*Available online at http://www.journalcra.com*

*International Journal of Current Research*
*Vol. 4, Issue, 04, pp.064-073, April, 2012*

**INTERNATIONAL JOURNAL OF CURRENT RESEARCH**

**ISSN: 0975-833X**

## RESEARCH ARTICLE

# TRADITIONAL LEGUMES IN SIKKIM HIMALAYAS: FOOD PREPARATION, USES AND ETHNO-MEDICINAL PERSPECTIVES

**[1]Dibyendu Talukdar* and [2]Tulika Talukdar**

[1]Department of Botany, R.P.M. College, University of Calcutta, Uttarpara, Hooghly 712258, West Bengal, India
[2]Department of Botany, Krishnagar Govt. College, University of Kalyani, Krishnagar, Nadia, West Bengal, India

**ARTICLE INFO**

***Article History:***
Received 27th January, 2012
Received in revised form
17th February, 2012
Accepted 29th March, 2012
Published online 30th April, 2012

***Key words:***
Legumes,
Ethno-biology,
Resources,
Medicinal,
Consensus factor,
Sikkim Himalayas.

**ABSTRACT**

An inventory was carried out in parts of Sikkim Himalayas (500-4200m, amsl) to document traditional wisdom on legumes regarding mode of food preparation and resource utilization. The study revealed rich biodiversity and conservation of traditional knowledge on use of legumes in food, fodder, medicine, organic farming and socio-religious festivals. As many as 42 ethno-taxa have been identified, of which 24 plants had use in different ailments including diabetes, high blood cholesterol, fever, digestive disorder and other general health problems. As edible food, 24 plants had extensive use either as vegetables or pulse-meal and 10 recipes have been identified. Cooking and boiling was the most preferred recipes among the tribes. *Phaseolus* and *Vigna* emerged as dominant taxa with maximum number of useful plants (8 each), followed by *Cassia* and *Lathyrus* (4 each) and then other taxa. Nepalese was the predominant tribes, utilizing highest number of plants, and it was closely followed by Lepchas and Bhutias and then other tribes. The informant consensus factor, used for the first time in Sikkim Himalayas, for preparation and usage of plant per category was high enough (> 0.90), indicating high degree of consensus in disclosing the traditional knowledge within the community in the study areas.



## INTRODUCTION

Sikkim is a small multi-ethnic State, located on the Eastern Himalaya covering a geographical area (GA) of 7096 sq.km, representing a meager portion of (0.22%) India's geographical area. The diverse topography of this biodiversity rich state is accompanied with colourful cultural practices and traditional uses of floras in different purposes (Badola and Aitken, 2003). The major ethnic groups are 'Bhutias', 'Lepchas', 'Nepalese', 'Limbos', of which 'Lepchas represent aboriginal tribes with richest knowledge on traditional uses of plants (Pradhan and Badola, 2008; Idrisi *et al*., 2010; Bhasin, 2011; Pal and Palit, 2011). All the tribes of Sikkim nurture traditional bio-resource utilization strategy for which several literatures are available (Bennet, 1983; Srivastava *et al*., 1987; Pandey, 1991; Subba, 2009; Joshi *et al*., 2011). Legumes constitute an important part in hill-based agro-biodiversity and traditional uses of legume products in different parts of the Himalayas (Subba, 2009). This group of plant is grown wildly and is also cultivated by local people as food, fodder and sources of fuel from sub-tropical (500-1500 msl) to mid hill temperate region (1500-2700msl) of Sikkim. The ethnic communities are predominantly vegetarians and rice-legume soup-curry-pickle is the basic diet of the Sikkimese meal (Yadav *et al*., 2009). Along with other crops, indigenous communities have been conserving landraces of domesticated, wild relatives and underutilized legume crops for traditional and cultural rituals since time immemorial. As legumes are the only and cheap sources of high protein, antioxidants and dietary fibers for peoples living in rugged terrain, documentation of ethnic recipes and their use are urgently needed. Many of these Himalayan traditional legume crops have high ecological and economic potential and thrive well in adverse environmental conditions with low external inputs (Maikhuri *et al*., 1997). Often described as 'poor man's diet, the grass pea or *Lathyrus sativus* L. for example, has recently been re-introduced in several parts of Europe, China, Australia and South America due to its remarkable capacity to withstand extreme cold conditions and diverse types of biotic and abiotic stresses for sustainable farming to prevent cereal-based overexploitation of land (Granati et al., 2003; Kumari and Prasad, 2005; Vaz Patto *et al*., 2006; Talukdar, 2009a, 2011a-d). Detail documentation was done on ethno-medicinal floras of Sikkim Himalayas from time to time (Gurung, 2002; Jha *et al*., 2004; Pradhan and Badola, 2008; Idrisi *et al*., 2010), but despite immense importance of Himalayan pulse crop and its preparation in daily life of different ethnic communities, report on use of legumes in Sikkim Himalaya is extremely limited (Jana and Chauhan, 2000) and no detail studies have been carried out in this direction. The objectives of the present study were, therefore, to document the traditional knowledge regarding the preparation (non-fermented) and uses of prominent pulse crops used in Sikkim Himalayas.

***Corresponding author:** dibyendutalukdar9@gmail.com

## MATERIALS AND METHODS

### Study areas and ethno-graphy

Field trips comprising of local knowledge persons, traditional healers and farmers mainly from ethnic *Nepalese*, *Lepchas*, *Bhutias*, *Lamas* (Bhutia priest), *Limbos*, *Sherpas*, and *Dokpas* were conducted in and around Ranipool (East Sikkim, 27°17′ N/88°35′E, 600m, amsl), Phodong (North Sikkim, 1400m, amsl), Labrang (North Sikkim, 1400m, amsl), Phensang (North Sikkim, 27° 26′ N/88°36′E, 1572m, amsl), Chungthang (North Sikkim, 27°37′ N/88°37′E, 1800m, amsl), Mangan (27.52°N/ 88.53° E, 1000m, amsl), Lachen mosastery area, Lachen Chu valley (North Sikkim, 2800m, amsl), Yumthang (North alpine Sikkim, 3610m, amsl), Thangu (2600-4200m, amsl) and Lachung valley (1545-3152m) between August and February of 2009-2011. Indigenous people inhabiting the target areas mostly belong to three major communities, i.e. Nepali, Lepcha and Bhutia. The Nepali community has established a wider base in their local traditional medicine system, which is commonly prevailed in various tropical and sub-tropical villages in Sikkim (Tambe *et al*., 2003). Being one of the oldest tribes in Sikkim, Lepchas have successfully managed to carry their ancient wisdom of ethnomedicinal practices. In recent times, Lepchas used to grow pulses and vegetables along with other crops, and emerged as specialized plant gatherers practicing 'Lepcha Shamanism' and ethnomedicine with having richest traditional knowledge on biological resources (Pradhan and Badola, 2008; Idrisi *et al*., 2010). Migrated to Sikkim, perhaps after the fifteenth century through Bhutan, Bhutias, the third major tribe of Sikkim in the study area, is believed to be of Tibetan origin. Lachen and Lachung are the traditional Lepcha Villages with a unique form of local democracy in which the pipon (headman) is elected every year. Nowadays, however, at north Sikkim, Bhutias inhabit in majority and known as Lachenpas and Lachungpas for their historical links with Lachen and Lachung, respectively (Idrisi *et al*., 2010). The Bhutias along with Lepchas and Sherpas constitute significant farming community, engaged in subsistence farming by cultivating a variety of legume crops such as peas and beans and fruits such as barley, wheat, potato, cabbage, apple, maize, peach, and medicinal plants between 3000-4300m (Chhetri, 2011). *Dzumsa* (*dzoms-sa*), a traditional institution of the *Bhutias* in the remote high altitude villages of Lachen, frames the guidelines of crop harvesting and utilization.

### Ethnobotanical survey and consensus analysis

The survey protocols were followed standard methods for interviews, data confirmation and field observation as suggested earlier (Etkin, 1993; Bernard, 1994; Alexiades, 1996). Community domains and differences in traditional knowledge (TK) among the informants were elucidated by cross checking the new informants and frequency of a particular response was determined within the survey. The local 'elders' helped us to gather information on the local customs, habits and beliefs, information on the surrounding area and individuals who are knowledgeable of the local flora. The consensus analysis utilized the informant's TK as defined by the surveys. Local informants having practical knowledge of plant medicinal utility of the study areas were interviewed during study periods of August-February 2009-11. During this period, about 9 field trips were conducted in the study areas for verification of collected data. Surveys were conducted by a stratified random selection of informants, based on methods suggested by earlier workers (Schultes, 1962; Jain, 1991; Bernard, 1994). Successive free listing was used to interview informants providing data for the consensus analysis. A total of 210 informants were selected and interviewed based on the questionnaire followed earlier for legumes (Bhagya and Sridhar, 2009), giving limited time and without discriminating gender. During these interviews, all possible information regarding uses of legumes, parts used, dosage and mode of administration, methods of preparation was documented and then verified by cross-checking. Informants were also requested to show the seeds of last harvest and to show the plant species on site. Members of different local community-based village-governance system such as '*Dzumsa'* (*dzoms-sa*), a traditional institution of the *Bhutias* in the remote high altitude village of Lachen, were involved in this exploration study. Documentation of knowledge on medicinal uses of legumes was carried out with the help of local folk healers known as Baidya, Dhami and Jhankri in Nepali Community, Amji and Pow in Bhutia Community, and Bongthing in Lepcha Community in study areas including local markets.

### Calculation of a consensus factor ($F_{ic}$)

Homogeneity of informant's knowledge was tested following methods of Trotter and Logan (1986) with little modifications for the present study. A consensus factor of $F_{ic}$ is given by: $F_{ic} = Nur - Nt /(Nur - 1)$. The factor provides a range of 0 to 1, where a high value acts as a good indicator for a high rate of informant consensus. Nur is the number of use-reports of informants for particular illness/ usage, where a use-report is a single record for use of a plant mentioned by an individual. Nt refers to the number of species used for a particular illness/usage category for all informants. The majority of illness/usage types are grouped into predefined ethno/economic botany categories. Documentation of knowledge per category of usage/preparation was at first performed community wise, and mean value of $F_{ic}$ was finalized, thereafter (Table 2 and 3).

### Botanical documentation and preservation

All plants utilized in the interviews were collected as vouchers for confirmation of identity. The identities were authenticated in herbaria, and by referring to recent taxonomic monographs and revisions. The authentication of collected specimens was performed using both on-line and off-line data bases of International Plant Names Index (www. IPNI.org), International legume data base (www.ildis.org) 'Flora of Sikkim Himalayas (Hajra and Verma, 1996) and persons from different institution and arboretums (www.klyuniv.ac.in; bsienvis.nic.in). Voucher specimens have been deposited in the departmental herbarium of R.P.M. College, Uttarpara, Hooghly, West Bengal.

## RESULTS AND DISCUSSION

### Diversity of ethnotaxa

The ethnic communities in the study areas revealed a diversity of legume plants that have medicinal and nutritional utility in their culture. During the study period of over three

**Table 1. Legume crop plants used in Ethnobiology in Sikkim Himalayas**

| Botanical name | Common name | Habit | Growth period | Ethnic mode of preparation/usable plant parts | Uses |
|---|---|---|---|---|---|
| **Abrus precatorius* L. (Ranipool, Phodong) | *Lalgedi* Used in backbone pain (N) | Tree | Perennial | Seeds powdered and mixed with water to prepare liquid paste | |
| **Acacia Arabica* L. (Ranipool, Phodong) | *Babul* Used in cut and Wounds (N)= | Tree | Perennial | Bark and gum-directly used or as paste | |
| **Bauhinia purpurea* L. (up to 1200m, amsl) | *Tanki* | Small Tree | Perennial | Flowers collected, stamens removed along with calyx, to prepare paste | Used as pickles (N, L, B, O) and dysentery (N) |
| **Cajanas cajan* (L.) Millsp. | *Rahar* | Erect | Sep-Dec | Cooked with vegetables | Taken during jaundice Dried stem as fuel (N) |
| *Cassia alata* L. | *Dandmari* | Erect shrub | June-Dec | Dry plant parts collected | Fuel (N) |
| **Cassia javanica* L. (Ranipool to Pakyong) | *Sungen Kung* (L) | Erect tree | Perennial | Pods and seeds. Seed extract prepared in saline water | Medicinal value of seeds as purgative, hemolytic (extract) agent (L) |
| **Cassia occidentalis* L. (Up to 2400m, amsl) | *Tapray* (N), *Sung en durn* (L) | Erect under-shrub | June-Dec | Leaves and roots powdered, mixed with water to form paste | Medicinal in worm infection, scorpion sting, stomachic, used in fever, cough and cold (N, L) |
| **Cassia tora* L. (up to 1200-1400m) | *Toppariya* | Sub-erect | March-Nov | Leaves were cut into pieces, grinded with little water in wooden morter to extract juices | Leaf juices used as anthelmintic, taken at empty stomach (N), used also in skin diseases (N, L) |
| *Cicer arietinum* L. (up to 3000m) | *Chana dal* | Sub-erect | Oct-Feb | Cooked as 'dal', dry seeds powdered to make 'besan' form fried product. Whole plant & sprouted seeds | Taken with cooked(u rice, fried product Sprouted seeds for general health (N, B) Fodder and recycling (N, B, O) |
| **Clitoria ternatea* L. (Ranipool to Phensang) | *Sveta koyala/ aparajitha* | Climber | Feb-Nov | Flower (white) mixed with water to form paste, entire plant | Paste used in eye infection, whole plant bite (N), religious (N, B) |
| **Glycine max* (L.) Merrill. (Ranipool to Chungthang) | *Kalo or Pahelo Bhatmash* | Sub-erect | June-Nov | Seeds processed or roasted, grains, whole plant, seed paste | used as legume meat with cooked rice, seed and plant as fodder (N , L), paste in skin rash Cold bite (S, B, L) |
| *Indigofera atropurpurea* Horn em. (1530m, amsl) | *Chiringi jhar* Used as vegetables | Shrub | Sep-Oct | Leaves cut into pieces, mixed (flowering) with amaranth, palak and (N, L, B, O) cooked | |
| *Lathyrus sativus* L. | *Soshta Batura*/ (1200-4200m, amsl) | Vine | Oct-Feb | Cooked as 'dal' or mixed with | Highly nutritious but vegetables or with chana dal always taken as |
| | (white-seeded) | *Seto Batura* | | Tender leaves, whole plant, leaves and pods, seed flour | mixed legume diet (L, S, O).Tender pods |
| | *Kalo Batura* (black seed) /*Pahelo batura* (brown mottled) | Sub-erect | Sep-Feb | Tender pods and seeds, mixed with millet or buck-wheat, | Raw leafy vegetables, rough 'chapatti' (S,O) whole plant as fodder, manure (S, O) |
| **Lens esculenta* Moench. (Ranipool to Phensang) | *Masuri dal* | Bushy | Oct-Feb | Grains cooked as 'dal' or as mixed meal with Lettuce leaf, palak, amaranth ('dhuti ghans') and spice | Light meal taken during severe jaundice, indigestion and loss of appetite (N), in measles (L) |
| **Lespedeza speciosa* Schindl. (2000-4000m, amsl) | *Chikley* | Shrub | June-Oct | Leaf cut into pieces, paste | Used in skin rash (L) |
| **Lespedeza elliptica* Michx. (1500-4200m, amsl) | *Chikley* | Vine | July-Oct | Leaf pieces made into paste | Used in skin rash (L) |
| **Macrotyloma uniflorum* (Lam.) Verdc., 100-2500m, amsl | *Gahat* | Sub-erect | June-Sep | Cooked as 'dal' or processed of water-soaked seeds or grains | Taken to withstand extreme cold, kidney |
| *Phaseolus lunatus* L. (Ranipool to | **Ghew simi* Vegetables (N), (White seed) anti-diabetic (N, | Pole type | July-Oct | Tender pods cooked, mixed with leaves of palak, cabbage, and radish (white), no potato | monks),in digestive |

| | | | | | |
|---|---|---|---|---|---|
| Chungthang) | | | | | disorder, constipation (N, L), high cholesterol (N, B, S) |
| **Ghew simi (suno and talo)* | Pole type Break-fast or evening meal (N, B, L), in pregnancy cooked, stored cholesterol (N, B, S) | July-Oct Large and bold seeds (Tulo) | | Powdered seeds (small-suno) sun-dried, mixed with maize flour to form bread or besan served as pulse meal at lunch (N), high | |
| *Phaseolus lunatus* L. (Phodong to Lachen /Lachung valley) | **Lachen Tibi* germinated seeds) cholesterol, low blood pressure), mixed meal during fever (S, B, D) | Pole type | Aug-Oct | Sprouted seeds as such or mixed with potato, ginger, millet (flour) and cardamom for medicinal (anti- or simply cooked as 'dal' | At break-fast (only |
| *Singtamey simi* | Pole type Vegetables (N, B), | Aug-Oct | | Tender pods cooked, raw plants, mixed with | |
| othe | Mulching (N, B, L) | fodder (N, S), | | pulses during festivals | |
| *Ghew bori* | Pole type Food supplement in nutrition (N, L) | July-Oct | vegetables for high | Seed flour mixed with water to form 'bori' | |
| *Phaseolus vulgaris* L. (Ranipool to beyond Chungthang) Pulse as raw | *Kalo Mantulall simi* buckwheat or millet bread (B, L) | Pole type | July-Oct | Seeds soaked in water, sprouted seeds mixed with ginger, onion, garlic, palak, and other herbs -us or boiled five min, kept 4-5 h, water discarded and cooked meal with | Delicious meal in cultural and religio- festivals (N, L, B, others). |
| *Alpatre simi* | Pole type Vegetables (N, S) | July-Nov | | Young pods boiled and cooked | |
| *Harey simi* pulses served | Pole type Vegetables (N, L) | July-Nov , | | Cooked sprouted legumes; curry mixed with other as mixed mealat socio-cultural festivals ( B, L, S) | |
| *Pisum sativum* L. | **Matar/Kerau* | Vine | Oct-Feb | Cooked as 'dal' or as mixed (Ranipool to Chungthang) Tender pods, seeds pods and leaves | Nutritious daily meal, with masuri, arhar, chana or L, O), as salad (N), |
| **Pithecellobium dulce* benth. (Ranipool) | *Jilebi* | Tree | Perennial | Juices of leaves and fruits extracted in water by wooden mortar | Used in fever (N, L) |
| *Tamarindus indica* Linn. (900m, amsl) | *Tittiri* Used as pickle, in | Tree (Flowering Nov-Jan) | Perennial | Mealy fruit pulp separated from seeds, mixed with water to form paste, mixed with tomato, salt, slight sugar, turmeric and chilli | fever, appetizer (N, L, B) |
| *Trifolium repense* (Chungthang valley) | *Setclove* | Creeping | Perennial | Whole plant, often mixed with Grasses and *T. pratens* | Fodder to increase milk production (B,L) |
| **Trigonella foenum-graecum* L. (up to 1700m) | *Methi* morning in diabetes | Oct-Feb | Herb | Seeds or sprouted seeds mixed with vegetable preparation, (N, L, B, O) | As spice, and seed-soaked water taken in empty stomach at |
| *Vicia faba* L. (Phensang to upper Chungthang 1000-2400m) | *Bakulla* | Oct-Jan | Erect | Young pods and whole plant. Dried bean fried, roasted or mixed with pea, gram, mung, | Pods cooked as ((u( vegetables, mixed diet for socio-cultural |

| | | | | | |
|---|---|---|---|---|---|
| | | | | germinated to form soup, eaten with rice during 'rakhi' festival | festivals (N), green manuring (N, L, O) |
| *_Vigna mungo_* ssp _viridis_ (L.) Hepper | _Panheli dal_ (green Seed) | Semi-spreading | Aug-Oct | Seeds boiled with turmeric powder in pressure cooker for and boiled for 2-4 min minimum | Medicinal (for low blood pressure and Dal diet (N), often with (N) |
| *_Vigna mungo_* ssp _niger_ (L.) Hepper (2400-2800m, amsl) | _Kalo dal_ (black seed) | Semi-spreading | Aug-Oct | Cooked as pulse meal or 'dal' or mixed with radish, cabbage, salt and lettuce leaves | Medicinal (at constip--ation, weakness) and as mixed meal (N, L) |
| _Vigna umbellata_ (Thunb.) Ohwi and Ohashi (900-3000m, amsl) Phodong, Chungthang | _Rato Maysum dal_ (red-seeded) | Twining | July-Oct | Raw plants or tender pods cook -ed. Seed flour mixed with Paddy straw and water to form feed meal | Vegetables or cattle feed (N) |
| Lower part of Lachung Chu/Lachen Chu Lachen Monastery | _Kalo Maysum dal_ (black-seeded) | Vine | July-Oct | Mixed with other pulses, maize millet, and salt. Whole plant | Energetic cattle feed, green manure (N, L) |
| *_Seto Maysum dal_ | Twining (white-seeded) | July-Oct | | Dry seed or cooked, mixed and boiled with pea and urd. Tender Pods with young seed | Used as 'dal' and vegetables (N), in high cholesterol (N, |
| *_Tulo Maysum dal_ | Vine | Aug-Nov | | Mixed with pea and chana, palak, carrot, cooked as mixed eaten during extreme flavored pulse meal | A delicious plate cold, fever (N, L, O) |
| _Vigna unguiculata_ (L.) Walpers (Phodong-Lachung) | *_Tuney bori_ | Sub-erect | July-Oct | Grains are cooked, or mixed with local herbs or processed into stuffed 'pakodi'. Whole plant mulched or uprooted | Cooked dal without salt taken to prevent child pox, whole plant as Fodder (N, L, O) |
| _Vigna sinensis_ (4000m,amsl, Yumthang) | _Thangre_ | | | Seed flour mixed with paddy straw | Fodder, green manure (B) |

N-Nepalese, B-Bhutias, L-Lepchas, S-Sherpas, O-others (Dokpas, Limbos, Tibetans etc.), * plant used in medicinal purposes

**Table 2. Ethnobotanical consensus index for traditional legume plant usage categories based on response of a total 210 selected informants during 2009-2011in different parts of Sikkim Himalayas**

| Categories of usage | Number of use-Reports (Nur) | Number of taxa (Nt) | Informants' consensus Index factor ($F_{ic}$) [a] |
|---|---|---|---|
| Vegetables (pod/leaf) | 120 | 10 | 0.92 |
| Pulse-meal ('dal') | 164 | 14 | 0.92 |
| Pickle | 43 | 02 | 0.97 |
| Diabetes | 27 | 02 | 0.96 |
| Digestive disorder/dysentery and constipation | 30 | 05 | 0.86 |
| Fever | 78 | 06 | 0.93 |
| Pregnancy | 69 | 01 | 1.00 |
| Jaundice | 138 | 02 | 0.99 |
| High blood Cholesterol | 117 | 03 | 0.98 |
| General health (as Nutritious diet) | 88 | 10 | 0.89 |
| Anthelmintic/worm | 65 | 02 | 0.98 |
| Backbone pain | 49 | 01 | 1.00 |
| Menstrual disorder | 87 | 01 | 1.00 |
| Other medicinal purposes [b] | 102 | 11 | 0.90 |
| Fodder | 183 | 09 | 0.95 |
| Green manuring | 200 | 07 | 0.96 |
| Socio-religious purposes | 95 | 09 | 0.91 |

[a] $Fic = N_{ur}-N_t/(N_{ur}-1)$, providing a value between 0 and 1, where high value indicates a high rate of consensus among informants
[b] other medicinal uses include-child pox, skin rash/disease, purgative and hemolytic, cut and wounds, cold bite, snake bite, loss of appetite, measles, and kidney problem

**Table 3. Ethnobotanical consensus index for traditional legume recipes based on response of a total 210 selected informants during 2009-2011in different parts of Sikkim Himalayas**

| Categories of preparations | Number of use-Number of Reports (Nur) | Informants' consensus taxa (Nt) | index factor ($F_{ic}$) [a] |
|---|---|---|---|
| Cooked and boiled | 189 | 20 | 0.89 |
| Sprouted seeds | 147 | 04 | 0.97 |
| Cereal-mixed dish | 89 | 04 | 0.97 |
| Spice-mixed flavored dish | 111 | 06 | 0.95 |
| Seed flour | 165 | 06 | 0.94 |
| Seed paste | 48 | 05 | 0.91 |
| Processed or roasted | 39 | 03 | 0.94 |
| Salads | 93 | 01 | 1.00 |
| Juices (leaves/fruits) | 56 | 03 | 0.96 |
| Bark paste | 77 | 02 | 0.98 |

[a] $Fic = N_{ur}-N_t/(N_{ur}-1)$, providing a value between 0 and 1, where high value indicates a high rate of consensus among informants


**Figure 1. Study areas in Sikkim marked (■); KNP denotes 'Khangchendzonga National Park' and 'NH' represents National Highway 31A.**

consecutive years, 42 ethnotaxa that have considerable utility in food, fodder, medicinal, general health care, and socio-religious purposes have been documented (Table 1). Among the cultivated legumes, species of *Vigna* and *Phaseolus* occupied major share in traditionally managed homestead, representing 8 taxa under each genus. Among rest of the 26 plants, 16 genotypes were represented by solitary species of *Acacia*, *Abrus*, *Pisum, Cicer*, *Lens*, *Cajanas*, *Glycine*, *Macrotyloma*, *Tamarindus*, *Vicia*, *Trigonella*, *Trifolium*, *Indigofera*, *Pithecellobium, Clitorea* and *Bauhinia*, while two species of *Lespedeza*, and four genotypes each of *Lathyrus* and *Cassia* were documented in the study areas. Although most of these genera are mainly adapted in tropical to sub-tropical (500-3500m, amsl) climate, *Lathyrus sativus* L. and *Lespedeza* are grown in much wider altitudinal range with tropics to alpine (500-4200 m, amsl) climate, suggesting better hardiness of these two legumes in the study area. Several genotypes of *Lathyrus* have been identified in mid-hill conditions of Himachal Pradesh and sub-alpine region of Western Himalayas (Arora and Chandel, 1972; Kumari and Prasad, 2005). However, identification and documentation of four genotypes of *Lathyrus* was carried out for the first time in the present study area.

**Resource utilization by ethnic tribes**

Diversity of utilization of legumes for food by the ethnic communities is noteworthy in the study areas. Tamang *et al*. (2007, 2009) reported 29 types of fermented foods, 9 types of alcoholic beverages, and 85 types of traditional non-fermented foods of different ethnic communities of Sikkim Himalayas. The present study, however, is mainly concentrated on non-fermented legume products, and revealed ethnic diversity in utilization of leguminous resources at different altitudes. Among the tribes, ethnic Nepalese and Lepchas dominated other communities, closely followed by Bhutias in use of plants. Sherpa, nomadic Dokpas and Limbos preferred species of *Phaseolus*, *Glycine*, *Lathyrus* at higher altitude for diverse purposes. The 42 plants and plant parts documented here have been used for food, fodder, medicinal, organic farming, fuel and socio-religious purposes (Table 1), and most of the plants have multiple uses (Table 2). Largest numbers of taxa (14) were used as pulse-meal while 20 plants were used as vegetables and to make nutritious dishes (Table 2). Cooking through boiling dominated the mode of preparation of food items using 20 taxa, and it was followed by spice (ginger, garlic, cardamom)-mixed flavored dish and seed flour from 6 plants, each. Cereal (millet, maize, rice, wheat, buck-wheat)-mixed dish and sprouted seeds were prepared with four taxa each, while pods/seeds of three taxa were roasted or processed to prepare food items. Raw seeds were served as salads only for *Pisum sativum* L, while fruit pulp of *Tamarindus* and flower of *Bauhinia* were used to make pickle. Interestingly, pulse-meal mixed with different legumes and cereals, and flavored with spices was identified as more popular lunch items among the tribes than the sole use of any particular pulse. This habit has immense significance in nutritional perspectives as most of the legumes particularly *Phaseolus*, *Vigna*, *Lathyrus*, *Cajanas*, *Cicer*, *Lens*, and *Pisum*, documented here, are known to contain high level of antioxidant polyphenolic compounds in dry, processed and raw plant parts and seeds (Lo´pez-Amoro´s et al., 2006; Siddhuraju and Becker, 2007; Pastor-Cavada *et al*., 2009; Chikanea *et al*., 2011). It is also worth mentioning that pulse-meal prepared with *Lathyrus* was always taken by ethic people as mixed diet, incorporating seeds of *Cicer arietinum* ('chana dal') in it at high altitude. This traditional habit has great scientific value as seeds of *Lathyrus* contain a fatal neurotoxin, β-ODAP, which is reportedly increased in extreme stress (cold, drought etc) conditions and can cause neurological disorder if it is consumed as sole source of food for prolonged period of time (Cocks *et al*., 2000) The 'Sherpas', 'Dokpas', and Lepchas at Chungthang (1800m) three predominant consumers of this legume, however, pledged ignorance about this fact, although they disclosed that they usually take only white-seeded ('seto-batura') type for preparation of their daily meal. This genotype was bold-seeded and contain low seed neurotoxin (<0.09%, Talukdar D, unpublished observation). The invention of bold-seeded grass pea type at high altitude is unique in Sikkim Himalayas, as it has immense significance in genetic improvement of this type for subsistence legume farming (Talukdar, 2011e, f). Among the ethnic food preparations, Nepalese preparations were the most diverse in variations of items and use of legumes well as non-leguminous food ingredients/supplements. The Lepchas, Bhutias and nomadic tribes like Sherpas and Dokpas were, however, more traditional and conserved in this regard. While Nepalese are increasingly using steel made utensils, Lepchas still is highly fond of different wooden types made up of bamboo shoot to prepare their foods, as reported earlier (Pal and Palit, 2011).

Ethno-medicinal uses of identified taxa included utility of plants in diabetes, digestive disorder and constipation, fever, jaundice, backbone pain, skin disease, high blood cholesterol, child pox, measles, kidney problem, and other minor purposes

(cold bites, cut and wounds etc.). Jana and Chauhan (2000) reported 16 ethnic formulations of legume medicine at Sikkim Himalayas in a rather limited search, but the detail investigation and consensus of reporting is not known in wider climatic conditions. In the present investigation, covering tropics to alpine range (500-4200m, amsl), out of 42 taxa documented, 24 plants (57%) have been found used as herbal medicines predominantly by Lepchas and Nepalese (Table 1). Interestingly, one plant *Phaseolus lunatus* L. ('ghew simi'- small and bold seeded) was found used as pulse-meal during pregnancy by Nepalese people. Different varieties of this plant were also disclosed as effective to lower blood sugar and high blood cholesterol levels. Seeds of methi were also used as anti-diabetic by almost all tribes in the present study areas, although use of this medicinal herb in diabetes was earlier attributed to only Nepalese tribes (Chhetri *et al*., 2005). Exclusive use of *Lespedeza* for skin rash during extreme cold, *Lens esculenta* during measles, *Macrotyloma uniflorum* to prevent kidney disorder and *Cassia javanica* as purgative by Lepchas and of *Clitoria ternatea* for snake bite, *Vigna mungo* ssp *viridis* ('pahenlo dal') in low blood pressure and physical weaknesses by Nepalese community are also noteworthy to mention. Roles of two prominent legumes, *Lens esculenta* and *Cajanus cajan*, as hepato-protective pulses during jaundice and the latter in menstrual disorder also were disclosed by Nepalese tribes. Similarly, at lower altitude (500-1000m, amsl), bark paste of 'gum arabic' (*Acacia arabica*) and seed paste of *Abrus precatorius* were exclusively used by this community to treat cut and wounds and backbone pain, respectively. At least 6 plants have been used to counter fever; of which juices extracted from leaves and fruits of *Pithecellobium dulce*, cooked pulse-meal of *Macrotyloma uniflorum* and *Vigna umbellata* and liquid paste of *Cassia occidentalis* leaf had high acceptance among the ethnic community. Pharmacological preparations include seed/bark paste, water-soaked seeds, pulse-meal, leaf paste, juice and cooked vegetables (Table 1).

Besides cultivated for food and medicinal purposes, number of legume plants has been utilized for fodder, green manuring, fuel and religious purposes in the study areas (Table1, 2). Altogether, 9 plants have been identified which used extensively as fodder or animal feed, of which *Trifolium repense* or white clover was preferred mostly by Bhutias. Local 'Lamas', however, informed gastric problem or bloating of cattle in taking this plant which was in agreement with an earlier report in Bhutan Himalayas (Roder *et al*., 2007). Among the other legumes, species of *Vigna* have been widely used by ethnic tribes at different altitudes, and one taxa *Vigna sinensis* had exclusive use by Bhutias, as revealed during interaction and cross-checking at Lachen valley and Lachung regions. Likewise, all four genotypes (differentiated on the basis of seed colour) of *Lathyrus sativus* or grass pea were used as forage crops, but the black and brown-mottled-seeded type had more use than white-seeded one. 'Sherpas', 'Dokpas' and 'Limbos' emerged as dominant tribes in utilizing *Lathyrus* as fodder crop at high altitude (Chungthang, Lachung, Lachen), while Nepalese and Bhutias use it at comparatively lower altitude (Phodong, Phensang, Mangan). Presumably, tall, bushy and highly branched habit of black and brown-seed types (Kalo or Pahelo batura) have the greater potential to use as forage than short and thin white-seeded type (seto-batura). Seed coat colour varies greatly in Indian grass pea genotypes, and its relation with nutritional component of seed has been established (Talukdar and Biswas, 2005; Talukdar, 2009b). Although new methods are being introduced to improve hill-based organic farming, almost all local ethnic tribes (except Dokpas) practiced mulching of whole plant as one of the effective ways to preserve soil fertility. Recycling and green manuring are two other methods followed by hill people to maintain soil nitrogen status. Although all legumes under study have this potential, 7 plants were documented for their extensive use as green manuring, represented by species of *Phaseolus, Cicer*, *Vigna* and *Lathyrus*. Although Nepalese were identified as dominant ethnic tribes using legumes as green manuring, Bhutias and Lepchas are knowledgeable enough utilizing legumes as green manure in their traditional homestay garden, 'khet' and terrace farming.

Role of legume crops as source of fuel and in socio-religious festivals was also documented in the present inventory, as studied in sub-Himalayan plain also (Talukdar and Talukdar, 2012b). Dry parts of two plants, *Cajanas cajan* and *Cassia alata*, were the sources of fuel for the hill tribes, particularly Nepalese. While *Cajanas* was used in this purpose from low tropics to mid-temperate (500-2000m, amsl), *Cassia alata* mixed with *Lantana camara*, a dangerous invasive shrub of family Verbenaceae, and *Leucaena leucocephala*, an invasive legumes, was burned as fuel at low altitude tropical climate. The Nepalese 'Gorkhas' were found using *Cassia*, while 'Limbos', and 'Sherpas' preferred *Cajanas* to meet immediate fuel demand for low-intensive daily use. The cultural as well as socio-religious festivals are an integrated part of hill life, and legumes provide beautiful cuisine in traditional cultural rituals and festivals. In the present study, 9 plants were documented as used either directly (*Clitoria ternatea*) or to prepare delicious dishes (*Phaseolus vulgaris, Vigna mungo, Vicia faba* etc.) during different socio-cultural festivals. For instance, the '*Newar*' festivals include the *Kokkti-Purney* or *Kwanti Purnima* and the *Rakhi Purnima*. On the day of *Rakhi-Purnima*, '*Newar*' community was found to prepare a traditional recipes of special mixed soup comprising of newly germinated pulses (known as *Kwathi* or *Kokti*) of beans (*Ghew simi, Singtamey simi, Mantulall simi, Rajmah*), Mung (*Kalodal, Panhelidal*), Field Peas (*Matar/Kerau*), Horse gram (*Gahat*), Ricebean (*Masyam*), Soybean (*Bhatmash*), Cowpea (*Tuneybori),* Gram (*Chana dal*) and lentil *(Musuridal*). The mixed pulses were initially soaked in water and allowed until the sprouts come out. Thus mixed beans sprouts are used to prepare traditional delicacies with local spices (ginger, cardamon) and salts. Besides this particular occasion, delicious pulse-dishes were also prepared with *Phaseolus*, *Vigna*, *Pisum*, *Vicia*, and *Cice*r, mixing *Spinacea* (palak), Lettuce, Cabbage, carrot and local medicinal herbs and spices in different combinations to celebrate special occasions (wedding, child-birth, crop harvesting, new-year etc) in the form of *pitri puja*, *kul puja*, *Toksok-fingma*, *Nambun* (Lepcha New Year), *Himtongsing* / *Sitongsing* (traditional rituals of ethnic Limboos) and the like by the different local communities as per their culture or religion from time to time, as experienced during three years of study. The communities thus protect the agro-biodiversity of pulses and crops grown in the Himalayas through cultural agro-biodiversity (Tamang *et al*., 2009; Bhasin, 2011).

**Consensus of the traditional knowledge on use and recipes of legume plants/parts**

The result indicates an interesting twist in consensus of traditional knowledge on use of legumes within the study areas. Results in Table 2 suggested a high level of consensus of TK for edible as well as medicinal plants within the ethnic community. The relative frequency of TK for each individual ethnotaxa from the interviews was high (mean RF = 0.90 ± 0.03). The pattern of usage was broadly divided into 16 categories in which the informant consensus resulted in $F_{ic}$ ranging from 0.86 to 1.00 (Table 2) with a mean value of 0.94 ± 0.01. This indicated high range of consensus among the informants compared to similar studies in other countries (Heinrich, 2000; Amiguet *et al*., 2005). In the present study, fairly high number of people (120-164) exhibited consensus in disclosing 24 plants used to prepare vegetables and pulse-meal ('dal'), leading to Fic >0.90. For medicinal uses of plants, 69 informants identified one plant, *Phaseolus lunatus* ('ghew simi') for use during pregnancy, whereas 49 people were uniform to disclose *Abrus precatorius* in treating backbone pain. Likewise, 87 people exhibited consensus in identification of *Cajanas cajan* to treat menstrual disorder. This led to Fic value to touch 1.00 in all the above three cases. Except the category denoting digestive disorder/constipation/diarrhea and general health where Fic values were calculated just below 0.90, Fic ranged between 0.90-0.99 in rest of the cases including use of plants as fodder, in green manuring and socio-religious purposes (Table 2). The consensus within informants regarding recipes of food items was also studied, dividing modes of preparations (food and medicine purposes) into 10 broad categories (Table 3). Results indicated Fic ranged between 1.00 (preparation of salad) to 0.89 (cooked and boiled food) with a mean value of 0.95 ± 0.006. Among the food recipes, sprouted seeds and cereal-mixed dish along with spice-flavored items exhibited higher Fic values than seed paste and flour, indicating general preference of mixed diet over sole item and good consensus in the issue. The preparation for herbal medicinal practices included seed and bark paste and juices of leaves and fruits; of which informant consensus was much higher for bark paste and leaf/bark juices (Fic-0.96-0.98) than use of leaf paste (Fic-0.91) (Table 3). High level of consensus in use of herbal medicine was also found in South Indian population of ethnic tribes (Ragupathy and Newmaster, 2009). The high value indicated large number of people reporting usage of a same plant in different study areas, while lower Fic suggested people reporting several plants for a particular illness/purposes leading to high Nt values. Although, high Nt values revealed occurrence of diversity of plant taxa to treat particular ailment among the communities, its low value in most of the cases strongly justified uniformity and conservation of traditional knowledge within the community.

In conclusion, the present study revealed rich diversity of traditional knowledge on uses of legume flora in Sikkim Himalayas, quite distinct from its pattern of utilization in tropical Bengal (Talukdar and Talukdar, 2012a).The variations in number of flora, mode of preparation of food, usage categories and other types of resource utilization is worth mentioning. Identification of legumes in herbal medicinal practice by local tribes is also an important outcome. Collection of *Lathyrus* germplasm is also worth mentioning as this group of plant has immense importance in cytogenetics, genomics and proteomic research to develop as a model crop in holistic legume research (Talukdar 2010a, b, 2011g). The study revealed conservation of traditional knowledge, rituals and wisdom among the ethnic community, as evidenced by high consensus among informants per category, and all the major and minor ethnic tribes are equally important in preservation of Himalayan legume through their rich cultural traditions.

**ACKNOWLEDGEMENT**

Authors are highly grateful to Mr. Ganesh Kumar Chettri (Hee-Bermoik, Martan village, West Sikkim), and local people in every walk of life during the entire course of the present study.

## REFERENCES

Alexiades, M.N. 1996. Selected Guidelines for Ethnobotanical Research: A Field Manual. Advances in Economic Botany, The New York Botanical Garden, p10.

Amiguet, V.T., Arnason, J.T., Maquin, P., Cal, V., Sanchez Vindas, P. and Poveda, L. 2000. A consensus ethnobotany of the Q'eqchi' Maya of southern Belize. *Economic Botany*, 59(1): 29–42.

Arora, R.K. and Chandel, K.P.S. 1972. Botanical source areas of wild herbage legumes in India. *Tropical Grasslands*, 6(3): 213-222.

Badola, H.K. and Aitken, S. 2003. The Himalayas of India: A treasury of medicinal plants under siege. *Biodiversity*, 4:3-13.

Bhagya, B. and Sridhar, K.R. (2009). Ethnobiology of coastal sand dune legumes of South West coast of India. *Indian J Traditional Knowledge*, 8(4): 611-620.

Bhasin, V. 2011. Settlements and land-Use Patterns in the Lepcha Reserve-Dzongu Zone in the Sikkim Himalaya, India. *Journal of Biodiversity*, 2(1) (2011) 41-66.

Bennet, S.S.R. 1983. Ethnobotanical studies in Sikkim. *Indian Forester*, 109: 577–581.

Bernard, H.R. 1994. Research Methods in Anthropology: Qualitative and Quantitative Approaches, Newbury Park, California.

Chhetri, D.R., Parajuli, P. and Subba, G.C. (2005). Antidiabetic plants used by Sikkim and Darjeeling Himalayan tribes, India. *Journal of Ethnopharmacology*, 99:199–202.

Chhetri, G.K. 2011.www.dhungayhomestay.org., Hee-Bermoik, 13th mile, Martan, West Sikkim, 2011.

Chikanea, M.R., Parwate, D.V., Ingle, V.N., Chhajjed, S. and Haldar, A.G. 2011. *In vitro*, antioxidant effect of seed coats extracts of *Vigna mungo*. *Journal of Pharmacy Research*, 4(3): 656-657.

Cocks, P., Siddique, K. and Hanbury, C. 2000. Impact of stress on neurotoxins. In: *Lathyrus*: A new grain legume, RIRDC, Australia, pp. 12-24.

Etkin, N.L. 1993. Anthropological methods in ethnopharmacology. *J. Ethnopharmacol*., 38: 93–104.

Granati, E., Bisignano, V., Chiaretti, D., Crinò, P. and Polignano, G.B. 2003. Characterization of Italian and exotic *Lathyrus* germplasm for quality traits. *Genet. Resour.Crop Evol*., 50: 273-280.

Gurung, B. 2002. The medicinal plants of Sikkim Himalaya, Maples, Chakung.

Hajra, P. K. and Verma, D.M. 1996. Flora of Sikkim. Botanical Survey of India, Ministry of Environment & Forests, G.O.I., Kolkata, 1: 1-14.

Heinrich, M. 2000. Ethnobotany and its role in drug development, *Phytotherapy Res*., 14(7): 479–488.

Idrisi, M.S., Badola, H.K. and Singh, R. 2010. Indigenous knowledge and medicinal use of plants by local communities in Rangit Valley, South Sikkim, India. *NeBIO*, 1(2): 34-45.

Jain, S.K. 1991. *Dictionary of Indian Folk Medicine and Ethnobotany*. Deep publications: New Delhi, India.

Jana, S.K. and Chauhan, A.S. 2000. Ethnobotanical aspects of legumes in Sikkim. *Journal of Non-timber Forest Product*, 7 (1-2): 46-52.

Jha, A., Rao, A., Jha, S. and Suhag, V. 2004. A preliminary survey of plants used as food by Lepchas of Dzongu area in Sikkim, India. *Crop Research*, 28: 135-137.

Joshi, V., Rawat, M.S., Sharma, A.K., Kumar, K. and Panda, A.K. 2011. Traditional knowledge of natural disaster mitigation and ethno medicine practices in Himalaya with special reference to Sikkim. *Indian J Traditional Knowledge*, 10(1): 198-206.

Kumari, V and Prasad, R. 2005. Model plant type in 'Khesari' (*Lathyrus sativus* L.) suitable for hill farming. *Lathyrus Lathyrism Newsletter*, 4: 15-17.

Lo´pez-Amoro´s, M.L., Herna´ndez, T. and Estrella, I. 2006. Effect of germination on legume phenolic compounds and their antioxidant activity. *Journal of Food Composition and Analysis*, 19: 277–283.

Maikhuri, R.K., Semwal, R.L., Rao, K.S., Nautiyal, S. and Saxena, K.G. 1997. Eroding traditional crop diversity imperils the sustainability of agriculture system in Central Himalaya. *Current Science (Research Communication)*, 73: 777-782.

Pal, S. and Palit, D. 2011. Traditional knowledge and bioresource utilization among Lepcha in North Sikkim. *NeBIO*, 2(1): 13-17.

Pandey, V.N. 1991. Medico-Ethno-Botanical Explorations in Sikkim Himalayas, Central Council for Research in Ayurveda and Siddha, Government of India, New Delhi.

Pastor-Cavada, E., Juan, R., Pastor, J.E., Alaiz, M. and Vioque, J. 2009. Antioxidant activity of seed polyphenols in fifteen wild *Lathyrus* species from South Spain. *LWT-Food Science and Technology*, 42: 705–709.

Pradhan, B.K. and Badola, H.K. 2008. Ethnomedicinal plant use by Lepcha tribe of Dzongu valley, bordering Khangchendzonga Biosphere Reserve, in North Sikkim, India. *Journal of Ethnobiology and Ethnomedicine*, 4: 22.

Ragupathy, S. and Newmaster, S.G. 2009. Valorizing the 'Irulas' traditional knowledge of medicinal plants in the Kodiakkarai Reserve Forest, India. *Journal of Ethnobiology and Ethnomedicine*, 5: 10.

Roder, W., Dorji, K. and Wangdi, K. (2007). Implications of white clover introduction in East Himalayan grasslands. *Mountain Research and Development*, 27(3): 268-273.

Schultes, R.E. 1962. The role of the ethnobotanist in the search for new medicinal plants. *Lloydia*, 25 (1962) 257–266.

Siddhuraju, P. and Becker, K. 2007. The antioxidant and free radical scavenging activities of processed cowpea (*Vigna unguiculata* (L.) Walp.) seed extracts. *Food Chemistry*, 101:10–19.

Srivastava, T.N., Kapaki, B.K. and Atal, C.K. 1987. Ethnomedico-botanical investigations in Sikkim. *Journal of Economic and Taxonomic Botany*, 11: 413–421.

Subba, J.R. 2009. Indigenous knowledge on bio-resources management for livelihood of the people of Sikkim. *Indian J Traditional Knowledge*, 8(1): 56-64.

Tamang, J.P., Chettri, R. and Sharma, R.M. 2009. Indigenous knowledge of Northeast women on production of ethnic fermented soybean foods. *Indian J Traditional Knowledge*, 8: 122-126.

Tamang, J.P., Thapa, M.P., Sharma, R.M., Rai, A.K., Rai, P. and Dhakal, R. 2007. Carrying Capacity of Teesta Basin in Sikkim. Centre For Inter-disciplinary Studies of Mountain & Hill Development, University of Delhi, Delhi and Department of Botany, Sikkim Government College, Gangtok, Sikkim, vol VIII (Biological Environment and Food Resources), pp.1-139.

Tambe, S., Lachungpa, U., Swaroop, B., Bhadauria, S.B.S. and Arrawatia, M.L. 2003. *Plan for Medicinal Plants Conservation and Sustainable Utilization, Sikkim*. Department of Forest, Environment and Wildlife. Government of Sikkim, Gangtok.

Talukdar, D. 2009a. Recent progress on genetic analysis of novel mutants and aneuploid research in grass pea (*Lathyrus sativus* L.). *African Journal of Agricultural Research*, 4(13):1549-1559.

Talukdar, D. 2009b. Dwarf mutations in grass pea (*Lathyrus sativus* L.): Origin, morphology, inheritance and linkage studies. *Journal of Genetics*, 88: 165-175.

Talukdar, D. 2010a. Reciprocal translocations in grass pea (*Lathyrus sativus* L.). Pattern of transmission, detection of multiple interchanges and their independence. *Journal of Heredity*, 101: 169-176.

Talukdar, D. 2010b. Cytogenetic analysis of a novel yellow flower mutant carrying a reciprocal translocation in grass pea (*Lathyrus sativus* L.). *Journal of Biological Research-Thessaloniki*, 15: 123 – 134.

Talukdar, D. 2011a. Flower and pod production, abortion, leaf injury, yield and seed neurotoxin levels in stable dwarf mutant lines of grass pea (*Lathyrus sativus* L.) differing in salt stress responses. *International Journal of Current Research*, 2(1): 46-54.

Talukdar, D. 2011b. Effect of arsenic-induced toxicity on morphological traits of *Trigonella foenum-graecum* L. and *Lathyrus sativus* L. during Germination and early seedling growth. *Current Research Journal of Biological Sciences*, 3(2):116-123.

Talukdar, D. 2011c. Isolation and characterization of NaCl-tolerant mutations in two important legumes, *Clitoria ternatea* L. and *Lathyrus sativus* L.: Induced mutagenesis and selection by salt stress. *Journal of Medicinal Plants Research*, 5(16): 3619-3628.

Talukdar, D. 2011d. Morpho-physiological Responses of Grass Pea (*Lathyrus sativus* L.) Genotypes to Salt Stress at Germination and Seedling Stages. *Legume Research*, 34(4): 232-241.

Talukdar, D. 2011e. Genetics of pod indehiscence in *Lathyrus sativus* L.. *Journal of Crop Improvement*, 25: 1-15.

Talukdar, D. 2011f. Bold-seeded and seed coat colour mutations in grass pea (*Lathyrus sativus* L.): Origin,

morphology, genetic control and linkage analysis. *International Journal of Current Research*, 3: 104-112.

Talukdar, D. 2011g. The aneuploid switch: Extra-chromosomal effect on antioxidant defense through trisomic shift in *Lathyrus sativus* L. *Indian Journal of Fundamental and Applied Life Sciences*, 1(4): 263-273.

Talukdar, D. and Biswas, A.K. 2005. Induced seed coat colour mutations and their inheritance in grass pea (*Lathyrus sativus* L.). *Indian J. Genet*., 65: 135-136.

Talukdar, D. and Talukdar, T. 2012a. An inventory of alien invasive legumes at Gangetic West Bengal with a case study of allelopaythy. *International Journal of Current Research*, 'in press'.

Talukdar, D. and Talukdar, T. 2012b. Floral diversity and its indigenous use in old basin ('Khari) of river Atreyee at Balurghat block of Dakshin Dinajpur district, West Bengal. *NeBIO*, 'in press'.

The International Plant Names Index, www.IPNI.org., The Royal Botanic Gardens, Kew, The Harvard University Herbaria, and the Australian National Herbarium.

Trotter, R. and Logan, M. 1986. *Informant consensus: a new approach for identifying potentially effective medicinal plants. Plants in indigenous medicine and diet: biobehavioural approaches*, Redgrave Publishers: Etkin NL, New York, pp. 91–112.

Vaz Patto, M.C., Skiba, B., Pang, E.C.K., Ochatt, S.J., Lambein, F. and Rubiales, D. 2006. *Lathyrus* improvement for resistance against biotic and abiotic stresses. From Classical breeding to marker assisted selection. *Euphytica*, 147: 133-147.

Yadav, R.K., Deka, B.C. and Sanwal, S.K. 2009. Genetic resources of vegetable crops of North Eastern Himalayan Region. ENVIS Bulletin: Himalayan Ecology, ENVIS Centre, GBPIHED, p17.

*******