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Review Article

Tradable Plant Species of Sikkim Himalayas**Madhusmita Mahapatra, Sunil S. Thorat and Lokesh Deb****Institute of Bioresources and Sustainable Development - Sikkim Centre (Department of Biotechnology, Government of India), 5th Mile, NH-10A, Near Metro Point, Tadong, Gangtok, Sikkim, North-East India -795001***Abstract**

This paper deals with the documentation of the plants of Sikkim Himalayas that are having traded values. Our study reveals that these species are grown at various altitudes and are used for a variety of purposes. Species like *Swertia chirayita*, meant for its anti-diabetic, hepato-protective, antimalarial and anti-inflammatory properties is traded in large quantities at both national and international markets. Similarly, Sikkim is the largest producer of *Amomum subulatum* contributing up to 88% of India's total cardamom production, where India is considered as the largest producer. Likewise, the leaves of *Rhododendron campanulatum* are exported from Sikkim as it is mixed with tobacco, used as snuff and cures cold and hemicrania. As a result of this, there is a high demand of these plants in the market and hence they are in danger of economic exploitation from wild Habitats. Therefore, in order to conserve and safeguard the wild populations, commercial cultivation is required to meet up the market demand.

Keywords: *Swertia chirayita*; *Amomum subulatum*; annual production; tradable plant species; Sikkim Himalayas.

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1. Introduction

Sikkim-lies in between 27°3'47" to 28°7'34" N lat and 88°3'40" to 88°57'19" E long, is a small state in India having a total area of 7096km² which is 0.02% of the total area of the country [1]. Within the northeast region of India, this state is surrounded by China (Tibet), Nepal in the west direction, Bhutan to the south east and West Bengal to the West. The climatic condition of Sikkim varies from tropical to high alpine zones. With respect to the altitudinal range, the vegetation of Sikkim is categorized into five different types, Low Hill Forests i.e. up to 900m; Middle Hill Forest i.e. 750-1500m; Upper Hill Forest (1500-2700m) i.e. *Rhododendron cornifer* zone(2700-3600m) and Alpine Scrub and Grasslands meadow (3600-4300m and above) [2]. According to the information from Census, 2011, the state has a population of 6.11 Lakhs [3] comprising with

ethnic groups like *Lepchas*, *Bhutias*, *Limbus* and *Nepalese* who are different from each other in their customs, lifestyle and food habits. [1]. The *Lepchas* were considered to be the earliest known residents of Sikkim and the total population are 19% (1891 Census data) while presently *Lepchas* are only 8% i.e. about 30,000 of the entire populations. The *Bhutias* accounts for around 14% of the population of Sikkim, who obtain their source of livelihood from trades and animal husbandry. The majority of the populations are Nepalese, who cover around 70% of the population of Sikkim and basically depending on agriculture [2].

The state is rich in biodiversity and considered as one of the thirty-four global hotspots for biodiversity. According to Sikkim Human Development Report 2014, more than 47% of the area is covered with the trees and is

comprised of around 4458 species of flowering plants out of the total 15,000 species available in India. The floral elements are 527 orchids [4]; 60 Primula species, 36 species of Rhododendrons, 11 Species of oak, 23 Species of Bamboo, 16 Conifer species, 362 types of ferns and fern allies, 8 species of tree ferns and more than 424 medicinal plants [5].

The majority people in Sikkim are depends on agriculture for their livelihood and their cultivation practiced in terrace fields [6]. Different types of plants are used multipurpose like for food, fuel, timber, etc. Even the inhabitants of Sikkim collect wild edible plants to meet their daily food requirements [1]. The major crops of Sikkim includes Rice, Maize, Cereals like buck wheat; pulses are urd and rice bean; oil seeds like soybean and mustard, horticultural fruit crops like orange and pears; ginger, cardamom, turmeric and cherry pepper (spice crops), cole crops, peas, bean, tomato, potato (vegetable crops). Apart from this, the farmers are getting a good income from the cultivation of ornamental flowers such as *Cymbidium*, *Rose*, *Gebera* and *Anthurium* [7].

Thus, keeping all these potentialities in mind, we set out to document the plants which are helping the farmers in generating a good income and are tradable from Sikkim for their livelihood. The aim of this study is to provide detailed information on different types of plants of Sikkim that are being exported for various purposes, i.e. marketing status, their cultivation practices, use in industries, etc., which can help the people in widening their knowledge and adoption.

2. Methodology

2.1 Collection of data

Basic information regarding various tradable plants list of Sikkim was collected using various search engines such as Google and from literatures sources like International Journal of Applied Science and Technology, Current science, etc. Surveys were conducted in various parts of Sikkim and the required information was collected. Collected data includes the taxonomical classification of the plants, morphology, uses of the plants, its tradable values, economic aspects, pictures, etc.

2.2 Designing of Database

The database was designed with the help of a personal computer having a high-speed processor with a RAM of 1 GB and hard disk capacity of 320 GB with Microsoft Windows 7 Professionals operating system. Tools like MS Access and Visual Studio Web Developer were used for storage and front end designing respectively. Flow chart on the Database on the tradable species of Sikkim Himalayas is given in Figure-1.

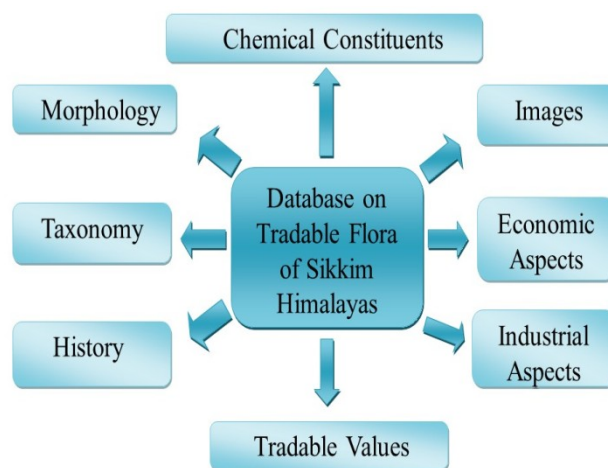


Fig.1: Flow Chart on the Database on the tradable floral Species of Sikkim Himalayas

3. Results and Discussions

This database offers useful information about the plants that are traded from Sikkim Himalayas. This database can be useful for the scientific and industrial personnel for a quick review of the tradable plants of Sikkim Himalayas. The basic information collected from various sources about the plants includes the trade name, morphological details, taxonomical details, economic aspects and others. This database also comprises of other information like how it is being used in industries, product from the plants that are used in the market, regions from where these plants are traded, its cultivation details, market price and, how it is traded i.e. locally or globally, etc.

In this study, we have found a number of plants from Sikkim that are economically important and are exported in both local as well as in international level. Some of the plants, includes *Swertia chirayita* (Roxb. Ex Flemming) H. Karst, *Amomum subulatum* Roxb., *Rhododendron campanulatum* D. Don, *Zingiber Officinale* Roscoe, *Citrus reticulata* Blanco, *Curcuma longa* L.; etc. are used in a variety of ways and are exported from Sikkim in large scale.

Swertia chirayita (Roxb. Ex Flemming) H. Karst (local name-*Chirata* [8], trade name-*chireta* [9] belongs to family Gentianaceae, is an important medicinal plant grows in various locations of Sikkim like Chungthang, Dentam, Pemayantse, Kyongnosla, Rabong, Bakhim to Tsokha, Karponang, 6th mile (East Sikkim), Lachung-Sarchok, Nathang, Phadamchen, Dzongu [8], possess anti-inflammatory, anti-diabetic, hepato protective and antimalarial properties [10]. It is best grown at an altitude of 1400 – 3270 m [9]. This species is usually collected in a large quantity by the people from Lachen and Lachung and are sold to the Commission agents in Gangtok from where it is sent out of the state [11]. It comprises of some of the

constituents like Amarogentin (chirantin), Amaroswerin, Gentianine, Swerchirin, Swertiamarin, Xanthones, Mangiferin, Lignan such as syringaresinol, the ubiquitous β sitosterol; Triterpenoids such as swertanone, swertenol, episwertinol, gammacer-16-en-3 β -ol, 21-a-H-hop-22(29)-en-3 β -ol, taraxerol, oleanolic acid, swerta-7, 9(11)-dien-3 β -ol, pichierenol and pentacyclic triterpenoids like β -amyrin, friedlin, chiratenol, kairatenol, oleanolic acid and ursolic acid. Chirayita is found to be used in herbal, liquor, drug, Ayurvedic and in cosmetic industries. Some of the industrial products derived from this plant include Safi, Ayush-64, Diabecon, Mensturyl syrup and Melicon V ointment [10,12]. According to our study the whole dried plant is sold in the market with a market price of Rs.75 per kg [9].

Similarly, some of the major horticultural plants like *Amomum subulatum* Roxb., *Citrus reticulata* Blanco, *Curcuma longa* L. and *Zingiber officinale* Roscoe. are found in Sikkim and exported from the state.

Amomum subulatum Roxb. (local name-*Elaichi*; Trade name-*Badi elaichi*) belongs to the family Zingiberaceae, is a major cash crop of Sikkim and is found in an altitudinal range of 700 to 1800 m [13, 14]. The inhabitants of Sikkim have been practicing the Crop agroforestry system to cultivate this plant since number of years to boost their economy. Besides offering a good income, this crop plant also provides additional income to the people from the timber and fuel wood. It has been said that the income of people from this plant is three-four times more than other cash crops [14].

The annual production of this plant from state is more than 4,500 metric tons i.e. 88% of the country [15]. Sikkim has more than 50% share in India in production of *Amomum subulatum* in the globe and is the largest producer in India. As this plant is used in various ways, the demand is increasing at a high rate and is exported to various countries in Europe, North America and Mainland China. But over the last few years, there is a decrease in the production of this plant [14]. According to our study, it has been found that during the year 2013-14, the annual production of cardamom was 3,860 metric ton and the same amount was traded at a market price of Rs.1350 per kilogram.

This plant possesses some of the important constituents that vary with age, variety and the region where it grows. The fruit of this plant consists of 70% seeds and 30% skin. It has been reported that the seeds comprise of around 2.5% essential oil consisting an important compound-1,8-cineole. Terpenyl acetate is present in a low quantity. It also consists of 5-17% of monoterpene hydrocarbons among which the main components are the limonene, sabinene, the terpinenes and the pinenes. The

seeds of this plant comprise of cardamomin, alpinetin and glycosides i.e. petunidin, 3, 5-diglucoside, leucocyanidine-3-O-Beta-D-glucopyranoside and subulin [16].

The species is beneficial to the people of the Himalaya. This is widely known spice and has a range of physiological and pharmacological characteristics. It is used in curing indigestion, vomiting, biliousness, abdominal pain and rectal diseases. Because of its aroma, it is used in mixed spices and its odour has a flavoring agent while preparing vegetables and meat, hot and sweet pickles and beverages. Traditionally, it is used in the treatment of throat trouble, congestion of the lungs, inflammation of the eyelids, digestive disorders and pulmonary tuberculosis, flatulence, loss of appetite, gastric troubles, congestion and liver complaints. Some of the products obtained from Large Cardamom include essential oil, oleoresin, encapsulated flavor, cardamom cola, flavored biscuits and flavored liquors [13].

Similarly, *Citrus reticulata* Blanco (local name-*Suntala*; Trade name-Santara) is another horticultural crop cultivated in Sikkim Himalayas. In the year 2013-14, its annual production was 16,855 metric ton and the same amount was exported at 8 per piece. This species is useful in treating dyspepsia, gastrointestinal digestion, coughs and profuse phlegm. The unripened exocarp is used in curing chest pain, hypochondrium pain, gastro-intestinal distension, liver cirrhosis, swelling of liver and spleen. The seeds are used in hernia, lumbago, mastitis and pain or swelling of testes. The peel comprises of an essential oil which is used as a food flavoring and is also used for both perfumery as well as medicines. From the leaves and twigs yields an essential oil known as petitgrain oil [17].

Curcuma longa L. (local name-*Besar*; Trade Name-Haldi) used as a spice has a growing importance in Sikkim. Of the total production of Haldi in the year 2013-14 in Sikkim, 70% i.e. 3460 metric tons were traded in fresh condition i.e. Rs.15 per kg. It is grown in various parts of Sikkim i.e. Sangtok, Kimrong, Upper Zimghung in North; Kamarey, Karmithang, Lower Sumin, Singbel, Rakdong, Rasey, Tarpin, Sudinglakha, Deoling, Mamring, Biring, Lingdok, Malangthang, Luing, Rumtek, Ranka, Sama Sivick, Thamidara in East; Palung, Pakzor, Ben, Legship, Dong, Phong, Doron, Rabikhola, Ruchung in South and Middle Geyzing, Kyongsa and Timburbong in West [18]. Some of its constituents include a flavanoid curcumin (diferuloylmethane), volatile oils like tumerone, atlantone and zingiberone, sugars, proteins and resins. Curcumin is considered to be the active constituents present in *Curcuma longa* L [19]. This species is used in curing various ailments like amenorrhoea, anemia, ascities, asthma, boils, bruises, catarrh, chronic bronchitis, chronic dysentery, chronic fever, conjunctivities, cough, cystitis,

dermatosis, diabetes, diarrhoea, dislocation of joints, dyspepsia, elephantiasis, eosinophilia, eye diseases, facial palsy, gonorrhoea, haemoptysis, helminthiasis, hepatitis, hysteria, impaired vision, indigestion, itching, jaundice, leech bite, leprosy, leucorrhoea, liver disorders, loss of appetite, malignant ulcer, piles, pteridium, pyriasis, ring worm infection, scorpion sting, senility, septic puncture wound, slow lactation, small pox and chicken pox, skin diseases, tonsillitis, toothache, toxicosis, trauma, urethral discharge, urinary infection, uterine pain, vaginal discharge, weakness of eye sight, wound and wound maggots, clears dark patches and clear skin colour [20]. Mostly it is used as a spice, food preservative, colouring material and in pharmaceutical industries [21,22].

Zingiber officinale Roscoe (local name-*Adua*, trade name-*Adrak*) unlike *Curcuma longa* of the total production in the year 2013-14 in Sikkim, 70% was traded i.e. 36,500 metric ton at Rs.60 per kg in fresh condition and the rest 30% were used for seed purposes. It is found in Sikkim in regions like Lower Tumlong, Tingvong, L Lingdem, Kabi, Singhik, Ringhim, Phensong, Toong, Naga and Lumin North; Nandok, Pabik, Rizay, Kadamtam, Chota Singtam, Pachak, Sapley, Saku, Premlakha, Padamchen, Nazitam, Riwa-Machong, Tumin, Khamdong and U.Samdong in East; Ningyang, Lingi-Paiyoung, Lingmoo, Kolthang, Ben, Namlung, Singithang, Omchung, Tirikhola, Denchung, Lalsor, Chisopani, Sumbhuk, Kerabari, Turuk, Sukrabarey, Sadam, Dalep, Namphing, Tokal, Dong, Chuba, Bikmat, Rateypani, Ruching and Karek in South; Nazor, Barfok, Majhigaon, TingTing, Chongrang,

Chumbong, L. Naky, Bengtan and Sapong in West [18]. This species consists of gingerol [5-hydroxy-1-(4-hydroxy-3-methoxy phenyl) decan-3-one], the key active compounds in the fresh rhizome. The volatile oil of Ginger contains mono and sesquiterpenes; camphene, beta phellandrene, curcumene, cineole, geranyl acetate, terpheneol, terpenes, borneol, geraniol, limonene, linalool, alpha-zingiberene, beta-sesquiphellandrene, beta bisabolene and alpha-farnesene. Dried ginger contains shogaol and acrid resinous substance. Ginger also contains essential oil containing constituents like sesquiterpenoids, whose major component is (-)-zingiberene, sesquiterpenoids (β -sesquiphellandrene, bisabolene and farnesene) and a small monoterpene fraction (β -phellandrene, cineol, and citral). Another compound namely Amadaldehyde is also found in the extracts of ginger. Other pungent components found in the rhizome of Ginger include paradols, gingerdiols, gingerdiacetates, gingerdiones, 6-gingersulfonic acid, gingerenones etc. The rhizome also comprises of diterpenes and ginger glycolipids A, B and C18. Mostly this is used as a spice. Fresh ginger is used in nausea, asthma, cough, colic, heart palpitation, swellings, dyspepsia, and loss of appetite, rheumatism, gastrointestinal disorders and piles [23]. Food, pharmaceutical, agricultural and cosmetic industries are the industries where this species is used largely [24]. The horticultural plants traded from Sikkim are listed in Table-1 with its local name, trade name, production per year and amount traded per year (2013-14) and graphically shown the amount of plant products traded in the year 2013-14 from Sikkim in Figure-2.

Table1: List of some Horticultural plants that are traded commercially from Sikkim together with its local name, trade name, production in assessed year and quantity traded in assessed year (2013-14)

Name of the species	Part used	Local Name	Trade Name	Production in assessed year (MT)	Quantity traded assessed year (MT)	Market price (In rupees/Kg)
<i>Swertia chirayita</i> (Roxb. exFlemming) H. Karst.	Whole plant	Chirata	Chireta	-	-	`75.00
<i>Amomum subulatum</i> Roxb	Dried fruit	Elaichi	Badi Elaichi	3860 MT	3860 MT	`1350.00
<i>Citrus reticulata</i> Blanco	Ripe fruits	Suntala	Santara	16855 MT	16855 MT	`90.00*
<i>Curcuma longa</i> L.	Rhizome	Besar	Haldi	4943 MT	3460 MT	`15.00
<i>Zingiber officinale</i> Roscoe	Rhizome	Adua	Adrak	52144 MT	36500 MT	`60.00

**Citrus reticulata* ripe fruit cost `8.00/- per piece i.e. come approximately `90.00/- per Kg that depend upon size of the fruits.

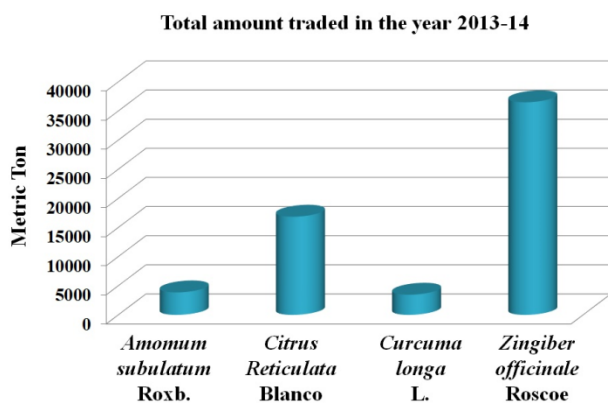


Fig-2. Graph showing the amount of plant products traded in the year 2013-14 from Sikkim

There are 36 species of Rhododendrons found in Sikkim, *Rhododendron campanulatum* D. Don commonly called as *Nilo Chimal* in Nepali belongs to the family Ericaceae, grown at an altitude in between 3000-4000m [25]. It is exported from Sikkim to the plain regions. The leaves of this species are mixed up with tobacco, used as a snuff and cures cold and hemicranias [26].

4. Conclusion

In this paper, databases of different types of plants have been shown that are tradable from Sikkim. This freely available database offers important information such as In which purpose industries used these plants, mood of use, its cultivation practices, taxonomical classification, and morphological characteristics along with the chemical compounds present in it. From this database, we came to know that these plants have a wide range of uses. The species are used in the treatment of diseases, perfumery industries, fuel wood and timber purposes. Thus, due to these characteristics of these plants they are of a great value to the mankind as economic species. As a result of over exploitation of some plants species populations are deteriorating. So, to conserve the wild habitats, proper means of cultivation needs for their population enhancement to meet the market demand.

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and Value Addition for Commercial Exploitation” (Code-PBD-4 and Subcode-4.1) and “Ethno Pharmacological Plant Database of Sikkim” (Bioresources database and Bioinformatics in-house core project).

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