Review Article

Concise Synopsis on Quantitative Ethnobotanical Tools for Medicinal Plant Analysis

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ABSTRACT

Quantitative Ethnobotany deals with the computation of the importance of plants and vegetation to people. It helps in quantification of qualitative data in the biological and social sciences. The various quantitative tools in Ethnobotany help in the calculation of values of plant taxon. Ethnobotanical approaches provide data which is agreeable to the hypothesis-testing, subsequent statistical validation, and comparative analysis. The use of ethnobotanical indices is now an emerging trend in ethnobotanical research, though there have been sporadic attempts in compilation and further standardization of these divergent methods. The aim of this study is, various quantitative Ethnobotanical tools have been discussed with their detailed description as to fundamental the utility. Emphasis has been laid for various ethnographic methods, categorization, sampling, and various statistical analyses. It is believed that the beginner as well as skilled researcher will find it extremely useful in learning about the ethnographic methods, sampling, indices, design and analysis of the research. Thus, it is recommended to the Ethnobotanists to select and choose the indices carefully along with the method employed for appropriately addressing the hypothesis.

Keywords: Quantitative ethnobotanical tools, Ethnomedicine, Ethnographic data collection, medicinal plants, traditional medicine.

INTRODUCTION

The quantitative methods were proposed by Philips, led to an increasing awareness for ethnobotanical research.[1] Ethnomedicinal studies have proved significance in valuing and discovery of contemporary drugs from indigenous medicinal plant resources. There are appropriate sources of information about useful medicinal plant species, which can be targeted for management and domestication.[1, 2] The documentation of traditional knowledge of native plant species has contributed a number of vital drugs.[3, 4] In modern pharmacopeia 25% of herbal drugs are plant based and chemical substances isolated from plants are the source of several synthetic drugs being manufactured.[5] The natural products play a fundamental role in the development of new drugs.[6, 7, 8] In the present era, medicinal plant species have an increasingly important role in traditional health care practices; this has drawn the attention towards ethnomedicine.[8]

For the rural communities of developing nations, the use of plant species as medicine for curing of any ailments or disease have provided them an alternative for better health care facilities with fewer side effects and with maximum efficacy.[9] In an estimate by WHO, it was revealed that around 80% of the population in developing countries rely on these medicinal plants transformed in to the polyherbal formulations for their primary health care needs. They are cost-effective, safe and affordable for the rural communities.[10] It has been estimated that around 85% of the traditional medicines are derived from plant species accounting that the, medicinal plants are heritage of global importance.[11] An important aspect for the documentation of the traditional information on herbal remedies is the conservation approach.

The present review work is therefore an approach in order to provide for:

1. Documentation techniques for recording of medicinal flora and traditional medical knowledge of local informants about the usages of the indigenous available plants for curing of various ailments and diseases.
2. Assemblage of data on the traditional treatments against various ailments, which forms the basis of consideration of any plant taxon. Thus, the evaluation of the data using various quantitative ethnobotanical indices for exploration of most popular species, which could be further subjected for discovery of potential therapeutic phytomoloecule (s).

Ethnographic Data

Ethnographic data provides reliability to the numbers and statistical analysis used in quantitative Ethnobotany. Various ethnographic methods, are helpful in collection of data amenable to ethnobotanical analyses were proposed by Bernard and Martin.[12, 13] One or more than one methods are often obligatory to address various research questions and environments.

The vital activity which is associated with ethnobotanical interviews is the collection of plant voucher specimens. Identification of the local names and botanical names of the collected plant specimen is the next step. Future researchers and others will be benefitted with the

employment of herbarium specimens in making useful comparisons.[14]

There has to be proper documentation of every interview, questionnaire and other associated essential data findings. The standard interview equipments tools are data sheets, field books, laptops, voice recorder and high resolution camera of high resolution. The special consent needs to be taken from the research participants.[15]

There may be open and semi-structured interviews which are guided by a series of outline. This includes the house interviews with the specific plant specimens. Free listing documents the plant parts used in the medicine preparation as suggested by research participants.[16] The other additional methods include participant observation and direct observation. They reduce the researcher bias and intrusion, rapport establishment and toning of the information provided by research participants.[17, 18, 19] Surveys, questionnaires, and checklists provide limit response about use of plant for any disease and ailments. These techniques are frequently useful in case of limited field survey.[20] Often visit to forests and procuring places of medicinal plants along with the informants ensures validation of the plants.

Quantitative tools for Ethnobotanical tools for data analysis

The standard quantitative tools are as follows:

- Relative Frequency of Citation (RFC)
- Consensus value for Plant Part (CPP)
- Informant Consensus Factor (*Fic*)
- Fidelity Level (FL%)
- Percentage of respondents who have knowledge regarding the use of species (PRK)
- Importance value [IVs]
- Use Values (UVs)
- Rank Order Priority (ROP)
- Informant Agreement Remedies (IAR)
- Cultural Significance Index (CSI)
- Simple Preference Ranking (SPR)
- Direct preference Ranking (DMR)
- Family Use Values (FUVs)

Relative Frequency of Citation (RFC)

It is an index which is obtained by division of the number of informants mentioning the use of species to the total number of informants who participated in the survey.[21] Less weightage is given to the variables like the type of use or disease category. The most popularly used plant species will get the highest number for the citation-frequency among the community members.[21] This is calculated using the following formula.

Relative Frequency of Citation; RFC = FCs / N

Where, RFC = Relative Frequency of Citation

FCs = Number of informants who mentioned the use of species

N = Total number of informants.

Theoretically, it varies from zero to 1. When few informants quote the species a value close to zero is obtained. The upper limit one is seldom obtained, it is possible only when all the informants quote a particular species.[21]

Consensus value for Plant Part (CPP)

It is the measure of the degree of agreement among informants concerning the plant part used.[22] The formula is as follows:

CPP = Px / Pt

Where Px = number of times a given plant part was cited

Pt = total number of citation of all parts.

Informant Consensus Factor *(Fic)*

It was developed by Trotter and Logan which tests the consistency of informant's knowledge regarding plants species for treating a particular illness category.[23] This parameter accounts for the degree of agreement among the different informants interviewed concerning the use. *Fic* value also reveals the cultural coherence of the selection of medicinal plants for curing of certain disease category.[23] This method helps the researcher in case of lesser familiarity with the community; lesser subjective thereby suitable for statistical analysis.[23] It is calculated as the number of mentions in each usage category (*Nur)* minus the number of taxa used in each category (*Nt*), divided by number of mentions in each usage category minus one.

***Fic* = Nur – Nt / Nt – 1**

A citation of each plant is recorded separately and it is an event. Thus, the same plant and same informant may participate in many such events. A high *Fic* value indicates the use of relatively few species in a certain use category. Its value ranges between zero and 1.

The *Fic* value is near to zero indicates there is no exchange of information about their use, among the informants. In case of well defined usage information, its value reaches one. This indicates high effectiveness of the plant species among the inhabitants of a community.[23]

Fidelity Level (FL %)

It is used to quantify the percentage of informants who claim the use of a certain plant for the same major purpose and is calculated as[24]:

FL= Np / N x 100

Where Np = number of informants who cited the species for a particular disease

N = total number of informants that cited the species to treat any given disease.

The percentage of respondents who have knowledge regarding the use of species (PRK) in the treatment of diseases was estimated using the formula[24]:

PRK = (No of people interviewed citing species / Total no of people interviewed) x 100

Importance Values

Importance Values (IVs) measures the proportion of informants who regard a species as the most important.[25] It is calculated as:

$IVs = n_{is} / n$

Where, n_{is} = No. of informants who considers the species important; n = total no. of informants.

Use Value (UV)

Use Value counts the importance of each plant on the basis of the number of different uses reported.[18] The objective is to assess the importance of species in a community. Use value gives an idea about the important species used by a community[18]. It is calculated using the formula;

$UVs = \sum Us / N$

Where, UVs = Use Value for the species

Σ Us = Sum of the uses mentioned for a species

N = Total number of informants

Many use-reports indicate high informant Use Values of a plant. This implies that the plant is important. Fewer reports results in the value approaching zero.

Rank Order Priority (ROP)

Rank Order Priority (ROP) of a plant species can be calculated as[26]:

ROP = FL x RP

Where, FL = Fidelity level,

RP = Relative Popularity; no. of citations of a species divided by the number of citations of the most mentioned species.

Informant Agreement Remedies (IAR)

Informant Agreement Remedies (IAR) is an index to determine the importance of the individual species.[27] IAR was calculated by using formula:

IAR = nr – na / nr – 1

Where, nr = the total no of citations registered for species

na = the no of illness categories that are treated with this species.

Cultural Significance Index (CSI)

Cultural Significance Index (CSI) was proposed by Turner.[28] It was later modified by Stoffle *et. al.,* Lajones and Lemas, and da Silva *et. al*., in 1990, 2001 and 2006 respectively.[29] It is calculated by formula:

CSI = ∑ (I x E x C) CF

Where, I = species management

E = preference of use

C = frequency of use

CF = Correction Factor. It is the no. of citations of a species divided by the no of citations of the most mentioned species.

Simple Preference Ranking (SPR)

Simple Preference Ranking (SPR) is the informants' simple preference for the medicinal plants used for treatment of a disease.[30]

Direct Matrix Ranking (DMR)

Direct Matrix Ranking (DMR) compares the use diversity of given plant species on the basis of the data collected from the informants.[30]

Family Use Values (FUVs)

It was first formulated by Phillips and Gentry.[15] This index calculates the use value of a family and the formula is as follows:

FUVs = ∑ UVs / NS

Where, FUVs = Family Use Value

∑ UVs = Sum of the Use Values of all the species quoted from a family

NS = Total number of species quoted from the family

CONCLUSION

Present review revealed the various tools which are applicable for a number of medicinal plant species used by indigenous people for treating various ailments. The indigenous community relies on traditional medicine though the modern health-care services are available signifying that the plants based healing is noteworthy. The sustainable management of medicinal plant species can be done on the basis of the ethnobotanical data. Thus, the threat owing to over exploitation can be managed. The high ethnobotanical values of medicinal plant species give an indication of their preference by indigenous communities for curing various ailments. Hence the plant species could be further analyzed for probable bioactive phytoconstituent(s), *in vivo*/*in vitro* biological activities. This will lead to the development of newer and potential drugs.

For effective and efficient use of the ethnobotanical indices as a tool in quantitative Ethnobotany, the investigator must be familiar with various ethnographic

methods and research design. These indices are essential in determining the appropriate methods, so that the pertaining questions can be answered. The researcher must create a complete mock-up of the data recorded in spreadsheet or statistical software. This requires routine check for sample size considerations. The researcher in collaboration with an expert may either combine or split the previously employed methods and further develop new approaches. Researcher must aim for being at least proficient with indices; as their importance is increasing in the field of Ethnobotany hence they have widespread applications.

In this review, an attempt is made to sort out and study the various indices of statistical importance. These indices have improved the precision and scientific validity of ethnobotanical research very significantly in a very short span of time. Recent interests of various authors across the globe have brought in diverse fresh perspectives and makes quite clear that these indices will play a pivotal role in ethnobotanical research and subsequent conservation applications.

Thus it is believed that the beginner as well as skilled researcher will find this review extremely useful in learning about the indices, design and analysis of the research. Thus, it is recommended to the ethnobotanists to select and choose the indices carefully along with the method employed for appropriately addressing of the hypothesis.

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