ANNALS OF PHARMACY AND PHARMACEUTICAL SCIENCES
Volume 1 Issue 2 (October, 2010) Page : 92-97

● *RESEARCH ARTICLE* ●

Accepted : *September, 2010*

A quantitative study of ethnobotanical knowledge distribution of North-east India

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ABSTRACT

This paper proposes an appropriate regression model as a mechanism for the maintenance of traditional ecological knowledge (TEK) of individuals associated with indigenous plants of North East India, which are handed down through the generations of ethnic people by cultural transmission and practices. On the basis of cross-sectional survey conducted in five reserve forest areas of Charaideo subdivision of Sivasagar district, the ethnophytotherapy knowledge distribution and the TEK distribution of ethnic groups are analyzed by using linear regression.

Key words : TEK, Ethnophytotherapy, Linear regression

INTRODUCTION

Methodological contributions are essential in any branch of science and many researchers have shown concern in contemporary ethnobiology (Steep, 2005). In the past, most ethnobotanical studies have recorded vernacular names and uses of plant species with little emphasis on quantitative studies. Then research in ethnobiology was primarily descriptive. In order to enhance the indicative value of ethnobotanical studies, there have been attempts in recent years to improve the traditional compilation-style approach through incorporating suitable quantitative methods of research in ethnobotanical data collection, processing and interpretation. Such quantitative approaches aim to describe the variables quantitatively and analyze the observed patterns in the study, besides testing hypotheses statistically. The concept of quantitative ethnobotany is relatively new and the term itself was coined only in 1987 by Prance and coworkers (Prance, 1991).

Accumulated knowledge about nature, termed traditional ecological knowledge (TEK) is an important part of people's capacity to manage and conserve both wild and agricultural systems over extended periods. It is acquired through frequent interaction with the local environment driven by a need to pursue daily subsistence strategies for food and economic provision. This knowledge is transferred between generations through observations and narratives as a key survival tool. It differs from modem knowledge by being dynamic, adaptive, and locally derived, thus coevolving with the ecosystem upon which it is based (Berkes *et al.,* 2000).

Wild plant resources are severely threatened by habitat loss and species-selective overexploitation. In addition, indigenous knowledge about the uses of wild plant resources is rapidly disappearing from traditional communities. In the context of conservation, sustainable and equitable use of wild plant resources, quantitative ethnobotany can contribute to the scientific base for management decisions. Indigenous knowledge and biodiversity are complementary phenomena essential to human development. But a very little of this knowledge has been recorded, yet it represents an immensely valuable database that provides humankind with insights on how numerous communities have interacted with their changing environment including its floral and faunal resources.

The aim of the present investigation is to study the maintenance of traditional ecological knowledge (TEK) of ethnic communities associated with indigenous plants of North East India, which are handed down through the generations by cultural transmission and practices. On the basis of cross-sectional survey conducted in five reserve forest areas of Charaideo subdivision of Sivasagar district, a quantitative analysis is done to build the 'ethnophytotherapy knowledge distribution' and the 'traditional ecological knowledge distribution' of ethnic tribes using regression analysis.

Ranjana Gogoi and Manjit Gogoi (2010). A quantitative study of ethnobotanical knowledge distribution of North-east India, *Ann. Pharm. & Pharm. Sci.,* **2** (10) : 92-97

The Charaideo sub-division of Sivasagar district of Assam is situated in the north eastern part of India and lies between longitude $94^0$8'-$95^0$4' East and latitude $26^0$7'-$27^0$2' North and altitude between 110m and 126m above sea level. The total area covers 1069 sq kilometer with 16027 hectare land including five reserve forests-Sapekhati, Rangoli, Abhoypur, Sola and Charaideo Maidam area. Charaideo sub-division is a transitional area in between Assam, Nagaland and Arunachal Pradesh. Tropical monsoon climate with rainfall ranges from 2400 mm to 4000 mm and the average range of temperature lies in 09^0-36^0C. Mean maximum relative humidity is least in December (92.8%) and high in May-July (96%). The vegetation of the area comprises of evergreen, deciduous and swamp forests. A survey of plant diversity of this area was done for the first time in 2004-2005(Gogoi and Islam, 2008) covering five reserve forests of Sapekhati, Rangoli, Abhoypur, Sola and Charaideo Maidam area. The geographical status, percentage of floral diversity, the list of predominant families of plant species and the major threats to biodiversity of these study sites are tabulated in Appendix:I (Gogoi and Islam, 2008). Among the five reserve forests -Sapekhati, Rangoli and Sola are considered as disturbed area where as Abhoypur and Charaideo maidam area as protected. These reserve forests areas are the inhabitance of around twelve ethnic communities of north eastern region of India, comprising an approximated population of more than twenty five thousands. Several ethnic communities are residing there from centuries back. Basically they belong to- Tai Ahom, Tai Khamyang, Tai Phake, Tai Turung, Sonowal Kachari and Chutia, Moran, Bodo, Naga, Mising, Tea Tribes and ex Tea Tribes (consists number of sub-communities), including Indian Nepalese. The human settlement under government initiatives by setting up forest villages for ethnic people in the buffer zone of Rangoli Reserve, encroachment by small tea growers and exploration and drilling activities by oil companies are noticeable in these forests areas.

These ethnic people in rural communities often have detailed and profound knowledge of the properties and ecology of locally occurring plants. Also rely on them for many of their foods, fibre, medicines, fuel, building materials, ceremonial occasions and other products. However, much of this knowledge is being lost with the transformation of local ecosystems and local cultures. But day by day traditional communities become less reliant on local resources and begin to adopt modem lifestyles under the influence of urbanization, modernization of public services including formal education systems, and globalization of trade and belief systems. So it becomes crucial to conserve the ecosystem upon which traditional knowledge are based.

To study the TEK and ethnophytotherapy knowledge of the ethnic communities regarding indigenous plants, which are identified in these forests areas, an ethnobotanical survey was carried out combined with interviews with local people, for gathering social and economic data. Here the authors highlight the identification of the indigenous plants and their functions and uses (which are local and indigenous) on the basis of the assumption that these are the indicators of overall traditional ecological knowledge.

MATERIALS AND METHODS

During survey, information was gathered by personal interaction and questionnaire method from the selected sites of the study area. Thirty nine indigenous plant species are chosen and collected (collected specimens were deposited in the laboratory of Department of Botany, Gargaon College). Number of collected specimens were cited as MG and RG from the study area, to whom the local people have an affinity. The species were shown to them for identification with local name and asked for list of any uses of it. In addition, demographic data were collected for each respondent including age, gender, village of residence, livelihood and education. A total of 120 people were interviewed excluding village heads. The respondents were randomly chosen by the method of stratified cluster sampling. As most of the ethnic communities are clustered among themselves, at first the clusters (*i.e.* villages) were randomly selected and then within each (cluster) village stratification is done to ensure fair representation of all subpopulations (*i.e.* different ethnic communities, men and women; age groups- 10-20,21-35,36-50, and 50+ years etc.).As actual population sizes of each cluster was unknown, on the basis of approximation made by village heads (Gaonbura) sample sizes (no. of respondents) were chosen to collect the quantitative information required for statistical testing and model building.

The quantifiable measures of ethno-phytotherapy knowledge and traditional ecological knowledge was generated from following methodology - (i) number of traditional medicinal use of plant by ethnic individual, (ii) number of traditional uses (including medicinal uses) of plant parts known by ethnic individual, (iii) mean percentage participation of different ethnic groups {knowledge group) - for different age groups and for male and female separately. The results of this ethnobotanical survey are shown in Table 1 and 2.

Table 1 : List of indigenous phytodiversity use of study area

Sr. No.	Species	Common name	Family
1.	*Acorus calamus* L.(81IMG and RG)	Boss	Arecaceae
2.	*Aegle mannelus* L. (3IMG and RG)	Bel	Rutaceae
3.	*Adhatoda zeylanica* Medic.(28MG and RG)	Bahek	Acanthaceae
4.	*Aquilaria agalocha*.(36MG and RG)	Hashi	Thymileaceae
5.	*Angiopteris evecta*.(23MG and RG)	Hati Dhekia	Angiopteridaceae
6.	*Agalis grandiflora* Pers. (29MG and RG)	Bok phul	Fabaceae
7.	*Actinodophne angusitifolia* Pers.(13MG and RG)	Patihonda	Lauraceae
8.	*Ajuga bracteosa* L.(32MG and RG)	Nilakantha	Lamiaceae
9.	*Baccaurea ramiflora* Lour.(38MG and RG)	Leteku	Euphorbiaceae
10.	*Barringtonia acutargula* L.(42MG and RG)	Hidol	Barringtoniaceae
11	*Cucuma aromatica* Salib.(46MG and RG)	Bonhalodhi	Zingiberaceae
12.	*Cymbopogn nudrus* DC.(49MG and RG)	Citranella	Poaceae
13.	*Cyathea assamica* L.(56MG and RG)	Treefem	Cyatheaceae
14.	*Disopyros peregyine* Roxb.(65MG and RG)	Kendu	Ebenaceae
15.	*Dendrobium assamica* L.(69MG and RG)	Ground Orchid	Orchidaceae
16.	*Clerodendron coledbrokianum* Walp.(7IMG and RG)	Nefafu	Verbiaceae
17.	*Dioscorea deltoidea* Wall.(72MG and RG)	Kathalu	Dioscoreaceae
18.	*Flacourtia catafrachta* Meer.(80MG and RG)	Poniol	FIacourtiaceae
19.	*Garcinia pendonculata* Roxb. (82MG and RG)	Borthekera	Clusiaceae
20.	G. *keeniara* Roxb. (17MG and RG)	Thekera	Clusiaceae
21.	G. *lenieafolia* Roxb. (2IMG and RG)	Kujithekera	Clusiaceae
22.	*Litsea cubeba* Pers. (20IMG and RG)	Mejankari	Lauraceae
23.	*L. assamica* Hookf. (204MG and RG)	Patihonda	Lauraceae
24.	*Enteda scandence* L. (211MG and RG)	GhiIa	Papilionaceae
25.	*Magnolia chmpacha* L. (16MG and RG)	Titachopa	Magnoliaceae
26.	*Mesua assamica* L. (2MG and RG)	Siam NahOT	Clusiaceae
27.	*Ocimum basciHicum* L. (4MG and RG)	Bon Tulakhi	Lamiaceae
28.	*O. grattissimum* L.(5MG and RG)	Ram Tulakhi	Lamiaceae
29.	*O. sanctum* L.(6MG and RG)	Tulakhi	Lamiaceae
30.	*Oroxylum indicum*.(70MG and RG)	Bhat Ghila	Bignoniaceae
31.	*Paederia foetida*.(53MG and RG)	Vedailota	Rubiaceae
32.	*Pogostimon benghlensis*.(105MG and RG)	HukIoti	Lamiaceae
33.	*Caesalpinia bonduc*.(173MG and RG)	Letaguti	Caesalpiniaceae
34.	*Cannabis sativa* (I22MG and RG)	Bhang	Canabinaceae
35.	*Conarium resiniferum Brace* L.(18MG and RG)	Dhuna	Burseraceae
36.	*Crinum asiaticum* L.(66MG and RG)	Bon naharu	AmaryIlidaceae
37.	*Crinum defixum Kar-Gawl*.(4IMG and RG)	Bon piaz	AmaryIlidaceae
38.	*Houttonia cordata Thumb*.(9MG and RG)	Mosondari	Sawuraceae
39.	*Drymaria cordata* Wild.(IOIMG and RG)	Laijabori	Canyophyllacea

RESULTS AND DISCUSSION

After collecting information and data from the study sites to evaluate the predictive values of TEK and ethnophytotherapy knowledge statistically, the nature and structure of the data were thoroughly examined and organized for empirical regression model building. The authors' initial assumption was that, the complex saturated statistical models might be a default for representing natural systems. Because the physical processes of interaction with nature is truly a complex manner (Hoft *et al*., 1999). So, we restricted our attention to smaller models to evaluate the predictive power. PASW18 was used for database construction, data handling and statistical analysis. Variables considered for building traditional knowledge regression of the study are described below. In the present study 'plant' refers only indigenous plants mentioned in Table 1 and the word 'use' indicates any

Table 2 : Number of plants used for each illness

Sr. No.	Illness	Number of plant used
1.	Abortion	2
2.	Appetite stimulation	I
3.	Asthma	2
4.	Boil	2
5.	Burn	2
6.	Bronchitis	2
7.	Cancer	3
8.	Chest pain	1
9.	Cholera	1
10.	Colic pain	1
11.	Constipation	2
12.	Contraceptive	2
13.	Cough	3
14.	Diabetes	2
15.	Dropsy	1
16.	Dysentery/ Diarrhea	11
17.	Ear pain	1
18.	Epilepsy	2
19.	Fever	2
20.	Fracture	2
21.	Family planning and birth control	5
22.	Fertility increase	3
23.	Fungal Infection	2
24.	Gastric	1
25	Glandular tumour	1
26.	Hemorrhage	1
27.	Headache	3
28.	Hypertension	7
29.	Hysteria	1
30.	Indigestion	1
31.	Kidney stone	1
32.	Leprosy	1
33.	Leukemia	1
34.	Liver disorder	1
35.	Malaria	1
36.	Menopause	1
37.	Mucous Diarrhea	1
38.	Pain	1
39.	Piles	1
40.	Pneumonia	1
41.	Ring worm	3
42.	Rheumatic Pain	1
43.	Rickets	1
44.	Scabies	3
45.	Seminal weakness	2
46.	Sinusitis	1
47.	Skin disorder	5
48.	Snake bite	2
49.	Swelling	1
50.	Teeth infection	1
51.	Thyroid problem	1
52.	Urine Infection	1
53.	Vomiting	1
54.	Wound	4
Total		107*

* Several species have multiple medicinal uses, but in reality there are only 39 species

local or traditional use of plant by ethnic individuals.

Medicinal use:

An indigenous plant used traditionally for number of illnesses as medicine, traditional healing practices, treatment through spiritual practices - this is called ethnophytotherapy knowledge.

Plant part use:

Different parts of the plant used traditionally by ethnic individual in day to day life, such as-medicine, edible, timber, firewood, craft, ceremonial, spices, fodder, perfume, construction, dye, fibre, aesthetic etc. Plant parts are classified as-stem, leaf, bark, root, fruit, flower, seed, tubers, bulb, resin/gum, rhizome, young shoot and leaf bud. This plant part use is described as traditional ecological knowledge (TEK).

Ethnic participation:

Mean percentage participation of ethnic group using TEK.

Data were collected for all above mentioned variables for different age groups and male and female separately for uniform representation. For each ethnic group data were collected separately and centered the data for each age group. Then analyzing regression in PASW18, the Ethnophytotherapy Knowledge model and Traditional Ecological Knowledge models were formed as given below.

Model :I: TEK Regression Model:

$\widehat{\text{Log (PlantPart)}} = 1.387 + 1.051(\text{EthnicGroup})$

se = (0.471) (0.049)

t = (2.947) (21.465)

p value = (0.006) (0.000)

$R^2 = 0.1864852$ $\hat{\sigma}^2 = 0.4815555$

F = 8.2524227 p value = 0.0068

Model II : TEK Regression Model:

$\widehat{\text{EthnicPartn}} = - 54.800 + 1.089 \text{ (Education)}$

se = (22.016) (0.361)

t = (-2.489) (3.018)

p value =(0.042) (0.020)

$R^2 = 0.565$ $\hat{\sigma}^2 = 7.37107$

F = 9.082 p value = 0.020

Model III : Ethnophytotherapy Knowledge Regression Model:

$\widehat{\text{MedUse}} = - 1.553 + 0.585 \text{ (EthnicGroup)} - 0.0062$

$(\text{EthnicGroup})^2$

se = (0.828) (0.0.348) (0.031)
t = (1.877) (1.684) (-1.954)
p value =(0.069) (0.101) (0.059)

$R^2 = 0.2877835$ $\hat{\sigma}^2 = 1.1266857$
F = 7.0711822 p value = 0.003

The three regression models fitted above for ethnobotanical knowledge of individual belonging to ethnic communities inhabited in reserve forests area of Charaideo subdivision reflect the results as expected. Although linear regression is analyzed, Model: I and Model : II are not linear in variables, but all three are linear in parameters. In Model: I, repressor is in logarithmic scale, whereas Model: III is a quadratic model. These data transformations are required so as to approximate a normal distribution.

The Fig. 1 and 3 show that the approximations for normal are almost appropriate in above two models as well as for second model also. In all three Regression models, the signs of estimated coefficients are in accordance with theoretical expectations and they are statistically significant. The p value for 'EthnicGroup' is high (about 10%) in Model:III, but in ethnobotanical knowledge due to complex epistemology related to observational data , sometimes p value up to 15 to 20 per cent are considered as significant (Steep, 2005). The values of R^2's are low but significant, which may be due to cross-sectional study of the problem. For a short regression (one predictor only) R^2 normally becomes low. In the first two models 'PlantPart' and 'EthnicParticipation' are the dependent variables (depicts TEK), where ethnic group and education are the independent variables, respectively.

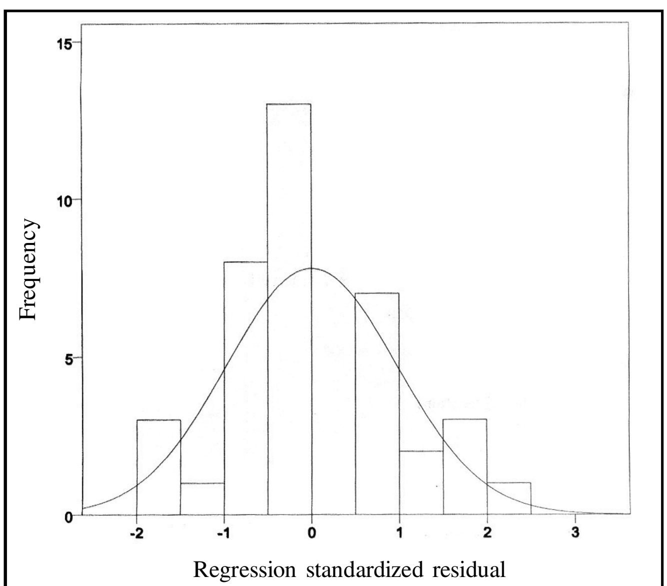

Fig. 1 : Dependet variable : Meduse

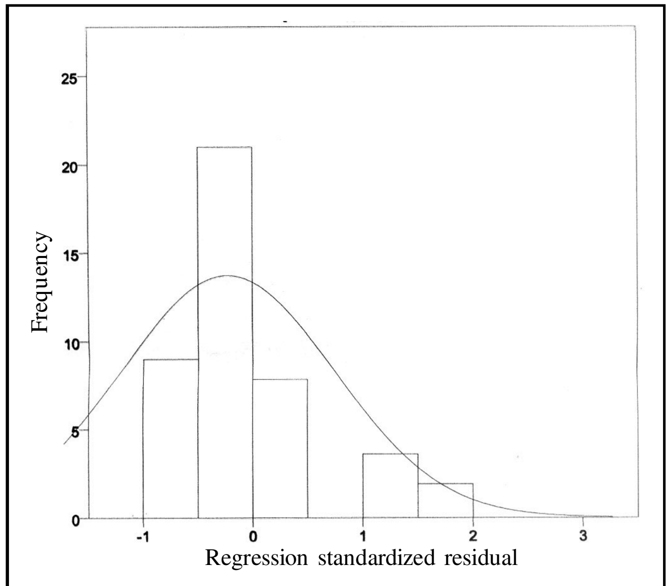

Fig. 2 : Dependet variable : Plantpart

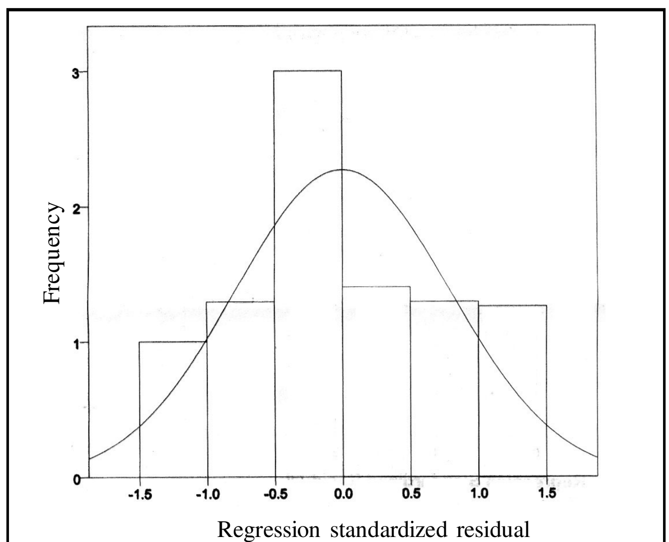

Fig. 3 : Dependent variable : Ethnicpartn

The negative intercept term in Model:II indicates the declining tendency of traditional ecological knowledge of ethnic individual. Although statistically significant, impacts of education and ethnicity of individual show little influence on TEK. Phytotherapy knowledge regression (Model:III) shows theoretically as well as statistically significant influence of ethnic group on medicinal use knowledge of indigenous plants. Comparing two regressions (1 and 3), it is observed that ethnic communities are traditionally more knowledgeable in various use of plant for medicinal purposes rather than various need of livelihood. It may be due to their gradual adoption of modem lifestyles and less reliant on local resources. But in case of medicinal knowledge, in country like India, traditional healing practices are very common and herbal remedies for illness are widely used, for which Indian herbal medicine and ayurveda go global That is why, it is high time to conserve TEK for economic growth also.

Conclusion:

Regarding quantitative analysis of TEK distribution and Ethnophytotherapy knowledge distribution, it is observed that, regression fitting may provide us good model to examine the ecological knowledge issue for biodiversity conservation. Because the prediction and estimation of TEK through regression may be the indicators for researchers and policy makers in decision making of environmental conservation. For quality fitting of observational botanical knowledge data with high statistical power, data should be collected at several time points. It is observed that traditional knowledge experience of individual is changing in accordance to change of season (such as, autumn, winter, rainy, summer etc.).Thus by considering spatial as well as temporal effect on variables and increasing the size of the sample may provide a better fit regression model with high predictive power. It is also experienced that, theoretically viable all possible variables should be included in the model. A rich TEK model with all possible variables (*i.e.* the factors responsible for TEK accumulation, its transmission, ecology, socio-economic status and demography etc.) can be made richer by considering interactions. It is already mentioned that the physical processes of interaction with nature is truly a complex manner. So considering interaction effects of variables under theoretical domain in fitting TEK regression should be an important criterion for researchers. Finally data collection and survey should be done carefully by observation and interview method to minimize the all types of sampling and non-sampling errors.

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