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Quantitative Ethno-Medicinal Studies of Staple Foods Used by Tribals of Southern Rajasthan (India)

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Abstract
Ethno-medicinal field study of functional foods with special reference to staple foods carried out in Southern Rajasthan reveals usage of seeds and grains of 16 plants deployed for seven different maladies among which 11 plants are used in diabetes. These staple foods are either consumed as flour / flour additives or boiled as rice. Quantitative analysis for four parameters viz. use value, percent fidelity level, relative index and relative frequency citation reveals maximum dispersion and use of *Echinochloa crusgalli* by all tribes while *Echinochloa colonum* and *Ipomoea pes-tigridis* attributes as a functional millet is least known in studied area.

Keywords
Southern Rajasthan, Millets, Use value, Percent fidelity level, Relative index, Relative frequency citation, *Echinochloa crusgalli*

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INTRODUCTION
In modern voyage a large number of populations is suffering from lifestyle mediated maladies. The servings are continuously replaced by short span formative junk foods which lack healthy and balanced nutritive schedules. In addition to this shortcoming lack of physical activity and enhanced stress boosters have stolen many lives. Among these three factors the food servings are gaining researchers eye worldwide. According to the medical nutrition therapy (MNT) foods containing high fiber such as cereals and millets (wheat, rice, bajra, jowar etc.), fruits and vegetables should be consumed regularly. Nutraceuticals or functional foods can be defined as, "a food or part of a food that provides medical or health benefits, including the prevention and / or treatment. Such foods must not only supplement the diet but should also aid in the prevention and / or treatment of disease and/or disorder".

Among various foods, cereals and millets form an important food profile as they form the staple food with carbohydrates as chief energy reservoirs. Compared to other cereal crops such as wheat and maize, millets are high in nutritional contents and are gluten free with low glycemic index. They provide high energy, high dietary fiber, protein with balanced amino acid profile and many essential minerals [www.fao.org/docrep/t0818e/T0818E0e.htm#Minerals]. These components play a substantial role in prevention of many human illnesses such as T2D, cancer, cardiovascular and neurodegenerative diseases. In traditional food practices various staple

foods are deployed for various maladies. In Rajasthan tribal's use various seeds and grains to get rid of different ailments. These staple foods are used as flour or boiled as rice [1, 2].

In order to enhance the indicative value of ethnobotanical studies, in recent years there have been attempts to improve the traditional compilation-style approach through incorporating suitable quantitative methods of research in ethnobotanical data collection, processing and interpretation. Such quantitative approaches aim to describe the variables quantitatively and analyze the observed patterns in the study, besides testing hypotheses statistically [3]. Quantitative ethnobotany may be defined as "the application of quantitative techniques to the direct analysis of contemporary plant use data" [4, 5]. Quantification and associated hypothesis-testing helps to generate quality information, which in turn contributes substantially to resource conservation and development. Further, the application of quantitative techniques to data analysis necessitates refinement of methodologies for data collection. Close attention to methodological issues not only improves the discipline of ethnobotany but also enhances the scope of ethnobotany among other disciplines.

The most popular techniques (indices) are based on "informant consensus"- the degree of agreement among the different people interviewed concerning the use of a given resource [6]. Numerous authors have applied these techniques to investigate the impact of exploitation of locally important resources, based on the supposition that however more important a resource is the greater will be the exploitation pressure placed upon it. Although these interpretations have sometimes been questioned [7, 8] neither their use as tools for evaluating the importance of a given resource, nor their limitations or scope, have been critically examined. According to Reyes-Garcia *et al.,* [9] it is necessary for "*Studies That Assess the Reliability of the Different Indices Que Presumably Proxy for The Same Phenomena".*

MATERIALS AND METHODS

The present study was carried out in two phases-

I. Documentation of functional staple food plants.
II. Quantitative analysis of documented plants

I. Documentation of functional staple food plants –

i. Various localities of Southern Rajasthan (District-Udaipur, Dungarpur and Banswara) were selected to unearth the information from all the dominating tribes.
ii. For the documentation of ethno-medicinal plants, field surveys were carried out all around the year from 2015 to 2017 in various tribal, rural and sub-rural pockets.
iii. For recording and documentation, field interviews were made from different practitioner's i.e. ritual therapist, herbalist, grain diviner, priest and ancestral practitioner through local transcends to avoid language ambiguity and data were recorded in information retrieval form.
iv. According to CBD guidelines prior informant consent (PIC) was obtained and inscribed for usage, dose, mode of dose, tenure/ time interval etc.
v. In order to determine the authenticity of information collected during field visit, data was cross checked with published data of the same array and region. Data was also authenticated in criss cross manner by interviewing other informants.
vi. Plant specimens were collected and herbarium sheets were prepared with all related information. Plants were identified up to species level through flora of region and prior work. Herbarium sheets were deposited in Department for further reference.

II. Quantitative analysis of documented plants -

Documented data was categorized as per ICD 11 for the treated body systems while sub-categorized as per WHO [http://www.who.int/classifications/icd/revision/en/].Field data was tabulated for following three factorials-

a. On the basis of informant's report.
b. On the basis of therapeutic applications for body system.
c. On the basis of diseased specified for each application of ethno medicinal plant/s.

Data was quantitatively analyzed for following four parameters-

1. Use Value (UV)
2. Percent fidelity level (% FL)
3. Relative index (RI)
4. Relative frequency citation (RFC)

1. <u>Use Value (UV)</u>

A plant is used in different ailments which may vary according to the mode of usage or parts deployed or a solo or recipe or any other form but its value as a whole demarks its therapeutic

importance. Therefore, the use value (UV) demonstrates the relative importance/ usefulness of plants known locally. UV was calculated using the following formula [10] –

UV = ∑Ui / N

Ui is the number of uses mentioned by each informant for a given species and N is the total number of informants.

2. **Percent fidelity level (% FL)**

The healing efficacy of each plant is expressible by its fidelity level (FL) which is generally expressed as percent. It 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 species for any use.

It is calculated as [11] –

FL (%) = (Np/Nu) X100

Np is the number of informants that claimed a use of species to treat a particular disease and Nu is the number of informants that used the plants.

3. **Relative index (RI)**

It is the comparison of species for their pharmacological importance for revealing its capacity to treat more than one health problem. Regardless of the number of informants citing the species, it is calculated on the base of normalized number of pharmacological properties attributed to it and the normalized number of body system (BS) it affects [12].

The RI was calculated using the following formula:

RI = [(RelPH + Rel BS) / 2] × 100

RI is the relative importance, PH is the number of reported pharmacological properties for the given plant, RelPH is the relative number of pharmacological properties (PH of a given plant/maximum PH of all reported species), BS is the number of body systems treated and Rel BS is the relative number of body systems treated (BS of a given plant/maximum BS of all reported species).

4. **Relative frequency citation (RFC)**

It is an index which highlights the dispersion of usage among the informants. Relative frequency of citation (RFC) index is obtained by dividing the number of informants mentioning a useful species (FC or frequency of citation), by the total number of informants in the survey (*N*). RFC value varies from 0 (when nobody refers to a plant as a useful one), to 1 (when all the informants mentioning it as useful) [13]. RFC index, which does not consider the use-category (UR or use-report is a single record for use of a plant mentioned by an individual) and RFC calculated by the following formula:

RFCs=FCs/N

RESULT AND DISCUSSION

Tribal communities hold their ancient practices in their day to day schedules. Despite prevalence of health centers, they rely on natural resources for therapeutic values. Ethno-medicinal documentation of these tribal rich pouches reveals usage of plants for all important and wide spread ailments as inscribed in international disease categories. Ethno-medicinal functional food array of 79 plants were reported from the present survey among which 16 are used as staple foods.

For ethno-medicinal documentation various practitioner's as well as non- practitioners were chosen at random. Respondents were either native born or had been living in the region for at least 20 to 30 years. Informants were selected on the basis of at least four independent recommendations on their erudition in this field. In the first phase 96 informants were selected for the survey. For the validation / authentication of informant, each informant was queried thrice after a defined time interval of 8 to 12 months for uses and each query was termed as an event. This information for a particular informant was tallied and mean was calculated for the three events. Care, however, was taken not to introduce hints which could affect or modify the answers. In second and third phases of field studies, information provided by 42 informants was found to be counterfeit and non-significant. To get through right decision about disease, the symptoms described by the herbalists were discussed and confirmed with general physician of allopathic system of medicine.

During documentation in present study the disease was classified as per nomenclature provided by WHO under Beta draft of ICD 11 (Int. Statistical Classification of Diseases and Related Health Problems, 11th Revision, Canada). The International Classification of Diseases is the standard diagnostic tool for epidemiology, health management and clinical purposes. Its 11th revision termed as ICD-11 Beta draft- Mortality and Morbidity Statistics

includes 26 chapters followed by Supplementary section for functioning and Extension Codes. Among 26 chapters 24 deal with ailments of various body systems whereas chapter 25 and 26 deal with Codes for special purposes and Traditional Medicine conditions – Module I respectively.

Ethno-medicinal survey of various tribal localities of Southern Rajasthan reveals twenty-five therapeutic usages of sixteen staple food plants for seven body system and thirteen disease category/ ailments.

Coix lacryma-jobi and *Paspalum scrobiculatum* is recommended in dysentery while *Alloteropsis cimicina, Amaranthus gangeticus* and *Ipomoea pes-tigridis* are used for gastro-intestinal tract disorders.

Liver is a chief detoxifying organ of the body. Liquor consumption with substandard practices predominates in tribal patches. Many plants are used in various forms for the restoration and regeneration of hepatic cells. The present study reveals usage of boiled grains of *Amaranthus gangeticus as liver tonic.*

Whooping cough, also called pertussis, is a serious respiratory infection caused by a type of bacteria called *Bordetella pertussis*. The infection causes violent, uncontrollable coughing that can make it difficult to breathe. To dilate the endothelial lining *Achyranthes aspera* is consumed as bread prepared by roasted seed powder mixed with wheat/ maize flour.

The primary function of the skin is to serve as a protective barrier against the environment. Loss of the integrity of large portions of the skin as a result of injury or illness may lead to major disability or even death. Wounds and cuts are the major entry doors of microbial world and in due time clogs the tissue [14].

Delayed wound healing sometimes leads to ulceration which becomes more crucial in diabetic patients. *Holoptelea integrifolia* is reported to enhance skin eruptions. Plants with metalloproteinase synthesizing capabilities promote wound healing through multiple routes and therefore are deployed ethnically [15, 16].

Eleven plants viz. *Alloteropsis cimicina, Coix lacryma-jobi*, *Echinochloa colonum, Echinochloa crusgalli, Eleusine coracana, Panicum miliaceum, Panicum sumatrense, Paspalidium flavidum, Paspalum scrobiculatum, Setaria glauca* and *Setaria italica* are used to reduce high glycemic levels. The active component of these plants effectively seizes post prandial hyperglycemia [17, 18].

Among different genital diseases *Coix lacryma-jobi, Setaria italica* and *Tribulus terrestris* are used for urinary complaints. Urinogenital disorders include bladder cancer**,** cystocele, hematuria, impotence/erectile dysfunction**,** interstitial cystitis**,** male factor infertility**,** neurogenic bladder**,** peyronie's disease**,** benign prostatic hyperplasia and prostate cancer**.** Informants claim uses of *Tribulus terrestris* to treat renal dysfunction. Renal maladies include tubular necrosis, acute interstitial nephritis, fanconi's syndrome, hypokalemia or hyperkalemia, hypertension, papillary necrosis, chronic interstitial nephritis, nephrolithiasis, urinary retention and cancer of the urinary tract. *Tribulus* might promote effective filtration by restoring the effective equilibrium between afferent and efferent filtration pressures [19] (Table 1).

Measuring the “importance” of plants and vegetation to people is a central concern in quantitative ethnobotany. Various calculated indices reveal the role of plants in specific cultures and their relevance for therapeutic purpose or purposes. In present study four indices viz. use value (UV), percent fidelity level (% FL), relative index (RI) and relative frequency citation (RFC) were used to quantize data. Use value (UV) is based on the number of uses and the number of people that cite a given plant. It is generally used to indicate the species that are considered most important in a given population i.e. it measures the relative usefulness/importance of plants or species known locally. Its value is high when there are many use-reports for a plant, implying that the plant is important, and low (approach to 0) when there are few use-reports. In study area *Echinochloa crusgalli* has maximum use value as 4.38 followed by *Panicum sumatrense* (4.33) while the *Echinochloa colonum* and *Ipomoea pes-tigridis* has low therapeutic value (0.32). The forest area located farthest from the community was less disturbed and had a greater family richness than the area adjacent to the community. Maximum diversity led to availability of plants with utmost usages. Tribal niches of all community thereof had the highest local relative and ecological importance for *Echinochloa crusgalli* [20].

% Fidelity level (% FL) indicates number of informants who independently suggest the use of a species for the same major purpose and the total number of informants who mentioned the plant for any use. High FL values (near 100%) are obtained for plants for which almost all use-mentions refer to the same purpose, that is the plants (and their use for a particular purpose) are most preferred, whereas low FLs are generally obtained for plants that are used for many different purposes. *Paspalidium flavidum* (93.48) and *Setaria italica* (90.00) carry high % FL whereas *Echinochloa colonum*, *Holoptelea integrifolia* and *Panicum sumatrense* (67.62) the

lowest. Higher % FL of these plants is an indication of their high healing potential. Priority should, therefore, be given to these plants to test their efficacy and their toxicity [21] (Table 2).

Relative index (RI) is a comparison of species for their therapeutic efficiency to treat more than one health problem. d the normalized number of body system (BS) it affects.

It was found to be 7.05 (minimum) in three species viz. *Echinochloa colonum, Holoptelea integrifolia* and *Ipomoea pes-tigridis* while it was maximum in *Panicum sumatrense* (63.86) with slightly lowered RI on *Coix lacryma-jobi* (61.09). The technique of relative importance (RI) emphasizes those plants that have the greatest absolute number of uses. As such, it cannot be used to validate the argument that the importance of a given plant is associated with its multiple uses [22].

Relative frequency citation (RFC) is an attribute to denote the usage popularity or frequency of the species among the informants or the therapists. Maximum RFC (0.84) was observed in *Echinochloa crusgalli* and *Achyranthes aspera* followed by *Setaria italica* (0.81) while minimum in *Echinochloa colonum* and *Ipomoea pes-tigridis* (0.19) (Table 2). This reflects the strong and long term association of inhabitants with local plants [23].

Table 1: Ethno-medicinal enumeration of functional staple food plants used by tribal's of Southern Rajasthan

S.No	Botanical name; Family (Local name) [No of treated diseases/ No of Disease category]	Form of usage; Application	Ailment/Disorder/Used as (Disease category -ICD 11)
1.	*Achyranthes aspera* L.; Amaranthaceae (Kantha) [1/1]	Roasted seed powder is mixed with wheat/ maize flour	Whooping cough (12)
2.	*Alloteropsis cimicina* (L.) Stapf.; Poaceae (Basanti ghass) [2/2]	Flour used for making bread	Diabetes (05) & Flatulence (21)
3.	*Amaranthus gangeticus* L.; Amaranthaceae (Kangani) [2/1]	Used as pseudocereal; boiled as rice	Constipation (13) & Liver tonic (13)
4.	*Coix lacryma-jobi* L.; Poaceae (Garelo) [3/3]	Boiled and consumed as rice. Seeds are also used for making porridge.	Dysentery (01), Diabetes (05) & Urinary complaints (16)
5.	*Echinochloa colonum* (L.) Link.; Poaceae (Sama) [1/1]	Boiled and consumed as rice	Diabetes (05)
6.	*Echinochloa crusgalli* (L.) P.Beauv. ; Poaceae (Sama) [2/2]	Boiled and consumed as rice	Diabetes (05) & Nostril hemorrhage (12)
7.	*Eleusine coracana* (L.) Gaertn.; Poaceae (Garelo) [2/2]	Boiled and consumed as rice	Diabetes (05) & Fever (21)
8.	*Holoptelea integrifolia* (Roxb.) Planch.; Ulmaceae (Bandarbatti) [1/1]	Eaten raw	Skin eruptions (14)
9.	*Ipomoea pes-tigridis* L.; Convolvulaceae (Ghebatti) [1/1]	As a powder used for bread preparation	Gastric troubles (13)
10.	*Panicum miliaceum* L.; Poaceae (Samlai) [1/1]	Flour used for making bread	Diabetes (05)
11.	*Panicum sumatrense* Roth. ex Roem. & Schult.; Poaceae (Samlai) [1/1]	Flour used for making bread	Diabetes (05)
12.	*Paspalidium flavidum* (Retz.) A.Camus ; Poaceae (Samlai) [1/1]	Flour used for making bread	Diabetes (05)
13.	*Paspalum scrobiculatum* L.; Poaceae (Kodra) [2/2]	Boiled and consumed as rice	Diabetes (05) & Dysentery (01)
14.	*Setaria glauca* (L.) P.Beauv. ; Poaceae (Kukarva) [1/1]	Flour used for making bread	Diabetes (05)
15.	*Setaria italica* (L.) P.Beauv. ; Poaceae (Kangini) [2/2]	Flour used for making bread	Diabetes (05) & Dysuria (16)
16.	*Tribulus terrestris* L.; Zygophyllaceae (Gokhru) [2/1]	Used as a famine food	Urinary infections (16) & Kidney dysfunction (16)

Table 2: **Quantitative analysis of documented ethno functional food plants for their Use Value (UV), Percent fidelity level (% FL), Relative index (RI) and Relative frequency citation (RFC) (TD-Types of disease; DC-Disease category and NoI-Number of informants)**

S.No	Species	TD	DC	NoI	UV	% FL	RI	RFC
1.	*Achyranthes aspera*	1	1	31	3.04 ± 0.15***	88.5 ±1.00*	45.23 ± 0.81*	0.84 ± 0.10*
2.	*Alloteropsis cimicina*	2	2	29	2.84 ± 0.90*	85.5 ± 0.66*	35.23 ± 0.13***	0.78 ± 0.40*
3.	*Amaranthus gangeticus*	2	1	24	0.85 ±0.10*	77.42 ± 0.19*	12.05 ± 0.08**	0.65 ± 0.23*
4.	*Coix lacryma-jobi*	2	2	25	2.45 ± 0.08*	79.5 ± 0.83*	61.09 ± 0.66**	0.68 ± 0.33**
5.	*Echinochloa colonum*	1	1	19	0.32 ± 0.05*	67.62 ± 0.19*	7.05 ± 0.69**	0.24 ± 0.07*
6.	*Echinochloa crusgalli*	2	2	31	4.38 ± 0.08*	77.13 ±1.00***	35.68 ± 1.55*	0.84 ± 0.18***
7.	*Eleusine coracana*	2	2	29	2.84 ± 0.15*	85.5 ± 0.66*	47.73 ± 1.33*	0.78 ± 0.33*
8.	*Holoptelea integrifolia*	1	1	24	0.85 ± 0.10*	67.62 ± 0.69***	7.05 ± 0.69**	0.65 ± 0.15*
9.	*Ipomoea pes-tigridis*	1	1	29	0.32 ± 0.13**	70.56 ± 0.10*	7.05 ± 0.69**	0.24 ± 0.04*
10.	*Panicum miliaceum*	1	1	25	2.45 ± 0.19*	79.5 ± 1.33**	45.23 ±0.46*	0.68 ± 0.32*
11.	*Panicum sumatrense*	1	1	26	4.33 ± 1.78**	67.62 ± 0.81**	63.86 ± 0.10***	0.70 ± 0.18**
12.	*Paspalidium flavidum*	1	1	23	0.81 ± 0.23*	93.48 ± 0.19**	16.59 ± 1.33*	0.62 ± 0.15*
13.	*Paspalum scrobiculatum*	2	2	13	0.46 ± 0.10***	78.4 ± 1.33**	14.09 ± 0.66**	0.35 ± 0.09**
14.	*Setaria glauca*	1	1	29	1.45 ± 0.75*	85.35 ± 0.66*	21.14 ± 0.15*	0.78 ± 0.15***
15.	*Setaria italica*	2	2	30	1.06 ± 0.08*	90.00 ± 1.78**	14.09 ± 0.66*	0.81 ± 0.66***
16.	*Tribulus terrestris*	2	1	29	1.45 ± 1.07*	85.46 ± 0.81**	21.14 ± 0.10**	0.78 ± 0.10***

Values are mean ± SEM and *<0.05; **<0.01; *<0.001**

CONCLUSION

Echinochloa crusgalli has maximum UV and RFC which reveals its utmost consumption as functional staple food by aboriginals though its usage is confined only for diabetes and nostril hemorrhage due to which it has poor RI as it does not support multiple body systems. *Echinochloa colonum* has low UV, % FL, RI and RFC followed by *Ipomoea pes-tigridis* having low UV, RI and RFC revealing its meager use and dispersion in tribal communities. *Echinochloa crusgalli* shows contrary attribute with maximum UV and RFC indicating its popular usage among tribals but its usage and applications differed among local therapists of southern Rajasthan.

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