



QUANTITATIVE ANALYSIS OF ETHNOBOTANICAL KNOWLEDGE ON ANTI UROLITHIATIC PLANTS OF PALAKKAD DISTRICT, KERALA

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ABSTRACT

Traditional herbal healer's claims can be evaluated using various quantitative ethnomedicinal indices. The adoption of such indices in ethnobotanical research helps to increase the credibility and reliability of that knowledge. In the present study investigator incorporated quantitative analysis of the traditional knowledge documented on the use of medicinal plants for treating urolithiasis by the traditional practitioners of Palakkad district, Kerala. Quantifying the relative importance of each antiurolithiatic plants was accomplished through the use of major ethnobotanical indices such as Fidelity Level (FL %), Percentage of Major Use Agreement (MUA%), Direct Matrix ranking based preference ranking (DMR) and importance value (IVs).

KEYWORDS: Ethnobotanical Indices, Urolithiasis, Antiurolithiatic medicinal plants.

INTRODUCTION

Urolithiasis is one of the common urinary tract disorders afflicting human kind since millennia. Urolith formation is multifactorial and complex. Over the past decades, major advances have been made in the understanding of the pathogenesis, diagnosis, and treatment of kidney stone disease. Due to significant side effects and failure to prevent recurrence by the present day allopathic treatment procedures for urolithiasis, alternative treatment modalities using herbal products have assumed importance. In Kerala, diversified systems of traditional practices including folk and tribal practices of healing prevail since time immemorial. People residing in the rural and remote tribal pockets have rich knowledge on the use of plants in their premises to cure illness and sufferings. Ethnobotanical studies have aimed to explore the plants having significant medicinal value that are unknown to the scientific world. Traditional knowledge of medicinal plants and their use by indigenous cultures are not only useful for conservation of cultural traditions and biodiversity but also for community healthcare and drug development in the present and future.^[1] Hence, the need for documentation of traditional knowledge on medicinal plants and further quantitative analysis using some ethnobotanical indices are relevant aspects in the domain of ethnomedicinal researches. Phillips^[2] verified that the quantitative approach benefits the academic study of ethnobotany. Quantification gave researchers the ability to assess people's knowledge of plant resources and incorporate the perspective of a large number of informants, as noted by Fraser & Junqueira.^[3] Here, the present study is significant in this direction to

capturing information on diuretic and antiurolithiatic floral wealth of rural and tribal areas of Palakkad District of Kerala. The documentation of indigenous knowledge on the utilization of antiurolithiatic herbal resources by traditional practitioners including ethnic groups and communities and its quantitative analysis were the major objectives of the present study. The study also aims to collect information regarding the availability of these plants which will help to make a platform for further research with sustainable utilization of these resources.

STUDY AREA

The ethnobotanical survey was carried out in and around the Palakkad District of Kerala, India (Figure:1). The district is situated within the north latitude 10° 46' and 10° 59' and east longitude 76° 28' and 76° 39'. The district opens the state through Palakkad Gap, a natural depression through the Western Ghats ranges that run parallel to the West Coast of India and connects Kerala to the plains of the state of Tamil Nadu to the east. This is the only largest gap with a length of 30km for the whole of Western Ghats of 1600km length. Out of the total 4480 km² area of the district, 1360 km² of land is covered by forests. The district is bestowed with rich floristic diversity because of its unique geographical and climatic conditions. Hence the people residing in these areas may have excellent ethnomedicinal knowledge and documentation of which will be valuable to the future generation and in the related realm of pharmacological research.



Figure 1: Study Area –Palakkad District, Kerala State, India.

MATERIALS AND METHODS

To record the folk and tribal knowledge on antiurolithiatic medicinal plants, ethnobotanical survey was conducted to various localities of Palakkad District, including remote and tribal settlements. The ethnobotanical data were collected according to the methodology suggested by Cotton^[4] and Jain.^[5] Informants were randomly selected for the study. For the present study about 45 informants including folk as well as tribal practitioners were selected using Random sampling method. For quantitative ethnobotanical analysis 10 key informants were selected from this group based on their experience (not below 15 years) based on a method done earlier by Martin.^[6] Informants were made aware about the objectives of the study and verbal consent was sought from each informant to use their knowledge on antiurolithiatic medicinal plants for the present study. About 50 plants were listed and correctly identified plants were used to prepare Voucher specimens according to the standard techniques.^[7] Data collected from the ethnobotanical survey are needed to be authenticating by quantitative methods to ensure its reliability. Ethnobotanical indices such as Fidelity Level (FL %), Percentage of Major Use Agreement (MUA%), Direct Matrix ranking based preference ranking (DMR) and importance value (IVs) were used for quantitative analysis of the collected data.

a) Fidelity level (FL): The fidelity level (FL), which is the ratio between the number of informants who independently suggested the use of a species for the same major purpose and the total number of informants who mentioned the plant for any use.

$$FL (\%) = N_p/N \times 100$$

Here, N_p is the number of informants that claimed a use of a plant species to treat a particular disease and N is the

number of informants that used the plant as a medicine to treat any given disease. The fidelity level shows the percentage of informants claiming the use of a certain plant for the same major purpose.

b) Direct Matrix Ranking (DMR) and Preference Ranking:

Based on the data collected from the respondents, the plants were ranked or preferred for analysis. As reported earlier by Martin Preference ranking exercise was conducted by 10 key traditional practitioners on 12 medicinal plants used to find out the most effective medicinal plant for antiurolithiatic property. The informants were given the plants and asked them to arrange plants based on their personal experience regarding efficacy of the plants. Medicinal plant that believed to be the most effective was given the highest value i.e. 5 and the one with least effectiveness was given a value of 1. The values given to each medicinal plant were summed up and ranked using the method of Cotton and Martin.^[4,6]

c) Major Use Agreement (MUA): To establish the relative importance of the species, quantitative approach like the percentage of Major Use Agreement of the plant (MUA) described by Amorozo and Gely^[8] was used. The percentage of MUA was calculated as:

$$MUA = FL \times CF$$

Here, FL is the fidelity level and is determined as the ratio between the number of informants who independently cited the use of a species for the same major purpose (MU), and the total number of informants who mentioned any use for the species (TU). The resulting number was multiplied by a hundred ($FL = MU/TU \times 100$). To avoid bias between the species cited by many informants and those cited by few informants, the value of the FL found was multiplied by a correction factor (CF), which corresponds to the ratio between the number of informants who mentioned the species for any use (TU) and the number of informants who cited the most popular species.

d) Importance Value (IVs): The Importance Value (IVs) measures the proportion of informants who regard a species as most important.^[9] Importance Value and Direct Matrix Ranking are supporting each other. The highest score for Importance Value of a plant also highlights that these plants are therapeutically very important and tribal healers in the area rely mostly upon them for effective treatment.

$$IVs = nis/N$$

Where n_{is} is the number of informants who considered species s the most important and N = total number of informants. The N value was taken from the DMR data. Measures the proportion of informants who cited one species as the most preferred. Value ranges from 0 to 1.

To find out the relationships between different ethnobotanical indices, statistical parameter like correlation analysis are used in the validation of ethnobotanical knowledge. Pearson Product Moment

Correlation Coefficient^[10] of paired indices was calculated and the Significance (P value < 0.05) of Correlation Coefficient (Pearson r value to P value) was analyzed using r value to P value calculator to ensure the statistical significance of correlation between the above ethnobotanical indices.

RESULTS

The present Ethnobotanical survey on antiurolithiatic medicinal plants at Palakkad district have documented 50

plants belonging to different families. The data obtained from survey were quantitatively analysed using above methods. The fidelity level and Percentage of Major Use Agreement of documented plant species are given in the table 1.

Table 1: The Fidelity Level (FL) of Plants Selected from Ethnobotanical Survey.

Sl.No	Name of the Species	FL=(Np /N) × 100	correction factor (CF)	Percentage of Major use agreement(FL*CF)
1	<i>Achyranthus aspera</i> L.	60.0	0.5	30.0
2	<i>Aerava lanta</i> (L.)Juss.	75.0	0.8	60.0
3	<i>Ageratum conyzoides</i> L.	40.0	0.5	20.0
4	<i>Amaranthus spinosus</i> L.	75.0	0.4	30.0
5	<i>Anacardium occidentale</i> L.	75.0	0.4	30.0
6	<i>Asparagus racemosus</i> Willd.	57.1	0.7	40.0
7	<i>Benincasa hispida</i> (Thunb.)Cogn.	66.7	0.6	40.0
8	<i>Boerhavia diffusa</i> L.	62.5	0.8	50.0
9	<i>Bryophyllum pinnata</i> Lam.	50.0	0.4	20.0
10	<i>Calamus thwaitesii</i> Becc	50.0	0.4	20.0
11	<i>Citrus limon</i> (L.) Burm. f.	66.7	0.6	40.0
12	<i>Cocos nucifera</i> L.	60.0	0.5	30.0
13	<i>Crataeva magna</i> (Lour.)DC.	80.0	0.5	40.0
14	<i>Cucumis melo</i> L	50.0	0.6	30.0
15	<i>Cucumis sativus</i> L.	50.0	0.4	20.0
16	<i>Cynodon dactylon</i> (L.) Pers.	57.1	0.7	40.0
17	<i>Cyperus rotundus</i> L.	42.9	0.7	30.0
18	<i>Dendrophthoe falcata</i> (L. f.) Etting.	50.0	0.4	20.0
19	<i>Didymocarpus tomentosa</i> Wight	50.0	0.4	20.0
20	<i>Elettaria cardamomum</i> (L.) Maton	66.7	0.6	40.0
21	<i>Ensete superbum</i> Rox.	83.3	0.6	50.0
22	<i>Gymnema sylvestre</i> (Retz.)R.Br.	25.0	0.4	10.0
23	<i>Homonoia riparia</i> Lour.	66.7	0.6	40.0
24	<i>Hygrophila schulli</i> Buch.-Ham.	62.5	0.8	50.0
25	<i>Ichnocarpus frutescens</i> L.	50.0	0.4	20.0
26	<i>Macrotyloma uniflorum</i> Lam.Verde.	50.0	0.6	30.0
27	<i>Melia azedarach</i> Linn.	25.0	0.4	10.0
28	<i>Mimosa pudica</i> L.	60.0	0.5	30.0
29	<i>Mimusops elengi</i> L.	50.0	0.4	20.0
30	<i>Moringa oleifera</i> Bedd.	87.5	0.8	70.0
31	<i>Musa paradisiaca</i> L.	62.5	0.8	50.0
32	<i>Nervilia aragoana</i> Gaud.	50.0	0.6	30.0
33	<i>Ocimum sanctum</i> L.	37.5	0.8	30.0
34	<i>Pedaliium murex</i> L.	60.0	0.5	30.0
35	<i>Phyllanthus niruri</i> L.	42.9	0.7	30.0
36	<i>Piper longum</i> L.	50.0	0.4	20.0
37	<i>Plectanthus amboinicus</i> (Lour.) Spreng.	42.9	0.7	30.0
38	<i>Portulaca oleraceae</i> L.	80.0	0.5	40.0
39	<i>Punica granatum</i> L.	60.0	0.5	30.0
40	<i>Rotula aquatica</i> Lour.	88.9	0.9	80.0
41	<i>Saraca asoca</i> (Roxb.) de Wilde	60.0	0.5	30.0
42	<i>Scoparia dulsis</i> L.	87.5	0.8	70.0
43	<i>Sida rhombifolia</i> L.	57.1	0.7	40.0
44	<i>Solanum torvum</i> Sw.	66.7	0.6	40.0

45	<i>Sphaeranthus indicus</i> L.	83.3	0.6	50.0
46	<i>Strychnos potatorum</i> L.f.	83.3	0.6	50.0
47	<i>Tamarindus indica</i> L.	40.0	0.5	20.0
48	<i>Tinospora cordifolia</i> Willd.	57.1	0.7	40.0
49	<i>Tragia involucrata</i> L.	50.0	0.4	20.0
50	<i>Tribulus terrestris</i> L.	88.9	0.9	80.0

The above table revealed that the Fidelity value ranges from 25 – 88 %. The plant species having highest fidelity rate (88.9) are *Rotula aquatica*, *Tribulus terrestris*, then *Moringa oleifera*, *Scoparia dulcis* with FL value 87.5. These are followed by *Sphaeranthus indicus*, *Ensete superbum*, *Strychnos potatorum* with FL 83 %, *Portulaca oleraceae* (80%), *Crataeva magna* (80.0%), *Amaranthus spinosus*, *Anacardium occidentale*, *Aerava lanta* having FL 75 %. *Achyranthus aspera*, *Benincasa hispida*, *Boerhavia diffusa*, *Citrus limon*, *Solanum torvum*, *Cocos nucifera*, *Elettaria cardamomum*, *Homonoia riparia*, *Hygrophila schulli*, *Mimosa pudica*, *Musa paradisiaca*, *Pedaliium murex*, *Punica granatum*,

Saraca asoca were found in the range of 60-70 %. The results of major use agreement showed that the plant species with highest MUA was *Rotula aquatica*, *Tribulus terrestris* with 80%, then *Moringa oleifera*, *Scoparia dulcis* 70% and *Boerhavia diffusa*, *Ensete superbum*, *Hygrophila schulli*, *Musa paradisiaca*, *Sphaeranthus indicus*, *Strychnos potatorum* with 50 % major use agreement. The results of MUA for plant species have confirmed the values of fidelity level. The results of Direct Matrix Ranking based on preference ranking by the informers and Importance Value of that plants are given in the table: 2.

Table 2: DMR Score, Preference Rank and Importance Value of Selected Plants.

Sl.No	Botanical Name	Total Dmr score	Pref. rank	IV=Nis/N
1	<i>Rotula aquatica</i> Lour.	25	1	0.56
2	<i>Tribulus terrestris</i> L.	24	2	0.33
3	<i>Moringa oleifera</i> Bedd.	22	3	0.38
4	<i>Scoparia dulcis</i> L.	20	4	0.38
5	<i>Sphaeranthus indicus</i> L.	17	5	0.33
6	<i>Ensete superbum</i> Rox.	16	6	0.33
7	<i>Strychnos potatorum</i> L.f.	20	4	0.33
8	<i>Portulaca oleraceae</i> L.	16	6	0.20
9	<i>Crataeva magna</i> (Lour.)DC.	10	9	0.20
10	<i>Amaranthus spinosus</i> L.	12	8	0.25
11	<i>Anacardium occidentale</i> L.	12	8	0.25
12	<i>Aerava lanta</i> (L.)Juss.	15	7	0.25

Highest DMR scores or first Preference ranks (Table:2) were observed for *Rotula aquatica* (25-1), followed by *Tribulus terrestris* (24-2), *Moringa oleifera* (22-3), *Scoparia dulcis* & *Strychnos potatorum* (20-4), *Sphaeranthus indicus* (17-5). DMR score for *Ensete superbum* and *Portulaca oleraceae* was 16 and 15 for *Aerava lanta*, *Amaranthus spinosus* and *Anacardium occidentale* have 12 and least score 10 was for *Crataeva magna*. The table shows that highest IVs (0.56) was for *Rotula aquatica*. Other plants like *Tribulus terrestris*, *Moringa oleifera*, *Scoparia dulcis*, *Sphaeranthus indicus*,

Ensete superbum, *Strychnos potatorum*, have importance value more than 0.33. Lowest importance value was for *Crataeva magna* and *Portulacca oleracea*. Correlations between ethnobotanical indices were calculated using Pearson-Product Moment Correlation. Correlations between the parameters were done in the following manner (Table: 3)

- Correlation between DMR score, FL, MUA and IVs
- Correlation between FL, MUA and IVs
- Correlation between MUA and IVs

Table: 3 Correlation between different Ethnobotanical indices.

Correlation between		Correlation coefficient (R)	P-value and Significance R to P
DMR score	FL	0.700	The P-Value is 0.017131. The result is significant at $p < 0.05$.
	MUA	0.537	The P-Value is 0.103407. The result is <i>not</i> significant at $p < 0.05$.
	IVs	0.701	The P-Value is 0.011092. The result is significant at $p < 0.05$.
Fidelity Level(FL)	MUA	0.828	The P-Value is 0.000881. The result is significant at $p < 0.05$.
	IVs	0.753	The P-Value is 0.0047. The result is significant at $p < 0.05$.
Major Use Agreement(MUA)	IVs	0.749	The P-Value is 0.005055. The result is significant at $p < 0.05$.

The above table revealed that the correlation between Fidelity level and Major use agreement shows highest positive correlation. The Correlation coefficient was 0.828 and P- value is 0.000881 which indicates that the correlations between these two parameters are significant at $p < 0.05$. The value of correlation coefficient between FL and IVs is 0.753 and its P-Value is 0.0047. This is also significant at $p < 0.05$. The MUA and IVs also showed a positive correlation (0.749) which is significant at $p < 0.05$. Correlation between FL and IVs with DMR are moderately significant with correlation coefficient value 0.700, 0.701 respectively. DMR and MUA shows negative correlation (0.537) having P-Value 0.103407. Thus the result is not significant at $p < 0.05$.

DISCUSSION

Quantitative ethnobotanical indices were used in the data analysis to authenticate the documented information. The scientific rigor of ethnobotanical research has increased dramatically in the past two decades due to the adoption of quantitative methods. Here in this study, different quantitative parameters like Fidelity Level (FL %), Percentage of Major Use Agreement (MUA %), Preference Ranking and Importance value [IVs], Pearson Correlation Coefficient were employed to analyze the collected ethnobotanical data. Result analysis showed that plants with 80% fidelity level have already proved for its antilithiatic activity through scientific methods. Fidelity level was analyzed in various ethnobotanical studies to quantify the healing potential of the species for a given purpose.^[11,12] The highest FL% value could be considered as an indicator for the high healing potential of those plants used against the corresponding diseases. Plants with highest fidelity level value could also be targeted for further phytochemical investigation to identify the bioactive compounds that are responsible for their high healing potential. Percentage of Major use agreement values confirms the result of FL. Major Use Agreement of the top 26 plants (Fidelity level range 88 %-60 %) was calculated. That indicates most of the practitioners are agreed with the potential of those plants to cure lithiasis. MUA as an important quantitative tool was used in the ethnobotanical survey conducted by Amelia *et al.*,^[13] In their work, they mentioned that MUA can be used as an important indicator of the possible pharmacological activity of a species and may serve as relevant information for future reference in search for new drugs. In the present study the results of major use agreement showed that the plant species with highest MUA was *Rotula aquatica* and *Tribulus terrestris* (80%), *Moringa oleifera* and *Scoparia dulcis* (70%) followed by *Boerhavia diffusa*, *Ensete superbum*, *Hygrophila schulli*, *Musa paradisiaca*, *Sphaeranthus indicus*, *Strychnos potatorum* with 50 % major use agreement.

DMR scoring and IV_s values were also showed relation with FL and MUA. DMR (Direct Matrix Ranking) scoring was used to compare the use diversity of a given plant species based on the ranking given by the Key

informants. DMR values are helpful to identify the multipurpose plants in the survey area; thereby it would possible to take necessary action to conserve those species. DMR value had taken to identify the use diversity of medicinal plants in the ethnobotanical studies of Khan *et al.*,^[14] The highest score for Importance Value of plants highlights that those plants are therapeutically very important.^[15] The analysis of result showed that there are significant relationship exists between DMR score and FL value. DMR score also has positive correlation with IVs value. The result indicates those plants that have been ranked for its multipurpose potential also has high healing efficiency for a particular disease, here it is for antilithiasis. Consequently the same plants have scored highest importance value. MUA and IVs also has significant relation with each other. In the present survey it was evident that DMR score and MUA were negatively correlated. This indicates that some plants are specifically used by the practitioners in their treatment which may not know or common for the other practitioner. Because of this reason that plants would be rated as high score in direct matrix ranking, but may have low MUA.

CONCLUSION

From the data collected by the ethnobotanical survey and its quantitative analysis, it can be seen that *Tribulus terrestris*, *Strychnos potatorum*, *Rotula aquatica* and *Ensete superbum* are mostly used as antiurolithiatic medicines but these plants are found to be rare in the locality. Many of these plants are unavailable in certain rural and tribal pockets as pointed out by the traditional practitioners should be taken seriously in the light of these findings. This is due to the urbanization of villages, increased pollution of soil and water and depletion of unique biodiversity in the inhabiting environment. If we do not take any immediate interventions of conservation programmes to protect these species, it will extinct soon from the district. Deterioration of tribal hamlets and their special ecosystem and belief system were also contributing to the loss of some medicinal plants from premises. Therefore the result of this ethnobotanical survey and its quantitative analysis confirms the earlier observations and stresses the need of conservation of indigenous knowledge on medicinal plants.

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