 showed that frequency of Kutki is higher in North aspect than other aspects. 43% of Kutki is found in north aspect. The lowest frequency was found in south aspect of the study area. If we categorize the study area in eight aspects, the

frequency was higher in north-west aspect. The highest density of Kutki was observed in east aspect

(7476.92/ha) while the lowest density was found in west aspect (7100/ha).

Table 2: Quantitative analysis of Kutki.

Species	Scientific	Frequency	Relative Frequency	Density	Relative Density	Abundance	IVI
Kutki	<i>Picrorhiza kurroa</i>	82.54	34.44	7263.492	47.93	8800	113.59
Pachaule	<i>Dactylorhiza hatagirea</i>	7.94	3.31	241.2698	1.59	3040	15.69
Nirmashi	<i>Delphinium denudatum</i>	31.75	13.25	1612.698	10.64	5080	41.91
Bikh	<i>Aconitum spicatum</i>	15.87	6.62	323.81	2.13	2040	16
Padamchal	<i>Rheum australe</i>	26.98	11.26	660.317	4.36	2447.06	24.3
Jatamashi	<i>Nardostachys grandiflora</i>	74.6	31.12	5053.97	33.35	6774.47	88.51

Figure 1: Aspect-wise distribution of *P. kurroa*.

Table 3: Aspect-wise distribution of Kutki.

Aspects	Frequency	Density
North	42.86	7259.26
East	20.64	7476.92
South	4.76	7466.67
West	31.746	7100

Altitude-wise distribution of Kutki

Parametric F test were applied based on one-way ANOVA for the significance test of Kutki with respect to the elevation at 5% level of significance (Figure 2). The result revealed that there was significant

difference between at least one pair of elevation class. Thus, elevation class 3500m-4000m was significantly different with respect to elevation class 4000m-4500m ($p < 0.05$) and the elevation class 4000-4500m was significantly different with respect to elevation 4500m-5000m ($p < 0.05$). While, elevation class 3500m-4000m was not significantly different with respect to elevation class 4500m-5000m ($p > 0.05$). Figure 3 shows that the frequency of Kutki is higher in 4000m-4500m elevation range (42.86%). Also, the moderate frequency was in 4500m-5000m (28.54%) and the lowest frequency was in 3500m-4000m (11.11%).

Figure 2: Altitudinal distribution of *P. kurrooa*.

Figure 2: Altitudinal distribution of *P. kurrooa*.

Participation for collection of Kutki

The Figure 4 shows that the male participation is higher as compared to female. The male participation

was 62% while female participation was just 38 % at the study area for collection of Kutki. Age group 20-30 highly travels to collect Kutki.

Figure 4. Participation for collection of *P. Kurrooa*.

CONCLUSIONS

Picrorhiza kurroa was mainly distributed in upper parts of the Lamtali CF with associate species *Dactylorhiza hatagireia* (Panchaule), *Delphinium denudatum* (Nirmashi), *Aconitum spicatum* (Bikh), *Rheum austral* (Padamchal) and *Nardostachys grandiflora* (Jatamashi). Kutki was found in larger density and higher frequency than other NTFPs. Generally, it was found from 3500m-4500m and up to snowline within Lamtali CF. Frequency, relative frequency, density, relative density and IVI were respectively 82.54%, 35%, 7263.492, 48% and 113.59. The abundance of Kutki was higher than other associate species which was 8800 number/ha. Frequency of Kutki was higher in northern aspect (43%) and density of Kutki was greater in eastern aspects 7476.92. Frequency of Kutki is higher in 4000-4500m elevation range. There was significant difference of average number of Kutki with respect to elevations ($p < 0.05$) but no significant difference with respect to aspects ($p > 0.05$). Male participation was higher than female for collection of Kutki at Lamtali CF. People from age group 20-30 was mostly involved in the collection of Kutki.

RECOMMENDATIONS

- CF committee should control the intensive harvesting by making necessary rules.
- DFO should also take initiative in regulating the amount of harvesting at the collection site and ensuring the proper season as well as methods for harvesting of medicinal plants including Kutki.
- Livestock grazing should be managed by stopping the grazing of livestock, or by enforcing to apply for rotational grazing.
- Awareness level of CF users should be increased by clarifying the importance, ecology, sustainable collection, marketing and its impacts on livelihood for sustainable management of Kutki in the study area.
- Community forests of this range need to be managed effectively for economic benefit for the rural populace.
- More effective NTFPs conservation plan is needed for the study area.
- RD and DFO office should be focused for research on high value medicinal plants.

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