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Census of Approaches Used in Quantiative Ethbobotany

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ABSTRACT This paper is aimed to produce a data-base of various approaches used in quantitative ethno-medicine. One hundred and forty- three different ethno-botanical study resources were reviewed quantitatively and they belonged to five different types of materials. Journal of Ethnopharmacology (15.3%) has been recognized as the pioneer in publishing facts on quantitative ethno-botany. One hundred twenty different indices were clumped under 8 different categories namely, consensus methods (23), use value methods (30), ethno-medicine methods (2), relative importance methods (12), equitability methods (6), methods related to food (3), specific methods (22) and ecological methods (22). Thirty- three different quantitative indices were compiled first time. Thus, this technical-article compiles the up-to-date information's of various methods presently utilizing in quantitative ethno-medicine.

INTRODUCTION

In order to enhance the indicative value of the ethno-medicinal studies, there have been attempts in recent years to improve the traditional compilation style approaches through incorporating suitable quantitative methods in collection, processing and interpretation of data on ethno-medicines. Such quantitative approaches aim to describe the variables quantitatively and analyze the observed pattern of study; besides testing hypothesis statistically. Quantitative ethno-botany deals with measuring of the importance of plants and vegetation to people (Hoffman and Gallaher 2007). However, Phillips and Gentry (1993a) defined it as the "application of quantitative techniques to the direct analysis of contemporary plant use data". In recent years, various quantitative methods are utilized for hypothesis testing, statistical validation and comparative analysis of ethno-medicine data's. Medeiros et al. (2011) have explained that quantification in ethno-botany encompasses aspects related to the analysis of people's knowledge of the uses of plant species and it includes the use of indices or quantitative techniques and /or the application of statistical analysis. They further emphasized that quantification in ethno-botany is not necessarily associated with the hypothetical that is, deductive method. According to Fraser and Junqueira (2010), quantification gave researchers the ability to assess people's knowledge of plant resources and incorporate the perspective/s of a large number of informants. Quantitative approaches also add new dimension to the conservation policies by providing importance of different vegetation types thereby neutralizing the effect of various anthropogenic pressures on the environment.

There are three schools of thought pertains to quantification of the ethno-medicine data (Reyes-Garcia et al. 2006). One school has developed indices of cultural approach that captures the importance of plant, such as types of uses or taste of the edible plants (Turner 1988; Pieroni 2001). A second type derived from ecological theory; used to determine the relative importance of different plant species or families to society (Begossi 1996; Benz et al. 2000). A third one estimated the economic value of forest goods for different ethnic group (Goday et al. 2005). Many quantitative indices have been put forth to give a broad spectrum approach about the traditional and localized indigenous knowledge. Hoffman and Gallaher (2007) have compared the relative indices of cultural importance in four categories, while Reyes Garacia et al. (2006) have pointed out to merge various approaches to allow a more comprehensive valuation of the plants of importance. Medeiros et al.

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(2011) have discussed different quantitative approaches and categorized them into used totaled, subjective allocation and cultural significance index. Albuquerque (2009) discussed the term, its need and history of various quantitative techniques used in ethno-botany.

In the present review, an effort is made to compile the various ethno-medicine indices with their description, formula and their interpretation. The main aim of this article is to categorize the scattered information related to various indices and combined them according to the data type so required for a researcher to prepare his schedule and questionnaires based on the indices accordingly.

MATERIAL AND METHODS

To retrieve relevant data, the authors searched through computer-based literatures by full text med line search (via Pub med), Science Direct, Current Contents Connect (ISI), Cochrane Library, CINAHL (EBSCO), Cross ref search.

RESULTS AND DISCUSSION

Various quantitative and qualitative tools have been developed to respond to questions on the interrelations between people and plants. The term "quantitative ethno-medicine was first cited by Balee 1987 (Medeirost et al. 2011) and after that various researches like (Bennett and Prance 2000; Castaneda and Stepp 2007; Gomez-Beloz 2002; Medeiros et al. 2011; Mathur 2012; Phillips and Gentry 1993a, b) have contributed immensely in these new approaches of looking the data set. Albuquerque (2009) analyzed the evaluation of the term" quantitative ethno-medicine" and found that this approach generally contributed to methodological advances in ethno-botany. Cultural significance is a keystone in the development of analytical and quantitative ethno biology. The cultural significance (CS) of an organism is defined as the importance of the role that the organism plays within a particular culture. It has been used in ethno-botanical research in many forms with many applications. However, its successful use depends on the quality and accuracy of measurements at par. Orijel et al. (2007) have demonstrated progress of cultural significance in form of pyramids in which the base was prepared with 'activity signature proposed as the way to describe the whole practical value of resources' and this pyramid was coupled with specific index/indices with specific factors affecting it and subjective scales was laying at the top. Turner (1988) developed the first theoretical model of CS, her index of cultural significance (ICS) of a plant relates to sum of its "use value" and her model was further polished by researches like Atanazio et al. (2006) and Stoffle et al. (1990). Phillips and Gentry (1993a) have proposed another way to measure the relative usefulness of plants, and referred it as 'Use Value'. This was plainly designed to allow hypothesis testing based on interviewing techniques, nature of data and statistics. Use value of a plant for an informant (UV_{is}) is the average of the number of different uses assigned to that plant in several different interviews. The overall use of plant (UV_{is}) is the average of the UV_{is} of each informant.

Phillips (1996) classified this technique as part of the "informant consensus" methods that allows quantitative analysis of informant's knowledge. Pieroni (2001) have applied a compound index to edible plants, the Cultural Food Significance Index (CFSI). His index differs from earlier proposals because it is the first explicitly developed for food resources and because it includes a more detailed group of factors influencing CS.

In the beginning of the era of quantitative ethno-medicine most of the researches were carried out on the relative importance of plant for different groups (Heinrich et al. 1998; Ngowkey 1995; Torter 1981) but these studies did not approached the variation on the ethno botanical knowledge of informants. Pattern of medicinal plant use by local people are considered to vary as a function of plant habitat collection, cultural changes and ecological and/or biochemical aspects (Albuquerque 2006). Many ethno botanical surveys have furnished lists of medicinal plants often using quantitative techniques to determine as to which plants are most important or most noted within a given culture (Almeida et al. 2006; Gazzaneo et al. 2005). However, rarely a distinction has been made what is considered to be useful and what is being actually used (Albuquerque 2006). Reyes-Garcia (2005) stressed the idea that the variables of knowledge and their use are not always positively correlated. Reyes-Garacia et al. (2007) have further studied quantitative ethno-medicine at individual level and they have concluded that ethno botanical knowledge varies across demographic and social characteristics and the factors underlying with this inconsistency associated with the types of plant (medicinal / wild / crop) and method of study (field trial, specimen identification or objective specific). Ladio and Lozada (2004) have interpreted that the discrepancies between knowledge and use indicate that local knowledge is eroding. Albuquerque (2006) has proposed two new concepts 'mass knowledge' and 'stock knowledge'.

The study of local knowledge has been measured through various approaches or indices however; categorizations of these indices are still lacking and they generally produce confusing web with many interrelated links. Medeiros et al. (2011) reviewed the nature of quantitative research in ethno-medicine and use of quantitative indices in ethno botanical research. They have reported the regional dominance (American and European continents) in the quantitative ethno-medicine producing the greatest number of publications in this field and thus summarized that Journal of Ethnopharmacolgy (34%), Economic Botany (15%), Journal of Ethno biology and Ethno-medicine (11%), Biodiversity and Conservation (7%) and Acta Botanica Brasilica (7%) are the pioneer journals that published related articles. They broadly categorized quantitative techniques in to informant consensus, subjective allocation and used totaled. While previously, Hoffman and Gallaher (2007) have categorized various Relative Cultural Importance (RCI) indices in to use total, subjective allocation (researchers score), informant consensus (informant tally) and informant consensus (informant score) that allege to estimate the relative importance of a plant for a particular culture. Both Hoffman and Gallaher (2007) and Medeiros et al. (2011) were able to categorize 24 and 87 different indices respectively. In the present investigation 143 different research materials are reviewed encompassing five different categories namely 1. Referred journal (35); 2. Books (edited /complete text books); 3. Monographs (4); 4. Doctoral thesis (1) and 5. One master thesis. Journal of Ethnopharmacology (15.3%) is still the pioneer in the field of quantitative ethno-medicine, followed by Economic Botany (13.2%), Journal of Ethnobioloy and Ethno-medicine (11.8%), Biodiversity and Conservation (6.3%), Ethno-medicine Research and Application (5.6%) and surprisingly Ecology (4.2%) which is mainly committed to ecological works has also been contributed in this new emerging field. Thus, at this stage the results are within the scope and agreement of research carried out by Medeiros et al. (2011). Contrary to the previous studies, the present investigation entails 120 different indices clumped under 8 different categories namely consensus methods (22), use value methods (30), ethno-medicine methods (2), relative importance methods (12), equitability methods (6), methods related to food (3), specific methods (22) and ecological method (22). The various indices are presented in Appendix 1.

Looking back to various indices, it is found that many researchers have constructed indices to measure the value of plant species with combining cultural and practical dimension. However, according to Rayes-Garcia (2006) these approaches suffered from two basic problems. First, researchers have mainly relied up on data from surveys and interviews and through this way response through questions on interview, do not reflect a strong relation of plants used daily and secondly, although researchers have combined the cultural and practical dimension of the plant uses, their index still lacks the economic value of plants. To resolve this problem Reyes-Garcia (2006) have proposed a new index entitled 'total value of ethno species' that comprises three components namely a. cultural value of an ethno species, b. its practical value and c. its economic value. According to them the combination of these three indices offers a more comprehensive valuation of the significance of plants for human that the use of only one index.

Informant-consensus

The most popular techniques (indices) are based on 'informant consensus' that is, data on the degree of agreement among the different people interviewed concerning the use of a given resource (Albuquerque et al. 2006). Generally, Phillips advocates the use of informant consensus when time and resources allow. This method works well when the researcher is less familiar with the community; less subjective and hence suitable for statistical analysis (Kristensen and Lykke 2003; Phillips 1996). Each plant citation is recorded separately and referred to as an event and the sample plant and same informant may participant in many events. Disadvantages of these methods includes: the inability to distinguish between past use, knowledge and actual use; an emphasis on plants with the greatest absolute number of plant uses; the necessity of a large sample size; the categorization of explanatory variables (Kristensen and Lykke 2003; Albuquerque et al. 2006). Hoffman and Gallaher (2007) have combined fidelity level, overall use value, salience value, cultural-, practical- and economic- value (Reyes-Garacia 2006) in to informant consensus groups. However, through these methods it is difficult to establish values between the actual and potential uses. In the present investigation, the authors reported 23 different informant consensus methods highlighted at par in appendix 1 and to convince the informant consensus and use value methods are spliced into two separate groups. In present investigation testing the uniformity or homogeneity of knowledge, frequency of species, family, plant uses, information about their collection site, period of their collection, frequency of plant part/s use and their substitution availability are identified as major objectives associated with informant-consensus methods. Particularly, Informant Consensus Factor (ICF) addresses the criteria selection by a particular community while, factor of informant consensus addresses the intra-cultural relevance.

Use Value Methods

These methods simply counts the number of different uses reported for each plant to assign importance. They require least amount of data collection, less field time and in fact the uses totalled methods could be based only upon literature review. It may be most often applied when documenting knowledge distribution (Caldwell 2007). However, they do not distinguish relative degree of importance for different use. Intra-cultural variability cannot be assessed because data is not recorded per-respondent or informant and these methods ignore the dynamics of cultural importance, such as: distinctions between current and historical uses, frequency of use and relative degree of importance. Despite critics like Hoffman and Gallaher (2007), these methods remain commonly used (Ankli et al. 1999; Begossi et al. 2002; Case et al. 2005; Frei et al. 1998; Voeks and Leony 2004).

There are 30 different use value methods as being comprehended from literature reflected in Appendix 1. The major objectives associated with such types of studies carries importance of species in a community, degree of decline of use of popular plants, importance of a species for an informant, frequency citation and occurrence of plants, comparison of importance of plant groups, combined studies of cultural, practical and economic values to quantity the average number of informant know how for each species.

Relative Importance Indices

Among different importance indices, the Relative Importance Value (RIV) is calculated based on the normalized number of pharmacological properties attributed to it and the normalized number of body system (BS) it affects (Bennet and Prance 2000). These indices were calculated with following objectives to quantify proportion of informant who referred a species as most important to establish the cultural significance of each species; to highlight the medicinal plants, families which were otherwise under estimated, importance of plants in relation to its versatility and to estimate conservation priority based on indicators from pharmaceutical products and to prioritize plant species for pharmacological investigation

Equitability Indices

A total of six equitability indices have been reported and these were formulated to measure the contribution of different species out of the total species used; the proportion of number of citations amongst the number of useful species; to measure how the uses of a species is distributed among informant and also, to measure the degree of homogeneity in them.

The Pharmacological Ethno-therapeutic Index

This indicates of the richness of popular folk knowledge on plants and their attachment between human beings. These indices have a practical value to quantify ethno-pharmacological knowledge of a locality.

Indices Related to Food

Three indices namely, Edible Mushroom Cultural Significance Index (EMCI); Regional Selection Index (RSI) and Cultural Food Significance Index (CSFI), were specifically designed to estimate the ethno-nutraceuticals knowledge, either be a very specific like EMCI or with a general approach like RSI. EMCI can be used in cross-cultural studies because it brings a list with the relative position of species among a cultural significance gradient. CFSI index takes into account a wide variety of factors in the evaluation of a specific plant including: quotation frequency, availability, typology of the used parts, frequency of their use, kind and number of the nutraceuticals uses, taste appreciation and perceived role as food and/or medicine. Very high CFSI values were identified for several wild *'greens'* whereas wild fruits seemed to play a subordinate role.

Specific Indices

In present investigation around twenty one different specific indices were gathered. Each one has its own merits and demerit. The Cultural Significance Index (CSI) was initially proposed by Turner (1988) to calculate the value or importance of species. Phillips (1996) considered it a very subjective technique, as it designated pre-established values of species according to their use categories. Some species, such as those used for food, were excessively valued, while others, such as: species used for ritual purposes, were undervalued. Cultural Value Index (CVI) can be divided in to three factors. The first factor is the relationship between the number of different uses reported for the species (ethno species) and the total number of use categories considered in the study; the second factor is the relative frequency of citation of the species; while the third factor is the sum of all use reports for the species, *that is*, the sum total of number of participants who mentioned each use of the species, divided by number of respondent and these three factors multiplied together. Index of ethno botanical knowledge can be applied to the whole community or the sub-group systematically, like based on age and gender etc. For Relational efficacy index one assumption of this technique is that the less related or connected two cultures are, the more likely their discovery of related plants to treat related diseases is an independent event and these plants should therefore be considered to have a higher potential than other plants that may be used for that disease in one culture. Person's ethno- botanical knowledge indices can be utilized to observe the vertical, horizontal and oblique transmission of ethno-botanical knowledge (Garacia et al. 2009)

On the other hand indices like Index of Cultural Significance (ICS) and Ethnic Index of Cultural Significance (EICS) fail to take into account the factors of "taste appreciation" and the "perceived" food-medicinal multifunction of ingested botanicals, which represent important anthropological aspects in the phenomenon of ingestion of herbs and other plant dietary supplements. Moreover, Tuner's index assigned arbitrary values to the "quality-of-use" category (for example medicinal or ritual plants were considered much less "important" than staples), while both indices don't consider the "perceived availability" of the species; rather include an indirect "ecological availability" index in the "frequency-of-use" parameter.

Reyes-Garacia et al. (2007b, 2008) have explained that the ethno botanical skills of the male household head are associated with an increase in the number of crops sown by a household and with a reduction in the amount of forest cleared per household. And to test whether ethno botanical skills, a proxy for local ecological knowledge, are associated to the clearance of forest through their interaction with agricultural labor Reyes Garacia et al. (2011) resolved and found that the interaction between ethno botanical skills and labor invested in shifting cultivation has opposite effects depending on whether the clearing is done in old growth or fallow forest.

Ecological Indices

Twenty two different ecological indices can be categorized into richness index (Margalef and Menhinick index), diversity index (Shannon and Waver Index, Simpson index Berger-parker dominance index, McIntosh D, Fisher's alpha and Hill diversity index), evenness indexes (Pielou J or E_1 Buzas and Gibson or E_2, Heip or E_3, Hill or E_4 and E_5), Species accumulation curve, Rarefaction, Richness estimators (Chao and Lee 1, abundance based coverage estimator, Incidence based coverage estimator, Ist and IInd order jackknife. Hanazaki et al. (2006) have utilized Hill's diversity numbers to compare proportions of rare, intermediate and common species. Hill's numbers provide a method to describe the relationship between diversity indices (Magurran

1988) and according to Williams et al. (2005), the values of N1 (Shannon- Wiener, base *e*), N2 (reciprocal of Simpson's index, 1/D) and N" (reciprocal of the proportional abundance of the commonest species or reciprocal of Berger-Parker index), corresponding to measures of abundant, very abundant, and most abundant species in a sample, respectively. The value of N" can be interpreted as a measure of the common species, N1-N" can be interpreted as a measure of the number of intermediate species, and N0-N1 corresponds to a measure of rare ones. The aim of such studies has generally been to gain a better understanding of the human-environment relationship and the factors affecting it and to find better ways to describe plant knowledge patterns. William et al. (2007) have utilized incidence based species richness, species accumulation curve and similarity measures to compare and predict species richness, to evaluate sampling effort and compare the similarity of species inventories for traditional ethno-medicine data. According to them, Michaelis-Menten means estimators was the best estimator because the curve approached a horizontal asymptote.

E1, also called the Shannon J0 or Pielou's J, is probably the most common evenness index in use; but is strongly affected by species richness, and the addition of rare species (or singletons) can greatly change the value of E1 (Ludwig and Reynolds 1988). Hayek and Buzas (1997) recommend the use of E1 and E2 (also known as the Buzas and Gibson E). Ludwig and Reynolds (1988) further describe E3–E5; but consider E1–E3 to be of limited value because they are highly sensitive to the number of species in the sample. A general problem with all measures of evenness, however, is that they assume the total number of species that could possibly be sampled, is known (Krebs 1989). Since the observed species numbers must always be less than true species richness, the evenness ratios are always over estimated, with the possible exception of E4 and E5. E4 and E5 remain relatively constant with sampling variations and hence tend to be independent of sample size (Ludwig and Reynolds 1988). This is because E4 and E5 are computed as ratios where S is in both the numerator and the denominator; thus effectively cancelling the impact of the number of species in the sample (Ludwig and Reynolds 1988). However, E4 and E5 are not totally unaffected by the large number of singletons found in small samples, including the samples collected in the initial stages of research at a site before an adequate sample size is accumulated.

Rarefaction provides a method of comparison between different communities, whereby each community is 'rarefied' and back to an equal number of sampled specimens (Colwell and Coddington 1994). With rarefaction it is possible to evaluate sampling efforts. Colwell et al. (2004) suggested that interpolation and sample-based rarefaction eliminates the need for re-sampling methods and permits a direct statistical comparison of the species richness between sampled sets. Begossi (1996) and Hanazaki et al. (2000) and used rarefaction curve to evaluate sampling effort and explore differences in plant use par category of uses (for example, age and gender) within different communities. Williams et al. (2007) advocated that such methods have the potential to be broadened to species richness between sites, as well as estimate the number of species with a complete census of the plants used/trade being possible. Although, rarefaction can be useful, it is very sensitive to the underlying pattern of species abundance, such that collections with much lower species evenness will often give lower estimates of species diversity than those with even abundances, regardless of species diversities in reality are equal.

Species accumulation curves are known to enhance the value of ethno-medicinal studies and create an opportunity for cogent arguments that advance scientific and practical knowledge (Williams et al. 2007). The curve can also be used as a means of estimating species richness, most commonly by fitting function such as the asymptotic Michaelis-Menten algorithm (Colwell et al. 2004) or non-asymptotic estimators such as log-linear model (Colwell and Coddington 1995). Boer and Lamxay (2009) have utilized this technique to find out the relationship between village studies and plants used in post partum recovery in Seak and Kry ethnic groups of Brazil. Mati and Boer (2010) used species accumulation curve of number of species reported during free list by computed Mao Tau function (Colwell 2006). They have concluded that expected species accumulation curve level off as the number of informant free list increase, indicating a reduction in the number of new species mentioned per interview. They further elaborate that the curve is approach an asymptote; but, the slope was still significant after interviewing 18 herbalists and further interview are likely to elicit additional less salient species. They showed that curve fits the logarithmic function, which predict that doubling the number of free list to 36 would elicit 20 species only. Mwafongo et al. (2010) have utilized this approaches to study the traditional use of genotype in 15 selected district of Malawi and compared it with six non parametric estimators of species richness (ICE, Chao2, First and second order Jacknife, bootstrap and Michaelis-Menten. Zar and Hanazaki (2012) have utilized this curve to assess the expected richness of used and known plants by the number of plant species.

The Jackknife is useful because it is known to reduce bias and for estimation of species richness. Another useful characteristic of the Jackknife estimator of species richness is that the estimator is based on the presence or absence of a species in a given plot rather than on the abundance of the species. Williams et al. (2007) have calculated it as based on the number of species occurring in only 1 sample.

CONCLUSION

In ethno-botany there are many forms of data collections like field trials, group discussion and visit to herbalist. Each and every informant or an event may have ability to generate a large data which ultimately produces a web of lexical information. With recognition of this entanglement, now ethno-botany has adapted many statistical approaches that can solve the data matrix into a logical conclusion. This study shows that there are many quantitative approaches have been utilizing all over the world, out of which some of the techniques are well adapted by many researchers, while some of the technique are region specific or objective specific. Two specific subjects namely anthropology and ecology were greatly contributed to build quantitative ethno-medicine. In the present review more than thirty three new indices were compiled first time that provides a key data base for ongoing researchers. This technical article compiles the up-to-date information of various ecological methods, presently utilizing in quantitative ethno-medicine.

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APPENDIX 1

Indices and developed by	*Description*	*Formula and interpretation*
	Informant Consensus Methods	
Informant Consensus Factor (ICF) developed by Trotter and Logan, 1986 Adapted by Molares and Ladi (2009) Musa et al. (2011) Mutheeswaran et al . (2011) and Addisie et al. (2012)	To test the consistency of informant knowledge in treating a particular illness category	$F_{IC} = n_{ur} - n_t \backslash n_{ur} - 1$ where n_{ur} refers to the number of use-reports for a particular use category and n_t refers to the number of taxa used for a particular use category by all informants ICF values are low (near 0) if plants are chosen randomly or if there is no exchange of information about their use among informants, and approach one (1) when there is a well-defined selection criterion in the community and/or if information is exchanged between informants (Gazzaneo et al. 2005)
Fidelity level (FL) Friedman et al. 1986 Adapted by Giady (2009), Ugulu (2012)	Used to quantify the percentage of informants claiming the use of certain plant for the same major purpose	FL (%) = $N_p \backslash N \times 100$ Where N_p = Number of informants that claim a use of a plant species to treat a particular disease; N =Number of informants that use the plants as a medicine to treat any given disease High FLs (near 100%) are obtained for plants for which almost all use reports refer to the same way of using it, whereas low FLs are obtained for plants that are used for many different purposes. Hoffman and Gallaher (2007) have further elaborate fidelity level in Rank Order Priority (ROP) and explained as ROP = FL * RPL RPL = Relative Popularity Level is a number between 0-1
Informant Agreement Ration (IAR) Trotter and Logan, 1986, Adapted by Collins et al. (2006), Inta et al. (2008) and Estrada et al. (2011)	It is a measure of the agreement between informants concerning what plants to use for specific usage categories	IAR = $(Ur - Npu)/(Ur - 1)$ Ur is the reported uses and Npu is the number of plants uses Values for the factor range from 0 to 1. A value of 1 indicates few taxa are used by informants, thus inferring a high degree of consensus and a well-defined medicinal plant tradition. Here, consensus is measured with reference to increased frequency of occurrence of the category of ailments. These values were a powerful tool that, together with searches in available bibliographical databases, facilitated the further development and depuration of the information When this value is equal to one, all respondents agree on a single species for a particular use or health problem (Estrada et al. 2011)
Use Consensus Value (UC_s) Byg and Balslev (2001)	Measure how large the degree of accordance is between informants concerning whether they regard a species as useful or not	$UC_s = 2n_s \backslash n-1$ Where n_s = number of people using a species $_{si}$ n = total number of informants Value ranges between -1 to +1
Factor of Informant Consensus Trotter and Logan (1986) Modified by Heinrich et al. (1998)	It was used to identify plants of particular intercultural relevance and to agree on their use.	$\text{Fic} = \frac{\text{Nur} - \text{Nt}}{\text{Nur} - 1}$ The *F*ic was calculated as the number of use citations in each category (*N*ur) minus the number of species used (*N*t), divided by the number of use citations in each category minus one (Heinrich et al. 1998): *F*ic values range from 000 to 100. High *F*ic values are obtained when only one or a few plant species are reported to be used by a high proportion of informants to treat a particular category, whereas low *F*ic values indicate that informants disagree over which plant to use As a result of this analysis, it was possible to identify species of particular importance within a culture (inter-cultural) and to compare different cultures. Over the last 5 years this tool was used at

Appendix: Contd...

Indices and developed by	*Description*	*Formula and interpretation*
		least in 70 publications mainly to analyze the use of plant species in different ethnographic backgrounds; recent examples include Karousouand and Deirmentzoglou (2011) in Cyprus; Jacobo-Salcedo et al. (2011) in Mexico; Pandikumar et al. (2011) in India; Teklehaymanot and Giday (2009) in Ethiopia *F*ic has also been used to analyze the use of animal species (Ferreira et al. 2009 and Upadhyay et al. 2010)
Consensus between Authors on Cited Species and Families Molares and Ladio (2009)	Estimate the frequency of species and families	Number of authors who cite the species $_s$ (or family) x 100\total number of authors
Consensus Index Lozada et al. (2006)	Evaluate consensus among individuals	Count the number of people who cited a plant species as useful
Consensus Value for Plant Part (CPP) Monterio et al. (2006) Adapted by Koura et al. (2011)	Measures the degree of agreement among informants concerning the plant part used	CPP = Px\Pt Where Px = number of times a given plant part was cited; Pt = total number of citation of all parts
Consensus Value for Substitutes (CVS) Monterio et al. (2006)	Measures the degree of agreement among informants concerning the possible substitutes for the plants used	CVS = Sx\St Where Sx = number of uses cited for a given substitute St = total number of citations for all possible substitutes
Consensus value for the Collection Site (CCS) Monteiro et al. (2006)	Measures the degree of agreement among informants concerning the collection site of the plant used	CS = Sx\St Where Sx = number of times a given site was mentioned St = total citation of all the localities
*Consensus Value for the Manner of Usage (CMU)*Monterio et al. (2006) Adapted by Koura et al. (2011)	Measures the degree of agreement among the informants concerning the manner of usage of the plant used	CMU= Mx\Mt Where Mx = number of citations for a given manner of usage; Mt = total citation for all manners
Consensus Value for the Period of Collection (CTC) Monterio et al. (2006)	Measures the degree of agreement among the informants concerning the period of collection of the plant studied	CTC = Cx\Ct Where = Cx = number of citation for a given period of collection; Ct = total number of citations for all periods
Consensus Value for Use-Types (CUT) Monteiro et al. (2006)	Measures the degree of agreement among the informants concerning species uses	CUT = (TU\Ut)\S Where = TU = Total number of times a given use was reported; Ut= Total number of uses; S = Types of uses separated into categories
Disease Consensus Index (DCI) Andrade-Cetto et al. (2006)	Select species which are relevant for the treatment of one specific disease	$DCI = (\sum_{i=1}^{0.0} \frac{Vxi}{Ccx}\ mVx)\ PM^{-0.1}$ x = any species; (ΣVxi) = sum of the individual values obtained for one species within the community Evaluates: (Knowledge, Mentions); mVx = Statistical mean of the individual values, for one plant Evaluates (Knowledge); Cc = correlation coefficient, defined as the maximal number of informants whom refer a plant Evaluate: (Mentions); Pm^{-01} = compensation factor, and analyses the dispersion for one plant, considering the mode of preparation and part used. For the application of the index, it is necessary to formulate a questionnaire with answers that can be evaluated in a binary way: 0 for no and 1 for yes. The questions must include personal knowledge about a specific species to treat the disease.
Informant Consensus Byg and Baslev (2001)	The importance of each specified category	Calculated directly from the number of informants who mentioned the specie

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Indices and developed by	*Description*	*Formula and interpretation*
Purpose Consensus value (PC_s) Byg and Balslev (2001)	Measures how large the degree of accordance is among informants using it concerning what purposes they use it for	$PC_s = \Sigma P^2u \backslash S$ Where: P^2u = proportional contribution of use u to the total utility of a species $_{sp,}$ that is equal to number of times use u was reported for species; S = total number of types of uses of species $_s$
Principal Use Agreement (PUA) Medeiros et al. (2011)	Based in the number of informants who cited the species x.	Use the number of informants that cited the principal use, multiplied per 100 and divided by the number of informant that mentioned the species.
Corrected Principal Use Agreement (PUA_C)	Based in the number of informants who cited the species x with respect the total number of all cited species.	To calculate the CUP_s it is used the multi-plication of the Principal Use Agreement (PUA) by the Correc-tion Factor (CF).
Simple Summation Informant Consensus, $IC1_s$ developed by Caldwell (2007)	Informant consensus is determined using a simple summation of number of use reports.	$IC1_8 = \Sigma \ (IC_u \ X \ nr_{us})$ Where nr_{us} is the number of reports of using species, s, for use, u, and IC_u is calculated as follows. $IC_u = \frac{nr_u - ns_u}{nr_u - 1}$
Relative Informant Consensus $IC2_s$ developed by Caldwell (2007)	This index determined by using a relative value of number of use report.	$IC2_s = \Sigma \ ICu \ X \frac{nr_{us}}{nr_u}$ Where nr_u is the total number of report of use, u.
Logarithmic Informant Consensus IC3 developed by Caldwell (2007)	This index determined by taking the natural log. By taking the natural log, the number of reports is less influential, decreasing the range of difference between species and allowing some species , which may be essential for a given purpose, but less frequently cited to be higher value	$IC3_s = \Sigma \ (IC_u \ x \ 1n \ (nr_{us}))$ IC1,IC 2 and IC3 can address the following inadequacies 1. The three new measures use the number of uses, the number of reports, and the agreement among uses while still allowing each use to be weighted by importance 2. The new, IC3, reduces the influences of the number of reports by using the natural log of this value in its calculation
Quality Use Agreement Value (QUAV)		The proposal is to combine both parameters (the emic perception of therapeutic qualities (QUV_s) and the informant consensus (IAR_s) into the Quality Use Agreement Value ($QUAV_s$).
	Use Value Methods	
Use –Value (UV) Phillips et al.(1994)	Indicates that species that are considered most important by a give population	$UV = \Sigma U \backslash n$ Where U = sum of the uses mentioned by the informant; n = total number of informantUse values are high when there are many use-reports for a plant, implying that the plant is important, and approach zero (0) when there are few reports related to its use. The use value, however, does not distinguish whether a plant is used for single or multiple purposes (Tardio and Santayana 2008)
Use-value For one Species proposed by Phillips and Gentry (1993a,b) and adapted by Albuquerque et al. (2007)	The use-value (UV) index was used to calculate the citation of plants during interviews	UVc = "ΣU_{is}/ ns where *U* is the sum of the total number of use citations by all informants for a given species, divided by the total number of informants (ns). This method evaluates the relative importance (RI) of each medicinal species based on its relative use among informants. This index is useful for the analysis of the use of a single species and to compare plants among the same sample
Species Use-value For One Informant Phillips and Gentry (1993a,b)	The species UV index was used to calculate the number of uses mentioned for species by one informant in different events)	$UV_{is=} \quad (\Sigma U_{is})/(N_{is})$ Where *U*is is the number of uses mentioned for species s by the informant and *N*is is the number of events in which the informant cites a use for species s. This index is useful if a researcher goes into the

Appendix: Contd...

Indices and developed by	*Description*	*Formula and interpretation*
		field with one informant with the aim of collecting a specific species, but during the course of the field study, the informant mentions other plants; each time the informant stops and gives information about a species is an "event". The expected score for each species is 1, which means that, if a species was found four times, the informant mentioned the species four times for the same use
Utilization Index (U\C or U\R) Adapted by Medeiros et al. (2012)	Provide an idea of the degree of decline of popular plant use	Obtained by dividing the number of plants used by the number of plants reported, expressed as a percentage
Use Value Index (UV_s) Phillips and Gentry (1993 a, b)	Quantify the importance of each species for each informant	UV_S = "$UV_{is} \backslash n_s$ Where UV_{is} = number of informants interviewed for species s, n_s = number of informant who mention the species $_{s.}$
Relative Use Value (RUV_i) *Phillips and Gentry (1993b)*	Measures how RUV_i many plant uses on informant knows relative to the average knowledge among all informants	$RUV_i = [(UV_{is} \backslash UV_s)] \backslash n$ Where UV_{is} = number of uses that informant $_I$ knows for species UV_s = use value of species that is equal to the average number of uses that informant know for species $_s$; n = number of useful species
Relative Frequency (RF) Case et al. (2005) and Ragupathy and Newmaster (2009).	The relative frequency (RF) of each plant from the interviews is calculated to determine a "remedy of choice"	Use three, four or five citation from different informants to establish consensus among the community that is being study
Family Use Value (FUV) Phillips and Gentry (1993b) adapted by Letsela et al. (2003)	Calculates the use importance of a family	$FUV = \Sigma UV_{is} \backslash nf$ Where: UV_{is} = Total number of species within a given family; nf = Sum the use values for all the species within a given family and divide by $n_{s.}$
Correction Factor (CF) Reported by Medeiros et al. (2012)		Based in the number of people who cited the species To calculate the correction factor is used the number of informants that mentioned uses for the species, divided by the number of informants that cited the principal species that is with the major number of reported uses
Frequency (Fsp)	Measure the frequency with which each of the species is encountered in the fences	Fsp = total number of residences in which species X is used\total number of fences maintainers (or residences) x 100
Intra-specific Use Value (IUV) Gomez-Beloz (2002)	It is the ratio of the specific reported use and the reported use for the plant part. Allows the ordering of use importance within a specific plant part. The intra-specific use value allows the ordering of use importance within a specific plant part It helps to identify for a specific plant part, the most frequently reported specific uses by the respondents from a sociolinguistic group. High values of IUV for a specific use generally indicate a consensus in this use of the concerned part within a socio linguistic group. Use by Avocevou-Ayisso et al. (2011)	$IUV = SU_{[plant\ part]}/RU_{[plant\ part]}$ Where: SU = specific use for the plant part; RU = reported use for the plant part

Appendix: Contd...

Indices and developed by	*Description*	*Formula and interpretation*
Informant Diversity Value (ID_s) Byg and Balslev (2001)	Measures how many informant use a species and how its use is ditributed among them	$ID_s = 1/\Sigma P^2_{i;}$ Where P_i = contribution of informant $_i$ to the total knowledge pool of species$_s$; ID = number of reports of use of species $_s$ by informant $_i$ divided by the total number of reports of use of species. Value range between 0 and the number of informant using it
Overall Use Value (OUV) Gomez-Beloz (2002)	llows comparisons of uses A within a group of plants and is used to compare use importance for this group of plants	*OUV*spp1 = Σ(*MWU*spp1) XΣ(*MWQ* spp1) where *MWU* are men and women values of plant species frequency of use, and *MWQ* are men and women values of plant species quality
Plant Part Value (PPV) Gomenz-Beloz	Is a value given for a specific plant part	PPV = (RU [plant part]ΣRU); Where: RU = number of total reported uses for each plant part; RU = total number of reported uses for that plant
Quality Use Value (QUV_s) Thomas et al. (2009)	Medicinal QUV_s values appear to be more sensitive to the number of ethno medicinal applications per plant species and incorporate the emic perception of therapeutic qualities, whereas IAR, values address informant consensus	$QUVs= \Sigma^n_{p=1}\ QU_{is}\ /_{ns}$ Where: QUis equals QU is = sum of the qualities of all medicinal uses assigned to species s by informant is ns = number of participants interviewed for species s. This implies tha the quality of each medicinal uses mentioned is to be assessed by each individual participant. Qualities are appraised on an ordinal scale, choosing between (a) good to excellent, (b) fair, or (c) bad, to which values of 1, 05 and 025 were attributed, respectively
Relative Use(RU) Stagegaard et al. (2002)	Allows identifying species actually extracted by people living in or close to the vegetation, providing a realistic estimation of the present use and importance of the individual species	The relative Use (RU) of extracted species is calculated as the frequency by which the species was recorded within a certain subcategory
Reported Use Value for Each Plant and Plant Part (RU) Gomez-Beloz (2002)	Is the total number of uses reported for each plant	It is similar to the use value of a species as reported by Philliphs and Genetry (1993). Theirs is a ratio of the number of uses reported in each events by an informants in relation to number of events for that species For RU, the number of events, the process of asking one informant on one day about the uses they know for one species, is one because the respondents were interviewed only once. Response use values were broken down by number of uses reported for each plant part (SRU [plant part])
Species Diversity Value Byg and Balslev (2001)	Measures how many species an informant uses and how evenly his uses are distributed among the species	$SDi = 1/\Sigma P_s^2$ Where P^2_s = contribution of a species, to informant total use palm, that is equal to the number of times species, was mentioned by informant, i divided by the total number of informants I's answer
Specific Reported Use (SE) Gomez-Beloz (2002)	Is the use an described by the respondent The use are simplified to facilitate analysis	The SU value refers to the number of times a specific reported by the respondent
Specific Use Value Index (SUV) Camou-Guerrero et al. (2008).	To find relevant plant species at the level of specific use	Calculated, taking into account men's and women's U and Q values, independently for each plant species specific uses described
Total Species Diversity (SD_{tot}) Byg and Balslev(2001)	Measures how many species are used and how evenly they contribute	$SD_{tot} = 1/\ \Sigma\ P^2_s$ Where:P^2_s contribution of species $_s$ to the total use of palms in the study communities, that is equal to the number of times species $_s$ was mentioned divided by the total number of reports of palm uses Values ranges between 0 to n
Total Value of an Ethno-species(V_s)	Calculate the cultural value of an ethno-species using	$CV_s = Uc_e\ ^*\ Ic_e\ ^*\Sigma IUc$ Where: CV_s = the cultural value of ethno-species,

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Indices and developed by	*Description*	*Formula and interpretation*
Reyes-Garcia et al. (2006)	information from free listing, and calculate the practical and economic values using observational information from scans	Uc_e = the total number of uses reported for ethno-species$_e$ divided by the six potential uses of an ethno-species considered in the study (that is, medicine, firewood, construction, tools food and other); IC_e = number of participants who listed the ethno-species as useful divided by the total number of people participation in free listing; Ic_e = the number of participants who listed the ethno-species$_e$ as useful divided by the total number of people participating in free listing; IUc_e = the number of participants who mentioned each use of the ethno-species$_e$ divided by the total number of participantsTo calculate the practical value of an ethnospecie $PV_e = UP_c * IP_c * DUp_e$; Where: PV_e = the practical value of ethno-species $_e$; Up_c = the number of different uses observed for ethno-species$_e$ during scan observation divided by the six potential uses of an ethno-species considered in the study; Ip_e = the number of times ethno-species$_e$ was brought to a household divided by the total number of informants participation in scan observation; the variable captures the share of participants who use the ethno-species; Dup_e = captures the duration of each useTo calculate the economic value of an ethno-species is used the village price of the ethno-species For ethno-species without a price, is used estimation in which are asked villagers how much time it took them to find the good, multiplied the amont of time by the prevailing daily wage in the village, and assigned the resulting value to the ethno-species Is used this Formula. $EV_e = Oe_e * Pe_e$; Where: EV_e = the economic value of ethno-species $_e$; Oe_e = the of the number of ethno-species $_e$; Oe_e = the number of observation for ethno-species $_e$ that is, , the total number of times the ethno-species was brought to any household in the sample; Pe_e = the price of the ethno-speciesThen is calculate the total value of an ethno-species (V_e) as the sum of its cultural, practical, and economic values: $V_e = Cv_e + Pv_e + Ev_e$;
Use Diversity Value (UD_s) Byg and Balslev (2001) Adaptedby Koura et al.(2011)	Measures the importance of use categories and how they contribute to the total value of uses	$UD_s = U_{cx}/U_{ct}$ Where: U_{cx} = number of indications recorded by category: U_{ct} = total number of indications for all of the categories)
Use Value Index (UV) Camou-Guerrero et al. (2008)	Combining the use frequency (U) and the quality perception (Q) of useful plant species by local people. The product of men and women's U and Q values of plant species	To assess plant species use value is considered the frequency of use (U) and the local perception of quality (Q). The U is defined as the proportion of positive mentions of plant species for a particular use, divided by the total number of interviews. The local perception of quality (Q) of plant species is calculated as the proportion of positive mentions of quality with respect to the total number of interview
*Use Value Index of Each Species for EachInformant $_I$ (UV_{is})*Phillip and Genetry (1993a,b)	Quantify the importance of each species for each informant	$UV_{is} = \Sigma U_{is} / n_{is}$ Where: U_{is} = number of uses quated in each interview (event) by informant $_I$; n_{is} = number of quotations for species $_s$ given by informant $_i$. An event is defined as the process of asking one informant on 1 day about the uses they know for one given species
Use Value of Each Species in the Category(UV_c) Modified by Rossato et al.(1999)	Measures the average number of uses informants known for each Species in the category	$UV_c = \Sigma UV/n$ Where: UV_c = the use value of each species in the category; n = number of species in the category c

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Indices and developed by	*Description*	*Formula and interpretation*
Use Value Calculated for Men andWomen Modified byRossato et al.(1999)	Measures the average number of uses men or women known for plant species	$UV = \Sigma U_{m,w} / n_{m,w}$ Where: $\Sigma U_{m,w}$ = sum of all the use citation of the men or of the women and $n_{m,w}$ = total number of men or women
Use Diversity Value (UD) Modified by Byg and Baslev (2001) and by Monteiro et al. (2006)	Measures the importance of use categories and how they contribute to the total value of uses	$UD = U_{cx}/U_{ct}$ Where: U_{cx} = number of indications recorded by category; U_{ct} = total number of indications for all the categories
Over Use Efficiency (OUV) Camou-Guerrero et al. (2008)	The Use value index defined through use frequency and quality perception allows identification of the relative importance of useful plant species among a group	$OUV_{spp1} = \Sigma(MWU_{spp1}) \times \Sigma(MWQ_{spp1})$ Where: MWU_{spp1} = men's and women's values of plant species frequency of use; $MWQ_{spp\,1}$ = men's and women value of plant species quality" it multiplied the U and Q components in order to amplify variations
Use Value for Each Species in the Plant Family Modified by Rossato et al. (1999)	Measures the average number of uses informants know for each species in the plant family	$UV_f = \Sigma\, Uv/n_f$ Where: UV = number of uses informants knows for species $_s$; n_f = number of species in the family
Relative Importance Method Relative Importance (RI) Bennett and Prance (2000) Adapted by Giady (2009), Mathur (2012)	Emphasizes a plant's importance in relation to its versatility	RI = NSC+ NP NSC = NCSS\NCSV NP = NPS\NPSV Where = NCS = relative number of corporal system; calculated by dividing the number of corporeal system treated by a given species (NCSS) by the total number of corporeal system treated by most versatile species. (NCSV) NP = Relative number of properties; calculated by dividing the number of properties attributed to a given species (NPS) by the number of properties attributed to the most versatile species (NPSV)
Cultural Importance Index (CI) Reyes-Garacia et al. (2006) adapted by Pardo-de-Santayana et al. (2007), Hinnawi (2010) and Mutheeswaran et al. (2011)	The cultural importance index (CI) of each species estimated for each locality as the summation of the use report (UR) in every use category mentioned for a species in the locality.	$CI_S = \sum_{u=u_i}^{U_{NC}} \sum_{i=i_i}^{i_{NC}} UR_{ui/N}$ Divided by the total number of survey participants (N) in that locality (Pardo-de-Santayana et al.2007) where u is the category of use, NC is the total number of different categories of use (of each 'i' species), UR is the total number of use-reports for each species Maximum value of the index is the total number of different use- ($_{NC}$) reached in the unlikely case that all the informants would mention the use of the species in all the use categories considered in the survey.
Mean Cultural Importance Index (mCI) Pardo-de Santayana et al.(2007)	Useful in evaluating CI differences among the various site.	Take in to consideration the Cultural Importance Index (CI). Since a null value may be due to either the species not growing in the area or growing but not being consumed, the mean value preferably needs to be calculated by considering only regions where the species grows. Thus the mean value take into account species selection or rejection and availability
*Cultural Importance of Family*Galeano (2000)	To highlight more diverse families this would otherwise be underestimated	Obtained by the some of the CI of the species from each family
Importance Value (IV_s) Byg and Balslev (2001)	Measures the proportion of informants who regard a species as most important	$IV_s = n_{is} \backslash n$ Where n_{is} = number of informants who consider species, most important n = total number of informants value range between 0 to 1
Cultural Importance Index (CI) Based on previous	To estimate the cultural significance of each species	$CI = \sum_{i=1}^{i=NU} UR/N$

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Indices and developed by	*Description*	*Formula and interpretation*
indices from Reyes-Garcia et al. (2006) and Phillips and Gentry (1993)		Obtained by adding the UR in every use-category (I, varying from only one use to the total number of uses, NU) mentioned for a species, divided by the number of informants in the survey (N). The theoretical maximum value of the index is the total number of different edible use categories
Importance Value Index (IVI) Modified by Dhar et al. (2000)	In order to establish conservation priorities based on indicators from pharmaceutical products	IVI = RI + SI Where; RI = relative importance of a species, already explained in this table (RI[2]);SI = Sensitivity index = [(SR x NR)/(SR x NR)] x 100 where; SR = sensitivity rank, considers attributes related to the manner in which a species is harvested and the degree of anthropogenic pressure to which it is subjected. NR = naturalness rank, concern the origin of the species that are used as a raw material in industry, values varying from 1 to 3
Performance Index (I_p) Betti (2002)	Evaluate the relative importance of medicinal plant species	The proportions used are calculated from the rations of number of citation for diseases The proportion of citation (records) for a specific disease to the total number of citation is considered as a theoretical proportion (P2). This proportion is compared to the proportion for a specific disease to the total number of citation for the same plants for all disease (PI). The difference (D) between the two proportions is then used to define a performance index (I_p).Value ranges from 0 to 3 according to the following scale; P1- P2< 0, I_p = 0 (the plants concerned are rejected, not significance); 0<P1-P2 1\3, I_p=1 (average performance); 1\3 <P1-P2 2\3, I_p = 2 (high performance); PI – P2>2\3, I_p = 3 (very high performance)
Relative Importance (RI) Adopted from Bennett and Prance (2000)	Developed primarily for measuring the usefulness of medicinal plants	RI = NUC+ NT; Where: NUC = number of use-categories of a given species (NUCS) divided by the total number of use-categories of the most versatile species (NUCVS); NT = number of types of uses attributed to a given species (NTS) divided by the total number of types of uses attributed to the most important taxon (NTMIT), independent of the number of informants that cite the species
Relative Importance Index (RI) Pardo-de-Santayana (2003), adapted by Tardio and Pardo-de-Santayana (2008)	Measures the plants that were the most frequently mentioned as useful and in the maximum number of use-categories	RI_s =RFC_s (max)+ RNU_s (max)\2 Where: RFC_s (max) = relative frequency of citation over the maximum, ie it is obtained by dividing FC_s by the maximum value in all the species of the survey [RFC_s(max) = FC_s\max (FC)]; RNU_s (max) = relative number of use categories over the maximum, obtained dividing the number of uses of the species $$NU_S = \sum_{u=ui}^{u\,uNC} UR_S$$ By the maximum in all the species of the survey [$RN_{s(max)}$]= NU_s \max (NU)]. The RI index theoretically varies from 0 when nobody mentions any use of the plant, to 1 in the case where the plant was the most frequently mentioned as useful and in the maximum number of use categories. Takes into account only the use categories –not the subcategories
Relative Importance Value (IV Remedy) Leaman et al. (1995)	Quantify the degree of confirmation among respondents within and between the communities surveyed	The importance value for Malaria (IV mal) = 1 for remedies reported once during survey; IV mal = 2 for remedies reported twice in one communities; IV mal = 3 for remedies reported at least three times in one community; and IV mal = 4 for remedies reported in more than one community
*Syndromic Importance Value (SIV)*Leduce et al. (2006)	In order to prioritize plant species for pharmacological investigation	SIV= [Σws\S]+ [Σwf\SF]\2 = Σws + [Σwf\F]; Where = w = is the weight of the symptom; s species; f =the frequency of citation for the species; S = total

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Indices and developed by	*Description*	*Formula and interpretation*
		number of symptoms used for the survey; F = the total number of interviews in the survey; the equation is divided by 2 since the SIV represent an average value equally dependent on both frequency and symptoms contribution. The weight of the symptoms, w, is the degree of association converted to a number between 0 to 1, where $\Sigma w = 1$. The symptoms contribution, s is either 1 or 0 based on the plant species being cited for the particular symptoms or not, respectively, where $\Sigma s = S = 15$, in the case where the species is cited for all symptoms. The frequency of citation, f, refers to the total number of instances the plant was cited for one of the symptoms, where a maximum $\Sigma f = SF = 15 \times 23 = 345$, if all informants were to cite the plant species for all 15 symptoms
	Equitability Methods	
Total Species Equitability Byg and Balslev (2001)	Measures how evenly different palm species contribute to total palm use, independently of the number of species used	$SE_{tot} = SD_{tot} \backslash n$ Where n = number of species used Value ranges between 0 and 1
Equitability (E) Begossi (1996)	Indicated in an area major ethno botanical knowledge that is important to the region that is being studied	$E = H \backslash H_{max}$ Where: H = -(pi In pi), where pi is the proportion between the number of citations for each species and the total number of citations; H_{max} = In R, where R = is the number of useful species
Informant Equibility Value (IE_s) Byg and Balslev(2001)	Measures how the use of a species is distributed among informants independently of the number of informant using it.	$IE_s = ID_s / ID_{s\ max}$; Where: $ID_{s\ max}$ = maximum informant diversity value for a species, which is known by a given number of informants Value range between 0 and 1
Species Equitability Value (SE_i) Byg and Balslev(2001)	Is the use are described by the respondent The use descriptions are simplified to facilitate analysis.	$SE_i = SD_i \backslash SD_{i\ max}$ Where $SD_{i\ max}$ = maximum people species diversity value for an informant $_i$ who uses a given number of species. Value ranges between 0 and 1
Use equitability Value (UEV) Bygand Balslev (2001) Adapted by Koura et al.(2011)	Measures degree of homogeneity of knowledge about use categories	$UEV = UD/UD_{max}$ Where: UD = use diversity value, UD_{max} = the index's maximum value Value ranges between 0 to 1
Interviewee equitability value (IE), Byg and Baslev (2001)	Measures the degree of homogeneity of the interviewee's knowledge	IE = ID/Dmax; Where IE, interviewee diversity value, divided by this index maximum value (IDmax) Adapted by Koura et al (2011)
	Pharmacological Ethno-Medicine Index	
Ethno-phytonymy index Bonet et al. (1999)	Indicative of the richness of popular knowledge of plants, and of the attachment between human beings and plants	The ratio between the number of plant species with opular names and the total number of plants of the flora in one regionmultiplied per 100, as it is a percentage. The highest number if taxa with popular phytonyms, the better plant knowledge and use is conserved in the region It will be indicative of the richness of popular knowledge of plants, and of the attachment between human beings and plants, since naming a plant (or an animal) is one of the very first activities undertaken in human societies regarding the systems in which they live and which they manage
Ethno-botanicity Index Begossi (1996)	Different parameters used to evaluate the ethno- botanical richness	Ratio between reported useful plants and the flora of an area, expressed as a percentage
	Food Indices	
Edible Mushroom Cultural Significance Index Modified from Pieroni (2001) by Garibay-	This index divides the cultural significance into several cultural domains and shows the causes that underlie this phenomenon. This	EMCSI = (PAI+FUI+TSAI+MFFI+KTI+Hi+EI)QI Mention index (QI), Perceived Abundance Index (PAI), Frequency of Use Index (FUI), Taste Score Appreciation Index (TSAI) and Multifunctional Food Index (MFFI) Knowledge Transmission Index

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Indices and developed by	*Description*	*Formula and interpretation*
Orijel et al. (2007)	approach can be used in cross-cultural studies because it brings a list with the relative position of species among a cultural significance gradient.	(KTI); health Index (HI) and Economic Index (EI)
Regional Selection Index (RSI) Pardo-de-Santayana et al.(2007)	This index was created to assess differences in edible species selection or rejection among regions	It is obtained by dividing the number of species consumed at a site by the number of species growing there
*Cultural Food Significance Index (CFSI)*Turner (1988) Adapted by Pieroni (2001)	The use of this index allows for the quantitative comparison of ethno botanical data in an intercultural ethno biolo-gical analysis	*CFSl* =Ql *x Al x* FUI *x* PUI *x MFFI x TSAl x FMRl x* 10^{-2} The formula takes in account seven indexes which express the frequency of quotation (QI). Availability Index (AI, comprises very common (40), common (30), middle (20) and rare (10), the Frequency of Use Index (FUI, week month or year), the Parts Used Index (PUl), Multi Functional Food Use (MFFI). Taste core Appreciation Index (TSAI), and the Food-Medicinal Role Index (FMRI). Similarly, as for the ICS and EICS of Turner (1988) and Stoffle et al. (1990), the components of the index are multiplied Yet, differently from those indexes, the total number of uses and/ or plant parts is not taken into account by adding the multiplied factors, but by specific independent indexes (PUI and MFRI). This method was chosen in order to avoid an overestimation of plants which do not present a unique useful morphological parts In contrast to medicinal taxa, diverse parts of food herbs are in fact commonly used for food
	Specific	
Mean Rank of Usefulness Lykke et al (2000)	In order to identify key species for local use, the species were ranked according to their total use-value	Calculated for each species as the average answer, ranging from 0 (no informants found it useful) to 2 (all informants found it very useful), and a ranking of the species is constructed in each use-category Total use-value for each species is calculated as the sum of mean rank for all requested use-categories
Number of Species Used Medicinally (MSPE) Moerman (1991)	Used to assess whether certain plant families were preferentially selected by the healers for neurological or mental disorders, thus indicating potential biologi-cal activity of the plants within these botanical families	MPSPE = A+ (B+FBSPE) Where: A = intercept, B= slop, FPSPE = total number of species per family It consists of a regression of the number of species in families that are used medicinally on the total number of species available per family in the total flora. The constant and the coefficient are determined using a slandered linear least squares regression. Subsequently, residual values are calculated for each family by subtracting the predicted value from the actual value. Negative residuals indicates that the families are underused, whereas positive values suggests overuse or preferential selection
U/K Index Reported by Medeiros et al.(2011)	Evaluates the degree of novelty in local names, or identify local names not yet published; or appraises the persistence of plant uses	Is calculated as the ratio between the number of local names not yet documented and the total number of reported useful species; or the ratio between the mean number of medicinal and aromatic plants used (U_s for use) and Known (K for knowledge) by the informant
Cultural Significance Index (CSI) Turner (1988), adapted by Stoffle et al.(1990) Albuquerque et al. (2006), Garibay-Orijel (2007) and Signorini et al. (2009)	With this index, the recognition and reputation of a species is linked to its function to the people and are considered auxiliary elements in the cultural recognition of a plant (Turner 1988), which is directly related to the	CSI = Σ (I x e x c) CF Where = i= species management. Species management considers the plant's daily life The value of 2 is given for species that are cultivated, managed, or manipulated in any way, even if an incipient manner; the value of 1 is given for species found in the area yet free from any kind of management or conservation practices e= use preference. This represents the preference given to the use of one

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Indices and developed by	*Description*	*Formula and interpretation*
	group's survival	species in relation to another for any given purpose. The numerical value of 2 is suggested for a species preferentially used for a given purpose, and value 1 is suggested for other available species not chosen preferentially for that purpose c= Use frequency. This considers plants effectively used In accordance with the values designated by Stoffle et al. (1990) a value of 2 is attributed to plant effectively known and used, and 1 is attributed to plant rarely cited CF = Correction factor (Informant consensus)
Cultural Value Index (CV) Reyes-Garcia et al. (2006) Adapted by Tardio and Pardo-De-Santayana (2008)	Estimate the cultural significance of each species	$CVs = \left[\frac{NU_S}{NC}\right] \text{ X } \left[\frac{FC_S}{N}\right] \text{ X } [\sum_{u=u_1}^{U_{NC}} \sum_{i=i_1}^{iN} UR_{ui}/N]$ NU_s = number of distinct uses reported for the species; NC = total number of use-categories considered in the study; FC = relative frequency of citation of the species (Previously defined); N = number of informants. Ultimate Factor = summitry of all UR to the species ie, the sum of number of participants who mentioned each use of the species
Index of Ethno-botanical Knowledge Phillips and Gentry (1993 a and b)	Information can be accessed from people's knowledge of the classification, identi-fication, naming and ecology of plants	$Mg_i = (1\backslash n)\Sigma V_i$ Where: Mg_i = mean degree of traditional knowledge held by members of $group_i$; V_i = the amount of traditional knowledge help by $member_i$ from group
Relational Efficacy Bletter (2007)	The goal of the "relational efficacy" is to raise the hit rate above even the30% seen with ethno- botanically-directed medicinal plantsear-ches, that is, to increase the efficiency of these searches	The hypothesis is that in a database with N_s species , N_d disease, and N_c cultures, the potential of a certain disease $_{ds}$ (P_{sdc}) should increase with greater phylogenetic proximity of other plants $_s$ used to treat related disease ($R_{s, s'}$) increase with greater etiology proximity of the disease $_{d'}$ treated by related plants ($R_{d\ d'}$) and increase with less phylogenetic proximity of cultures ($_{c'}$) using related plants to treat related diseases ($R_{c\ c'}$), but it should no increase solely be increasing the size of the dataset. The basic Formula for the potential $P_{a,b,c}$ of species $_s$ to treat disease $_d$ in culture $_c$ proposed to meet these conditions is: $P_{sdc} = 1\backslash N_s N_d N_c$ "$R_{s\ s'}.R_{d\ d'}\backslash.R_{c\ c's'd'c'}$ Where the relatedness factors are summer over all species $_s$ is used to treat disease $_d$ in culture $_{c'}$, N_s = number of species, N_s = number of disease and N_c = number of cultures. These relatedness factors, would be 1 for two plants, disease, or culture that are exactly the same, and would decrease towards 0 as they became less related
Relative Frequency of Citation (RFC) Tardìo J and Pardo-De-Santayana, (2008), utilize by Mosaddegh et al. (2012)	This index, which does not consider the variable (use-category), is obtained by dividing the number of informants who mention the use of the species, also known as frequency of citation (FC) by the number of informants participating in the survey (N)	$RFCs - \left[\frac{FCs}{N}\right] - \sum_{i=i_2}^{iS} UR_{ui}/N$ Where: FC_s = number of informants who mention the use of the species, also known as frequency of citation; N = number of informant participating in the survey. This index, which does not consider the variable (use – category) This index theoretically varies from 0 when nobody refers to the plants as useful to 1 in the unlikely cases that all the informants would mention the use of the species
Index of Cultural Significance Turner (1988)	For each species, scores for all uses cited from 1 to n uses) are added together The soccer for each use is determined from the multiplied scores derived from three ordinal scales of significance	$ICS = \sum_{i=1}^{n} (q * i * e)$ Where: q = quality of use [critical resources (5) to little noticed (0)] I = intensity of use [high (5), low (0)] E = exclusivity of use
Ethnic Index of Cultural Significance	EICS have been developed to facilitate the evaluationof	$EICS = \sum_{i=1}^{u} (\frac{P}{u^* i^* c^* c})$ Modified from Turner (1988) to be less subjective

Appendix: Contd...

Indices and developed by	*Description*	*Formula and interpretation*
(EICS)	every plant used or known in a given ethnic context and not specifically asspecies used for food	Calculated as the sum of the total number of uses and/ or plant parts used for a specific purpose (p/u) multiplied by: i = intensity of use [same as Turner 1988) e = exclusivity of use [preferred by at least one informant (2), not mentioned as preferred (1)] c = contemporary usage [contemporary (2) or not (1)]
Person's Ethno-botanical Knowledge Reyes-Garcia et al. (2009)	OKijv refers to a person's ethno- botanical knowledge, where i is the participant, j is the household, and v is the village	OKijv $=\alpha + \beta$PKijv + ÒSKijv + ψCKijv + ψDijv + ψ'VVv + èijv PKijv captures the ethno botanical competence of the same-sex parent SKijv captures the average ethno botanical competence of the subject's age peers (excluding the subject's own competence)
Interviewee Diversity Value (ID) Byg and Baslev (2001)	Measures how many interv-iewees used a species and how its uses are distributed among the interviewees	ID = Ux/Ut; where = ID, = number of use-citation by a given interviewee (Ux) divided by the total number of uses (Ut) Adapted by Koura et al. (2011)
Knowledge Richness Index (KRI) Araujo et al. (2012)	It measures the knowledge richness and uniqueness of a specific set of plants by a certain individual KRI values are inversely pro-portional to value or in other words, a lower KRI value corresponds to the greater knowledge of the informant	$KRI = KRI \Sigma J^2_i$ Where $J_i = R_i/$; Ri = recorded of species (s_1) cited by informant (I_i); FF_i = total recorded of species (S_i) cited by the family or community (F_i) The KRI assumes values starting from zero and represents a distance measure that ranges from o ti infinity The more distance from zero values presented by a determined informant, the smaller that the richness of a species known by that infor-mant inside the family nucleus or group
Knowledge Sharing Index (KSI) Araujo et al. (2012)	KSI , is based on the ration between the richness index of the informant and the maximum richness index of the family unit or commu-nity. It aims to evaluate the homogeneity of knowledge	The KSI is also a measure of distance, and the value may ranges from 0 to1, with 1 being the value that express the lowest degree of sharing among a determined informant (KRI_i) and the other components of the family unit or community (KRI_{max})$KSI = KRI_i/KRI_{max}$
Relational Efficacy, Bletter (2007)	This index was based on the hypothesis that closely rela-ted plants used to treat closely related diseases in distantly related culture have a higher probability of being effec-tive because they are more likely to be independent dis-coveries of similar plant compound and disease mechanism	$ICS = \sum_{i=1}^{n} (q^*i^*e)P_{s,d,c,} = \frac{1}{Ns, Nd, Nc} \sum_{s^1,d^1,c^1} \frac{ts^1\ d^1, c^1}{t_{max}} \frac{Rs,s^1\ Rd, d^1}{Rc, C'}$ Where Ns is the number of species, N_d is the number of diseases, and N_c id the number of cultures $t_{s',d',c'}$ is the length of time that species s' has been used to treat disease d' in culture c' in a particular time unit (most likely years). While t_{max} is the maximum amount of time in the same units that any plants has been used in the entire dataset
Ethno-ecolgical Importance Value (EIV), Castaned and Stepp (2007)	The EIV allows for a quantitative comparison of the ethno ecological value that particular habitats have to different gender, age or cultural groups according to their abundance of wild edible plants	$EIV = \sum_{x=1}^{N} (S) (\frac{n_x}{N_x})$ EIV = ethno ecological importance value for a particular habitat**;** S = salience of species; N = total number of species found in the study; x = the individual species found in the study N_x = the sum of individuals of species x fond in all habitats under study and n_x is the total number of individuals of species x found in one habitat
Index of Conservation Priority Martinez et al. (2006)	This index taken into account references infor-mation, data from interviews and field surveys. It relates biological aspects of the species (propagation or reproduction strategies, origin and distribution of taxon) with information about abundance (extracted	$ICP = \frac{(ROAxRCDxRPV)x100}{\Sigma (ROA\ x\ RCD\ x\ RPV)}$ Where ROA = range of origin of the species of the area (non-cultivated or introduced cultivation); RCD = range of commercial demand (Scale 1-4)' RPV = range of perceived vulnerability (scale 1-8).

Appendix: Contd...

Indices and developed by	*Description*	*Formula and interpretation*
	from references, field survey, as well as, the perception of local people expressed as accessibility) and socio-economic parameters (extracted method, plant harvested destination, commercial demand) obtained from interviews	
Local Conservation Priority Index (LCPI) *developed by* Albuquerque et al. (2009)	In LCPI it was assume that greater the number of use-categories reported for a given species, the more attention it would receive from the community	LCPI = CR+DA+RD CR = citation richness (Two point are summed for each use category scale 1-10) DA = degree of attention High frequency of species in homegrarden =1 Moderat = 4 Low<20 = 7 and absent score 10 RD= relative density Not encountered = 10 Low (1<35) = 7 Medium (35<7) = 4 and high (> 7) score 1
Cultural Importance Index Developed by Pardo-de Santayana, 2008 Adapted by Mosadehegh et al. (2012)	This index takes the spread of the use (number of informant) for each species along with its versatility that is, The diversity of its use	$CI = \sum_{U=ui} \sum_{i=ui}^{iN} \frac{URui}{N}$ Sum of the proportion of the informant that mention each species use It means sum the number of participant who mentioned each use of the species divided by total number of informant (N)
Relative Reliability Index (RRI) Developed by Khan (2001) Adapted by Malla and Chhetri (2012)	Relative reliability index (RRI) was used to express the reliability of ethno botanical data as a single numerical value. Relative Reliability Index is expressed as logarithm of fraction of '1'	Relative reliability index (RRI) = log [1/(A+B+C+D+E)] To calculate relative reliability index (RRI). Every claim/information is assigned a value ranging from 01 -04 in each of the five sets of criteria listed as A, B, C, D, and E Value of RRI varies from 09 (lowest reliability) to 11 (highest reliability)
Proxy Ethno-botanical Equation (Reyes Garacia et al. 2011)	To test whether ethno botanical skills, a proxy for local ecological knowledge, are associated to the clearance of forest through their interaction with agricultural labor	$Y_{pihct} = \alpha + \beta L_{pihct} - ES_{ihct} + \beta' L_{pihct} {}^{*} sES_{ihct} + \grave{O}P_{ihv} +.H_{hv} +.\tilde{O} C_{v} + e_{phict}$ Where the dependent variable (Y) is the logarithm of the area of a forest plot p cleared by person i of household h, in community c, at time t They predict that labor (L) inputs used in the clearance of the plot will have a positive association with the size of the plot as land clearing is a labor-intensive activity; and that ethno-botanical skills (ES) will have a direct negative association with land clearing
	Ecological Methods	
Margalef Richness Index Margalef (1958), adapted byWilliams et al.(2005)	This index represents the relationship bwteen species richness affected with sample size	D_{mg} = (S-1)/1n *N* It is calculated as the species number (S) minus 1 divided by the natural logarithm of the total number of individuals (*N*)
Menhinick Index Developed by Menhinick (1964), adaptedby Williams et al.(2005		$Dmin = S/\sqrt{N}$ N is the total number of individuals in the sample and S is species number
Shannon and Weaver Index Shannon-weaver index (1949),adapted byAkerreta et al. (2007); Yangand Gua (2011)	Shannon-weaver index (1949) is based on information theory The information content is a measure of the amount of uncertainty It generally falls between 1.5 and 3.5, and rarely exceeds 4.5 (Margalef 1958)	H = -∑ Pi $\log_e$ Pi Where Pi = is number of citation or informant per species (Begossi 1996) This index is based on information theory. The information content is a measure of the amount of uncertainty It generally falls between 1-5 and 3-5, and rarely exceeds 4-5 (Margalef 1958). Higher Shannon Weaver index values indicated that many species are represented by the same number and low value showed complete dominance of one species.

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Indices and developed by	*Description*	*Formula and interpretation*
Simpson Index Simpson (1949), adapted byBegossi (1996),Williams et al.(2005)	It measures the concentration of dominance (l)	Simpson index (1949) was calculated by using the number of citation for one plant divided by the total citation , and it can be expressed in following mathematical equation $D = \Sigma Pi^2$ Simpson index emphasis on dominance species value where is Shannon index is highly influence by rare species Simpson index measures the dominance of species in the vegetation, and it ranges from 0 to 1 It measures the probability that two individuals selected at random from a sample will belong to same species. Koura et al. (2011) have utilize modified Simpson index to determined the retention degree of the medicinal recipes in each ethnic group They used following formula $D = \sum_{i=1}^{S} \frac{ni(ni - 1)}{N(N-1)}$ Where: S being the total number of interviewees per ethnic groups; N = artithmetic sum of ni recipes and ni, the number of recipes per interviewee The diversity index of Simpson (1/D) ranges from 1 to S If 1/D tends to S, the recipes are shared by everyone in the group When 1/D approached 1, the recipes were only retained by a small group of people
Berger-Parker Dominance (d) Developed by May (1975) Adapted by Williams et al. (2005)	Description: It is dominance measure that express the proportional abundance of the most abundant species. This index is independent to sample size, but is subject to bias caused by fluctuations in the abundance of commo-nest species (Magurran 1988)	Formula: $d = N_{Max}/N$ Where N_{max} = is the number of individuals in the most abundant species, and N is the total number of individuals in the sample. Like Simpson's index, diversity increase and dominance decrease as *d* decreases
McIntosh D (D) Developed by McIntosh (1967), adapted byWilliams *et al.*(2005)	It measure the diversity independent of *N* William et al. (2005) have explained that as dominance increases (related to increase in abundance of species in the sample), the value of *D* decreases	$D = \frac{N - U}{N - \sqrt{N}}$ Where N is the total number of individual in the sample and U is given by the expression: $U = \sqrt{\Sigma n_1^2}$ Where n_1 is the number of individuals in the ith species and summations is undertaken over all the species U is the Euclidean distance of the community from the origin when plotted in an S- dimensional hypervolume (Seaby and Henderson 2006)
Fisher's Alpha	This is a parametric index of diversity that assumes that the abundance of species or informant consensus follows the log series distri-bution This index is a cons-tant used to fit the logarith-mic series distribution model This index is also known as log *series* alpha (Magurran 1988)	$ax, = \frac{ax^2}{2}, \frac{ax^3}{2}, ,........ \frac{ax^x}{2}$ Alpha is low when the number of species is low and therefore the smaller samples with fewer ethno- species have smaller value of alpha (William et al. 2005) This index is less affected by the abundance of the rarest or commonest species than Shannon and Weaver and Simpson index, and depend more on the number of species of intermediate abundance William et al. (2005) have summarized that, because of the incidence of the species sold at trader's shops/stalls equals abundance, the samples all initially have very number of erhno-species represented by one individual due to nature of sampling methods Hayek and Buzas (1997) recommend that alpha is used as a diversity measure when the parameter of *x* of the log series model is $1 \geq x \geq 061$ because when *x d"* 061 than > S and the statistic becomes unacceptable and biologically meaningless
Hill's Diversity Numbers	Hill produced a family of diversity numbers, correspon-	The general formula is: $NA = \sum_{i=1}^{S} (P_i)^{1/(1-A)}$

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Indices and developed by	*Description*	*Formula and interpretation*
	ding to the 'effective species richness', in which rare species are given progressively less weight than common species Hill diversity numbers are generally approaches to compare proportion of rare, intermediate and common species (Magurran 1988; William et al. 2005 and Hanazki et al. 2006)	Where P_i is the proportion of individual, belonging to the ith species Hill numbers provide a method to describe the relationship between diversity indices (Magurran 1988) and according to William et al. (2005), the values of N1 (Shannon and weaver), N2 (reciprocal of the proportional of Simpson index (1/D) and N" (reciprocal of the proportional abundance of the commonest species or reciprocal of the Berger Parker Index, corresponding to measures of abundant, very abundant and most abundant species in a sample respectively (Hanazki et al 2006) These diversity numbers, which are in units of number of species, measures what Hill calls the *effective number of species* present in sample (Ludwig and Reynold 1998)
Pielou J (All samles) or E_1 Developed by Pielou (1965), redeveloped by Magurran (1988) Adapted by Molares and Ladi (2009) and Yang and Gua (2011)	Evenness or equitability represents the distribution of individual among the species	The Evenness or equitability was calculated by the formula suggested by the $E = H'/\log_{10}S$ H'= Shannon index, S= total number of species of the interview or in a survey Evenness or equitability represents the distribution of individuals among the species It sometimes defined as the ratio of observed diversity to maximum diversity (Margalef 1958) The calculation of the evenness value help to find out whether the number of species utilized among geographical location is high or low A low evenness means a high dominance in the use of few species (Begossi 1996). When all species are equally abundant, an evenness index would be at a maximum (of 10) and decrease toward zero as t he relative abundance of the species diverge away from evenness (Ludwing and Reynold 1988)
Buzas and Gibson's (E_2) Index	This was proposed by Sheldon (1969) and adapted by Begossi (1996), Ludwing and Reynold (1988), and William et al. (2005)	$E_2 = e^{H'}/S$ Where H' is Shannon weaver index and S = Total number of species
Heip index (E_3) Proposed by Heip (1974), Adapted by William et al.(2005)	Heip (1974) developed this index to remove the dependence of S He felt that previous indices did not always give a low value when an ecologist would have thought evenness to be low A property which Heip considered important was that this index remains constant when the numbers of all species is multiplied by a constant	$E = (e^{H-1})/(S-1)$; Where H is the Shannon diversity and S = the species number
Evenness Index 4 or (E_4) Developed by Hill (1973) =		$E\ 4 = \frac{\frac{1}{D}}{eH^1}$ D = Simpson index and H' = Shannon weaver index
McIntosh E]	This is an equitability measure based on McIntosh dominance index (Pielou 1975).	$D = \frac{N - U}{N - N\sqrt{S}}$ Where N is the total number of individuals in the sample and S is the total number of species in the samples Measures of evenness (or equitability) attempt to quantify the unequal representation of species against a hypothetical sample in which all species are equally abundant (Krebs 1989), that is, the ratio of observed diversity to maximum possible diversity Hence,

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Indices and developed by	*Description*	*Formula and interpretation*
		evenness may be referred to as relative diversity or homogeneity (Brower and Zar 1977; Zar 1984). A low evenness means a high dominance in the use (or presence) of a few species (Begossi 1996). When all species are equally abundant, an evenness index would be at a maximum (of 10) and decrease towards zero as the relative abundances of the species diverge away from evenness (Ludwig and Reynolds 1988).
*Species Accumulation Curve*In recent years species accumulation curve as a potential technique inethno-medicine were utilized forseveral researchers likeBegoosi (1996); Boer and Lamxay (2009); Boer (2010); Hanazaki et al.(2000); Mati andMwafongo et al.(2010); Williamet al. (2007),	A species accumulation curve is a graph of the cumulative number of observed species as a function of some measure of sampling effort (Colwell et al 2004) IF the species are randomly and sequentially recorded one after another within a sampling area, then the resulting accumulation curve are individual based If, however, the survey area is subdivided into smaller sampling units and the total number of species is accumulated as a result of successively sampling additional quadrats, then the accumulation curve are sample based (Goetelli and Colwell 2001)	The plot of the cumulative number of species/uses of species S (n), collected against a measure of the sampling effort/interviews/ (n) is termed as species accumulation curve The sampling effort can be measured in many different ways; like number of interviews or tribes visited or number of stalls or shops or stockholder inventoried etc As effort increases, gradually more and more of the species living in a habitat will be caught, until eventually only the rarest species or occasional visitors remain unrecorded When this occurs increased effort will not increase the recorded species number The species accumulation curve will have reached an asymptote When a species accumulation curve approached an asymptote the user knows that sampling effort has been sufficient to collect most of the species present, and also that the asymptotic value is a measure of the total species complement
Rarefaction Developed by Krebs (1999), adapted by Yang and Gao (2011)	The rarefaction method is a statistical method for estimating the number of species expected in a random sample of individuals taken from a collection (Kerbs 1999)	$E(n) - \sum_{i=1} 1-\left(\frac{\binom{N\quad Ni}{n}}{\binom{N}{n}}\right)$ Where *E(n)* = expected number of species in a random sample of n citation; S = total number of species in the entire collection; Ni = number of citations per species i (or number of informants); N = total number of citations in the collection (N = " Ni); n = value of sample size (number of citations) chosen for standardization (nd" N).
Chao and Lee 1 Developed by Chao and Lee (1992)	This is known as an ACE estimator (Abundance –based Coverage Estimator of Species Richness).	$S1 = S_{OBS} + \frac{F_1^2}{2F_2}$ where *Sobs* is the number of species in the sample, *F*1 is the number of singletons (that is,, the number of species with only a single occurrence in the sample) and *F*2 is the number of doubletons (the number of species with exactly two occurrences in the sample). The idea behind the estimator is that if a community is being sampled, and rare species (singletons) are still being discovered, there is likely still more rare species not found; as soon as all species have been recovered at least twice (doubletons), there is likely no more species to be found. Tests of the estimator have shown that it does provide reasonable estimates, at least for modern data sets (Colwell and Coddington 1994) Lee and Chao 1994) have also published another pair of estimators, called the Abundance Coverage Estimator and the Incidence Coverage Estimator, which use abundance and occurrence based data sets, respectively.

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Indices and developed by	*Description*	*Formula and interpretation*
Abundance Based Coverage Estimator Developed by Lee and Chao (1994), adapted by William (2000) and (2007)		$S_{ace} = S_{common} + \frac{S_{rare}}{C_{ace}} + \frac{F_1}{C_{ace}} Y^2_{ace}$ $S_{rare} = \sum_{i=1}^{10} iF_1$ $C_{ace} = 1 - \frac{F_1}{S_{rare}}$ $Y^2_{ace} = Max\left(\frac{S_{rare}}{C_{ara}} \frac{\Sigma_1^{10} i\ (i-1)F_1}{C_{ace}\ (N_{rare})\ (N_{rare}-1)} - 1.0\right)$ where *S common* are the species that occur more than 10 times in the sampling, *S rare* are those species which occur 10 times or less, *Cace* is the sample abundance coverage estimator, and finally, *ace* is the estimated coefficient of variation for *F*1 for rare species (Chazdon et al. 1998). In simpler terms, the formula uses the number of rare species (>= 10) and the number of singletons (*F*1) to estimate how many more undiscovered species there might be. Although this formula is for the abundance estimator, virtually the same holds true for the incidence based estimator, except that instead of the species abundance, it uses the number of samples each species occurs in both of the coverage estimators have been found to give good results and are highly recommended (Chazdon et al. 1998; Hortal et al.2006).
Incidence-Based Coverage (ICE) Proposed by Lee and Chao, (1994), adapted by William et al. (2000) and (2007)		$Sice = freeq + \frac{S_{infr}}{C_{ice}} + \frac{Q_1}{C_{ice}} + Y^2_{ice}$ $N_{infr} = \sum_{j=1}^{10} jQ_j$ $Cic8 = 1 - \frac{Q_1}{N_{infr}}$ $Y^2_{ice} = Max\left(\frac{S_{infr}}{C_{ice}} \frac{m_{infr}}{(m_{infr-1})} \frac{\Sigma_j^{10}\ (j-1)F_1}{(N_{infr})^2} - 1,0\right)$
I[st] *OrderJackknife EstimatorDeveloped by*Heltshe and Forrester (1983), adapted by Mwafongo et al.(2010) and Williams et al.(2007).	To use the jack-knife estimator for species richness, data must be collected at n locations (for example, plots) in the designated a rea for which S is to be estimated. The basic idea behind the first order jack-knife estimator of S is to base it on the amount of unique species information that is contained in each observation	$\hat{S}_{max} = S_{obs} + a\ (n-1/n)$ Where n is the number of sample and a is the number of species only found in one sample $var\ (\hat{S}max) = \frac{n-1}{n}\left(\Sigma_0^s j^2 f_1 - \frac{L^2}{n}\right)$ Where Fj is the number of samples holding j of the L species only found in one sample.
2[nd] *OrderJackknife EstimatorDeveloped by*Burnham and Overton (1978) have developed the second-orderjack knife estimator	Burnham and Overton (1978) have developed the second-order jackknife estimato	$\hat{S}_{max} = S_{obs} + \left(\frac{L\ (2n-2)}{n} - \frac{M\ (n-2)^2}{n(n-1)}\right)$ Where L is the number of species only found in one sample and M is t he number of species only found in two samples.
Sample Size Estimation Developed by levy and Lemeshaw (2008)Adapted by Koura et al. (2011)	To quantity estimated sample size for proper sampling.	$n = \frac{N_p\ (1-_p)}{(N-1)\ (d_{\alpha/2})^{2+(1-p)}}$ N = population size $Z\alpha_2$ = confidence limit = 196% D= sampling error = 005.