Indian Journal of Natural Products and Resources
Vol. 13(1), March 2022, pp. 105-111

Gynocardia odorata R. Br., a poisonous plant made edible by the *Khasi* tribe of Meghalaya using traditional knowledge

H Tynsong[1*], M Dkhar[2] and B K Tiwari[3]

[1]Ministry of Environment, Forest and Climate Change, North Eastern Regional Office, Shillong 793021, Meghalaya, India
[2]Union Christian Collage Umiam, Ri Bhoi, Shillong 793122, Meghalaya, India
[3]Labanyamayee, Forest Colony, Shillong 793001, Meghalaya, India

Received 18 May 2020; Revised 23 December 2021

Traditional knowledge on the use of *Gynocardia odorata* R. Br. seed as medicine and poison has relatively been well documented, whereas there is still a lack of adequate research on its use as food. The seed of *G. odorata* is an important wild edible in the state of Meghalaya having well-established market chain and a consumer base. This study reports the traditional knowledge-based depoisoning process of the seed of *G. odorata* by the *Khasi* tribe of Meghalaya. The study revealed that the cost/benefit ratio is highly favourable to the collector/producer as well as traders leading to the domestication of the tree in arecanut agroforests. It is concluded that the valuable ethnobotanical knowledge of the people needs to be documented for sustainable utilization of this bioresource.

Keywords: Ethno-botanical knowledge, Management, Marketing analysis, Poisonous plants, *Sohliang*.

IPC code; Int. cl. (2021.01)- A01D 1/00, A61K 36/00, A23L 5/00

Introduction

People living in rural areas extract a wide variety of wild plant species from nearby forests and other wilderness areas. These plants are used as medicine, food, energy and in several other aspects of everyday life[1]. It is estimated that roughly 80% of the developing world including nearly 60 million indigenous people depend on wild fruits, seeds, poles for construction, and medicinal plants to satisfy their subsistence and supplemental income needs. Wild plants are gathered from varied habitats like natural forests, wetlands, agricultural fields fallow lands, abandoned mining areas and wastelands[1-3]. Tropical forests are the major reservoir of plant species used by rural poor[4]. According to research, wild plant harvesting adds significantly to the monetary income of India's rural poor[5-6]. The harvesting of wild plants by the Khasi tribe of south Meghalaya is not limited to the poor; it helps individuals of all levels of income earn money[7]. Forest managers are now increasingly aware of the role of wild edible plant species in generating income in recent years, and in some cases have begun to manage forests in ways that encourage the production of wild edibles and other non-timber forest products[8,9]. Majority of subsistence farmers living on forest fringes, cash income generated from the sale of forest produce plays a crucial role in their economy because the same is employed for vital cash-dependent transactions, viz., paying to the daily wage of labourers and buying of tools[1].

Gynocardia odorata R. Br. is a crooked, moderate to a large sized tree which grows in the dense tropical, temperate forest and on secondary forest margins[10-12]. It belongs to the family Achariaceae and the genus is monotypic[13,14]. It grows wild throughout India and other tropical countries of the world[15]. This plant is native to the moist evergreen forests of Northeast India[14] and it is fairly common in the evergreen forests of Meghalaya[16].

The seed of *G. odorata* locally known as *Sohliang* in *Khasi* (local dialect) is an important wild edible in the state of Meghalaya. In literature, it is described as a poisonous plant widely used as a medicine due to the presence of a variety of phytochemicals of medicinal value[11,12,17,18]. *G. odorata* is rich in protein, available carbohydrate, crude fibre, and mineral suggesting that it has a sufficient amount of nutritional value for human growth[19].

Poisonous plants are found in almost every country of the world and have become a part of daily life[20]. Poisonous plants pose danger to both the humans and

*Correspondent author
Email: h.tynsong78@gmail.com

animals life causing death or illness through accident[21]. Indigenous people all over the world use poisonous plants for different purposes such as hunting, fishing, wars and treatment of diseases[17].

Traditional knowledge on the use of *G. odorata* as a medicine, in hunting and fishing, as poison during wars and for treatment of diseases has been relatively well documented[17]. Whereas, there is still a lack of adequate research on its usage as a food. For example, the plant is used in various folk medicines and also in Ayurvedic formulations[22]. The juice from the paste of young shoots is used to combat jaundice[18]. The fruit and bark of *G. odorata* are used by different tribes of Arunachal Pradesh for the treatment of Diarrhea[23]. Tagin and Galo tribes of Arunachal Pradesh use crushed leaves and barks as poison in traditional fishing[24]. Also, *War Khasi* of Meghalaya and local tribes of Arunachal Pradesh use the barks of this tree in fish poisoning[25,26]. It is also reported that toxins extracted from *G. odorata* are often applied as effective treatments for some refractory symptoms of human diseases[27]. The fruits of *G. odorata* are sold on a large scale in the local markets of Meghalaya as wild edible[28]. There are also extensive studies on the pharmacological evaluation of the leaf extract for its anti-inflammatory, analgesic, and antipyretic properties[11,12,29]. However, a review of literature has revealed that there is very little information available on the use of *G. odorata* seed as food. This study reports the traditional knowledge of the *Khasi* tribe of Meghalaya related to the process of depoisoning of G. *odorata* seed for making it consumable as food.

Materials and Methods

Study area

Meghalaya situated in North-Eastern India, is a land-locked territory having a 22,429 km^2 geographical area lying between the latitudes of 25°47'N to 26°10'N and the longitudes of 89°45' E to 92°45' E and an altitude starting from 100-1965 m asl. It is bordered on the North-West, North and East by Assam and South and South-West by Bangladesh. The state encompasses three major hill regions namely the Khasi Hills, the Jaintia Hills and the Garo Hills. Meghalaya falls under the sub-tropical region and is characterized by a monsoonic climate. The average temperature ranges from 10 °C during cold months (November to February) to 27 °C during the warmer months (April to June). The average annual rainfall is 2420 mm[30]. The Meghalaya plateau is enormously dissected with irregular terrain in the western and northerly regions, and a non-stop escarpment with steep slopes to the south. The *Khasi*, the *Jaintia* and the *Garo* are the three primary tribal groups in the state of Meghalaya, together they comprise 86% of the state's overall population[31]. A high percentage of the population is engaged in occupations related to agriculture (85%), utilization of forests for collection of NTFPs (57%), timber harvesting (10%), and charcoal making (10%). Meghalaya is exceptionally biodiversity-rich and the Khasi and Jaintia Hills of the state are described as some of the richest botanical habitats of Asia[32]. Unique flora types ranging from tropical, subtropical and temperate forests, arising from the diverse topography, numerous climatic and edaphic conditions that favour the development of habitat and species diversity are found inside the state. The state is rich in forest resources with 76.33% (17 119 km^2) of the total geographical area under forest cover[33]. About 90% of the forest in the state belongs to communities and private individuals[34].

Methodology

In this study, four complementary approaches were adopted for data collection, namely, a) formal interview with the collectors/producers, b) field observation, c) market survey, and d) phytosociological study in natural forests (NF) as well as arecanut agroforests (AF)[7]. Household-level interviews with the collectors/producers were conducted in five contiguous villages namely viz., Nongkwai, Mawpran, Nongsder, Wahlakhiat, and Myllat to gather information about the fruiting period, harvesting time, drying, seed breaking, cooking, slicing, and soaking of seed. Market surveys were conducted in two important markets of the state namely Pynursla and Iew Duh (Shillong). The production and marketing were studied by using household questionnaires and PRA methods[35]. Respondents were asked to indicate the type of collection (for sale or home consumption) and then were asked to estimate the quantity collected. For understanding the economic value, data were collected on costs of collection/production, harvesting, processing, value addition, transportation, storage, and benefit-sharing. Marketing analysis was conducted only for Nongkwai village by interviewing local collectors, traders, local sellers and local buyers using the method used by Tiwari[36]. The marketing channels were investigated using methods described

by Raintree[37] and Karki[38]. To study the density and distribution of *G. odorata*, 40 quadrats (10 × 10 m size) were laid in the three NF as well as three AF. The plant specimen was identified with the help of the Flora of Jowai[39] and Herbarium of Botanical Survey of India, Eastern Regional Centre, Shillong was consulted for confirming the identification of the plant specimen.

Results

Density and production

We observed in the field that *G. odorata* R. Br. bears fruits both in the main stem as well as in the main branches. The mean density was found to be 12 (±5.80) stem/ha in AF and 8 (±3.5) stem/ha in NF. The density was more in AF because local people domesticated and propagated this plant. On average (10 trees enumerated), a plant bears 532 (±74.34) fruits and there are 15 (±0.46) seeds per fruit (Fig. 1). Therefore, on average, a tree produces 7980 (532 fruits × 15 seeds) seeds which weigh about 4 kg after drying. Hence, AF produces 48 kg/ha and NF produces 32 kg/ha of dried seeds. Household survey data on the number of households involved in the collection and the total quantity collected in each studied village is given in Table 1.

Management

In the state of Meghalaya, *G. odorata* R. Br. grows naturally in the tropical evergreen to sub-tropical evergreen forests at an altitude below 1000 m asl. However, due to its food value and economic potential, the plant is also domesticated in the arecanut agroforests and home gardens. The plant propagates naturally through seeds. No weeding and pruning is done.

Fig. 1 — Number of seeds in each fruit.

Harvesting

In the studied villages, majority of households collected the seeds for their own consumption. The collection of seeds for sale is mostly done by the landless and poor families. The fruits are collected during November to December. The collector/ producer climbs the tree and uses sharp knife to pluck the fruits. Then all the fruits are gathered together beneath the tree and covered with leaves of rgw trees till all the fruits have ripened which normally takes 6 to 12 days. When all the fruits are ripening, fruits were broken by using stick; thereafter the seeds are collected and washed thoroughly in water as seeds are covered by fleshy/jelly mesocarp. Fleshy/jelly mesocarp is not poisonous and people often eat them during fruit breaking. Washed seeds are carried to the village for drying. Harvesting of fruits/seeds is always done by men. During January to May, the processed fruits are available in the local markets. The expenditure incurred by the collectors/producers in harvesting, processing, transportation, and marketing of seed collected from 1 ha area is given in Table 2.

Drying

Seeds are kept in a basket made from bamboo locally known as *Ka Kriah* and dried in the sun for 15-20 days. Sun drying of seeds is required to make the embryo and endosperm shrink so that seed coat can be removed easily. Drying of seeds is always performed by women.

Cooking and processing

Dried seeds are then boiled in a pan on high flame continuously for 4 to 5 hours. The left-over boiled water is disposed of carefully away from the reach of children and livestock such as pigs, chickens as the

Table 1 — Name of village, number of households, type of collection and production of *G. odorata*

Name of village	No of HH	No of HH involved in collection		Quantity (kg) collected		Total production (kg)
		self	Sale	self	Sale	
Nongkwai	250	186	10	251	1201	1452
Mawpran	184	123	15	291	920	1211
Wahlakhiat	280	117	12	309	724	1033
Nongsder	110	75	10	180	200	380
Myllat	121	79	13	210	640	850

HH-household, village survey data collected in 2019

Table 2 — Mean annual expenditure/ha incurred by Collector/producer in harvesting, processing, transportation and marketing of *G. odorata* seed

Activity	Worker	No. of worker	Wage (Rs.)	Number of days/hours	Total cost (Rs.)
Harvesting	Men	2	400/day	2 days	1600
Drying	Women	1	30/hour	17 hours	510
Cooking	Women	1	30/hour	5 hours	150
Slicing	Women	2	240/day	1 day	480
Soaking	Men	1	400/day	1 day	400
Head load from forest to village	Men	1	400/day	1 day	400
Head load from village to road	Women	2	240/35 kg	-	480
Transport from road to market	Motor car	-	50/70kg*	-	50
Grand Total	-	10	-	-	4070

*Average total production per ha=40 (±8) kg/annum (average production both from NF and AF)

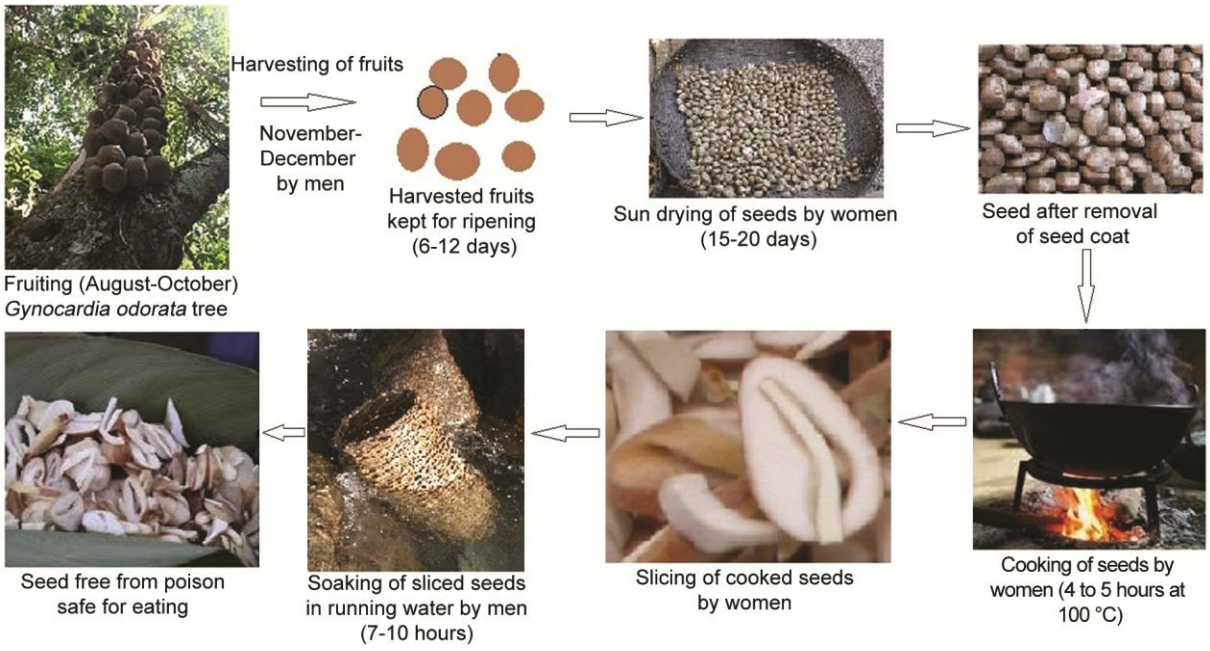

Fig. 2 — Illustration on steps involved in processing of *Gynocardia odorata* seeds.

water becomes very poisonous. Then the cooked seeds are thinly sliced and soaked in running water overnight to cleanse away the bitterness and poison present in the seed. After soaking, the sliced seed is safe for eating and selling in the local market. During cooking and processing, both men and women are involved. A diagrammatic illustration of steps involved in the processing of *G. odorata* by the *Khasi* tribe of Meghalaya is summarised in Fig. 2.

Market, pricing and economic impact

G. Odorata seeds have got a very good market in Meghalaya and fetches reasonably good income to the rural poor and landless farmers in the state. The producers bring the processed product to the local market where they sell it to the traders in bulk, who in turn sell it to the consumer at different local and regional markets. The product fetches a good price in Shillong which is the most important market in Meghalaya. In the year 2019, the traders of the Pynursla local market purchased the seeds from the producers at the rate of Rs 250/kg. Then traders sold the product to the consumer by measuring in a steel glass at the rate of Rs. 20 per glass weighing 50 g. Hence, consumers paid Rs. 400/kg to the trader. Since this product is used locally, the price remains almost stable year after year. The market channel of the produce is shown in Fig. 3.

A total of 1201 kg of *G. odorata* seed were marketed annually from Nongkwai village by 10 households, which was equivalent to 120.1 kg/year/household. With an average production of 120.1 kg/household (equal to 3 ha production), each household earned an average income amounting to Rs. 17,805/year (after deduction of management costs

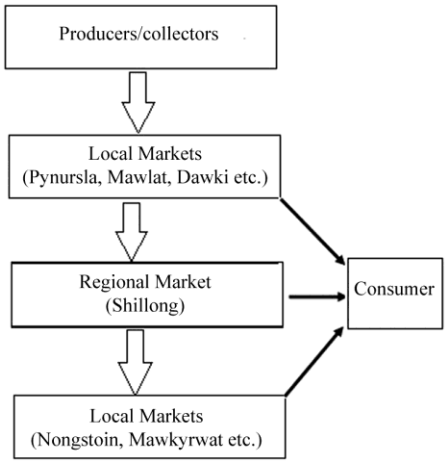

Fig. 3 — Marketing channel of *G. odorata* in Meghalaya.

amounts to Rs.12,220 from the trade of *G. odorata*'s seed. Based on our household survey, the average annual income at Nongkwai village for households engaged in *G. odorata* seed collection was found to be Rs. 70,000. Thus, 25.43 % of the mean annual income of the farmers engaged in *G. odorata* seed collection and trade came from this produce only. Further, for production of 1 ha, a trader earns a total of Rs. 16,000 (40×400) while the collector earns only Rs. 5,930 for selling off this forest produce.

Discussion

The study revealed that like several other indigenous tribal communities, the *Khasi* tribe of Meghalaya have a close association with nature and has developed a traditional knowledge system to use the poisonous seeds of *G. odorata* as food. The study also reveals that gathering and preparing *G. odorata* for self-consumption is carried out by almost every household in the studied villages. This valuable ethnobotanical knowledge of the people must be preserved and applied to the sustainable use of forest products. The Khasi, Jaintia, and Garo tribes in Meghalaya consume 110 wild-growing plants in raw or prepared form, according to ethnobotanical surveys[40].

In terms of cash income, the study revealed that 90% of collectors/harvesters were from landless and poor families. As a result, *G. cordata* can be considered a forest product for the poor, in contrast to NTFPs from south-west Cameroon and *Piper peepuloides* from south Meghalaya, which benefited a richer group who also harvested a larger volume[41,42]. However, this is also true in the case of *Phrynium* leaf another important NTFP of Meghalaya in which 80% of landless and poor families are involved in collection for cash income[7]. The majority of households in the studied village collected the seeds for their own consumption. However, in terms of quantity, more seeds were collected by the poorer families for sale. The value chain has developed and the collectors/producers are getting a good return on their investments. The study also revealed that the benefit is shared equally between the producer and trader. The traders invested Rs.10,000 for every purchase of 40 kg and sold the same at Rs.16,000. The final amount collectors/producers benefitted was Rs. 5,935 while traders earned Rs.6000 for 40 kg. The average production of *G. odorata* was 40 (±8) kg/year and the gross revenue was Rs.10,000/ha/year (40 × 250). This amount is much higher than the gross revenue of *Phrynium* leaf of Meghalaya amounting to Rs. 2880/ha/year and lesser than the gross production of other NTFPs collected from the state of Meghalaya, e.g. the gross production of *P. peepuloides* fetches Rs.1,75,000/ha/year and *Cinnamomum tamala* fetches Rs. 22,500/ha/year[7,42,43]. An output/input ratio of 1.4:1 was found in this study, which is lower than the 2.3:1 obtained from *Phrynium capitatum*, 1.8:1 from Amliso grass, 1.7:1 from broomgrass, 3.1:1 from bay leaf, and 41.1:1 from *P. peepuloides*[7,42-45]. A final value of 25.43% accrued to the producers/harvesters from *G. odorata* is a much better return when compared with the forest produce of Solika in Karnataka which received only 4% of the final value of *Emblica officinalis* and *C. tamala* collected by *War* community of south Meghalaya who benefited 23%[42,43,46]. However, forest produce of Meghalaya *Phrynium* leaf with 28% and *P. peepuloides* with 42% and *Thysanolaena maxima* of Darjeeling with 35% got a better return[7,42,45] (Table 3).

The study revealed that deforestation is the major threat to the regeneration of the plant. The unsustainable harvest of *G. cordata* from natural forests is also causing damage to the natural population of this economically important wild plant of Meghalaya. Some degree of domestication has been initiated in the agroforests of south Meghalaya, but greater attention is needed for the conservation of wild germplasm of this plant. Since *G. odorata* grows in wild natural forests, labour costs during harvesting, processing, transportation, and marketing of seed are the only input that the collectors/harvesters have to make. The expenditure incurred on the management of *G. odorata* in agroforests is also minimal and therefore the collection/production of *G. odorata* is quite

Table 3 — Comparison of benefits accrued to the collectors from different forest products

Forest product	State	Net benefit of collector (%)
Gynocardia odorata (Sohliang)	Meghalaya	25.43
Phrynium capitatum (Packing leaf)[7]	Meghalaya	28
Cinnamomum tamala (Bayleaf)[43]	Meghalaya	23
Phyllanthus emblica (Amla)[46]	Karnataka	4
Thysanolaena maxima (Broom grass)[45]	Sikkim	35
Piper peepuloides (Wild pepper)[42]	Meghalaya	42

remunerative and deserves to be promoted for income generation and livelihood enhancement of the rural poor.

Conclusion

The study revealed that *G. odorata* plays an important role in the livelihood of the rural poor in the region. The *Khasi* tribe of Meghalaya has a close association with nature and has developed a traditional knowledge system to use the poisonous seeds of *G. odorata* as food. There is also ample scope and the possibility of making this forest produce a livelihood-based resource to improve the income of the rural poor. Since *G. odorata* grows wild in the natural forest, labour during collection and processing is the only input that the farmers have to make. The expenditure incurred on the management of *G. odorata* in agroforests is minimal. We suggest that further research needs to be carried out to find out the phytoconstituents/compounds which make the seed poisonous.

Acknowledgement

The producers and respondents of Nongkwai, Mawpran, Nongsder, Wahlakhiat and Myllat villages who offered their valuable time and shared their knowledge pertaining to management, harvesting and steps involved in processing of *G. odorata* are highly appreciated.

Conflict of interest

The authors state that they have no conflict of interest.

References

1 Cavendish W, Empirical regularities in the poverty - environment relationship of rural households: Evidence from Zimbabwe, *World Dev*, 2000, **28**(11), 1979-2003.

2 FAO, Global Forest Resources Assessment, 2005, http://www.fao.org/ forestry/site/28699/en. accessed on 12.5.2020.

3 Tewari D N, *Tropical forestry in India*, (International Book Distributors, India), 1992, 387.

4 Plotkin M and Famolare L, *Non-wood products from the tropical rain forests*, (Conservation International, Washington, DC), 1992, 209-244.

5 Bahuguna V K, Forests in the economy of the rural poor: An estimation of the dependency level, *Ambio*, 2000, **29**(3), 126-129.

6 Mahapatra A K, Albers H J and Robinson E J Z, The impact of NTFP sales on rural households' cash income in India's dry deciduous forest, *Environ Manag*, 2005, **35**(3), 258-265.

7 Tynsong H and Tiwari B K, Contribution of *Phrynium capitatum* Willd. a non-timber forest product to the livelihoods of rural poor of south Meghalaya, north-east India, *Indian J Nat Prod Res*, 2011, **2**(2), 229-235.

8 Anderson A B, *Alternative to deforestation*: Steps towards sustainable use of the Amazon Rain forests, (Columbia University Press, New York), 1990.

9 Clay J, A rainforest emporium, *Garden*, 1990, **14**(1), 2-7.

10 Mohan C J, Deepa L, Unaidulla U and Ganesh N, *In vitro* antioxidant activity of hydroalcoholic extract of *Gynocardia odorata* Roxb. Leaf, *Int J Res Pharm Nano Sci*, 2013, **2**(3), 351-357.

11 Hina K, Nakul G, Safhi M M, Agarwal M, Gyas K, *et al.*, Antiulcer activity of seed extracts of *Gynocardia odorata* Roxb. on pylorus ligation and indomethacin induced gastric lesions in albino rat, *Int J Dev Res*, 2013, **3**(5), 49-54.

12 Sharma N, Sarma S K, Saha D, Das T, Hazarika B, *et al.*, Pharmacognostic and phytochemical evaluation of *Gynocardia odorata* leaves, *Saudi J Med Pharm Sci*, 2016, **2**, 112-121.

13 Rana T S and Ranade S A, The enigma of monotypic taxa and their taxonomic implications, *Curr Sci*, 2009, **2**, 219-229.

14 Khan M A, Spicer T E V, Spicer R A and Bera S, Occurrence of *Gynocardia odorata* Robert Brown (Achariaceae, formerly Flacourtiaceae) from the PlioPleistocene sediments of Arunachal Pradesh, Northeast India and its palaeoclimatic and phytogeographic significance, *Rev Palaeobot Palynol*, 2014 **211**, 1–9.

15 Roxburgh W, Plants of the Coast of Coromandel. Bulmer, London, 1820, **3**, 26-27.

16 Kanjilal U N, Kanjilal P C and Das A, *Flora of Assam*, (Government of Assam, Shillong), 1934, 84-94.

17 Al-Qura'n S, Ethnobotanical survey of folk toxic plants in southern part of Jordan, *Toxicon*, 2005, **46**(2), 119–129.

18 Shrestha P M and Dhillion S S, Medicinal plant diversity and use in the highlands of Dolakha district, Nepal, *J Ethnopharmacol*, 2003, **86**(1), 81-96.

19 Seal T, Evaluation of some wild edible plants from nutritional aspects use as vegetables in the state in Meghalaya state of India, *World Appl Sci J*, 2011, **12**(8), 1282-1287.

20 Secmen O and Leblebici E, *Poisonous Plants*, (Ege Univ Sci Fac, Book Series, Bornova, Izmir), 1987, 103.

21 Chopra R N, Badhwar R L and Ghosh S, *Poisonous plants of India*, (Academic Publishers, Jodhpur, India), 1949, 763.

22 Khare C P, *Indian herbal remedies rational western therapy, ayurvedic and other traditional usage, botany*, (Springer-Verlag, Berlin, Heidelberg, New York), 2004, 254.

23 Doley B, Gajurel P R, Rethy P and Buragohain R, Uses of trees as medicine by the ethnic communities of Arunachal Pradesh, India, *J Med Plants Res*, 2014, **8**(24), 857-863.

24 Wangpan T, Tasar J, Taka T, Giba J, Tesia P, *et al.*, Traditional use of plants as medicine and poison by Tagin and Galo Tribe of Arunachal Pradesh, *J Appl Pharm Sci*, 2019, **9**(9), 98–104.

25 Tynsong H and Tiwari B K, Traditional knowledge associated with fish harvesting practices of War Khasi community of Meghalaya, *Indian J Tradit Knowl*, 2008, **7**(4), 618-623.

26 Kalita B C, Tag H, Gogoi B J and Hui P K, Diversity and traditional uses of some poisonous plants of Arunachal Pradesh, *Int J Adv Res Innov Ideas Educ*, 2017, **3**(1), 755-763.

27 Harvey A L, Bradley K N, Cochran S A, Rowan E G, Quillfeldt J A, *et al.*, What can toxins tell us for drug discovery, *Toxicon*, 1998, **36**(11), 1635–1640.

28 Sawian J T, Jeeva S, Lyndem F G, Mishra B P and Laloo R C, Wild edible plants of Meghalaya, North-east India, *Nat Prod Rad*, 2007, **6**(5), 410-426.

29 Rupeshkumar M, Kavitha K and Haldar P K, Pharmacological evaluation of anti-inflammatory, analgesic and antipyretic effects of *Gynocardia odorata* Roxb in animal models, *Int J Pharm Pharm Sci*, 2014, **6**, 156-159.

30 Kumar R, Singh R D and Sharma K D, Water resources of India, *Curr Sci*, 2005, **89**, 794-811.

31 Tiwari B K, Tynsong H and Lynser M B, Forest management practices of the tribal people of Meghalaya, North-East India, *J Trop For Sci*, 2010, **22**(3), 329-342.

32 Hooker J D, *The Flora of British India*, vol 7, (Reeve and Co. Ltd., Kent), 1872–1897.

33 FSI (Forest Survey of India), State of Forest Report, Forest Survey of India, (Government Publisher of India, Dehra Dun), 2019.

34 Poffenberger M, Indigenous Forest Stewards of Northeast India, Technical Report, Community Forestry International, Santa Barbara, 2007.

35 Mukherjee N, Participatory methods and rural knowledge. Participatory rural appraisal methodology and applications, (Concept Publishing Company, New Delhi, India), 1993.

36 Tiwari B K, "Forest biodiversity management and livelihood enhancing practices of War Khasi of Meghalaya, India," in *Himalayan Medicinal and Aromatic Plants, Balancing Use and Conservation*, edited by Y Thomas, M Karki, K Gurung and D Parajuli, (Government of Nepal Ministry of Forests and Soil Conservation), 2005, 240–255.

37 Raintree J, Developing and marketing of non-timber forest products: methods used in protected areas in Vietnam, in *Shifting cultivation towards sustainability and resource conservation in Asia*, (International Institute of Rural Reconstruction Y. C. James Yen Centre, Biga, Silang Cavite, Philippines), 2001, 269–271.

38 Karki M, Medicinal plants for sustainable management of uplands in south and south-east Asia, in *Shifting cultivation towards sustainability and resource conservation in Asia*, (International Institute of Rural Reconstruction Y. C. James Yen Centre Biga, Silang Cavite, Philippines), 2011, 225-231.

39 Balakrishnan N P, *Flora of Jowai, Meghalaya*, (Botanical Survey of India, Howrah), 1981-1983 (I and II), 666.

40 Kayang H, Tribal knowledge on wild edible plants of Meghalaya, Northeast India, *Indian J Tradit Knowl*, 2007, **6**(1), 177-181.

41 Ambrose-Oji B, The contribution of NTFPs to the livelihood of the 'rural poor': Evidence from the tropical forest zone of south-west Cameroon, Int ForRev, 2003, **5**(2), 106-117.

42 Tynsong H, Dkhar M and Tiwari B K, Domestication, conservation, and livelihoods: A case study of *Piper peepuloides* Roxb. -An important non-timber forest product in South Meghalaya, Northeast India, *Int J Biodivers*, 2013, **2013**, 1-7.

43 Tynsong H, *Plant diversity and NTFP management in community forests of War area Meghalaya*, Ph.D. Thesis, North-Eastern Hill University, Shillong, India, 2009.

44 Gangwar A K and Ramakrishnan P S, Ethnobiological notes of some tribes of Arunachal Pradesh, Northeastern India, *Econ Bot*, 1990, **44**(1), 94-105.

45 Shankar U, Lama S D and Bawa K S, Ecology and economics of domestication of non-timber forest products: An illustration of broomgrass in Darjeeling Himalaya, J Trop For Sci, 2001, **13**(1), 171-191.

46 Shankar U, Murali K S, Shankar U R, Ganeshaiah K N and Bawa K S, Extraction of non-timber forest products in the forest of Bilgiri Rangan Hills, India. 3. Productivity, extraction and prospects of sustainable harvest of amla, *Phyllanthus emblica* (Euphorbiaceae), *Econ Bot*, 1996, **52**, 320-336.