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IN VIVO PRELIMINARY BIOCHEMICAL SCREENING OF ETHNO ANTI-DIABETIC PLANTS DEPLOYED IN SOUTH-EAST RAJASTHAN (INDIA)

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ABSTRACT

Ethno-medicinal survey with reference to hypoglycemic activity was carried out in various ethnic pouches of south east Rajasthan and on the basis of % fidelity level, 25 plants were selected and subjected to preliminary *in vivo* biochemical screening through oral glucose tolerance test (OGTT). Aqueous extract of respective plant part was orally ingested prior to intragastically glucose loaded wistar rats and blood glucose level was registered after 0, 30, 90 and 120 mins through glucose oxidase and peroxidase (GOD / POD) method. Glibenclamide (GBS) was used as a reference drug to mark the efficacy of plant. Percent variation of glucose level over initial time (% Gvt) and percent variation of glucose level with respect to reference drug (%Gld) were studied for all respective time intervals in all groups to mark the anti-hyperglycemic efficacy of the plant.Glucose levels with respect to initial time declined in groups treated with *Aerva lanata*, *Aloe barbadensis*, *Andrographis paniculata*, *Cassia sophera*, *Catharanthus roseus*, *Cayratia trifolia*, *Citrullus colocynthis*, *Cyamopsis tetragonoloba*, *Dalbergia sissoo*, *Gymnema sylvestre* and *Phyllanthus emblica*. Groups injested with phytoextract of *Aerva lanata*, *Andrographis paniculata*, *Boerhaavia diffusa*, *Catharanthus roseus*, *Cayratia trifolia*, *Costus speciosus*, *Cyamopsis tetragonoloba*, *Gymnema sylvestre* and *Phyllanthus emblica* were akin to GBS. On the array of both the variables i.e. declivity over time and with reference to GBS *Aerva lanata*, *Andrographis paniculata*, *Catharanthus roseus*, *Citrullus colocynthis* , *Cyamopsis tetragonoloba* and *Gymnema sylvestre* were found to be efficacious but the glucose level of *Aerva lanata* at source point i.e. 0 min was comparatively very high and statistically not significant

KEYWORDS: South east Rajasthan, Diabetes, OGTT, *Andrographis paniculata, Catharanthus roseus, Citrullus colocynthis, Cyamopsis tetragonoloba, Gymnema sylvestre*.

INTRODUCTION

Phyto-therapy is highly diffused in high-income countries whereas scientific medical model is more diffused in the developing countries. This contrast between the two models has raised the urgent need to compare the immense background of traditional knowledge with the scientific procedures of research and validation. WHO has also issued guidelines for the "Assessment of Herbal Medicines".[1,2] These guidelines has defined the basic criteria for the evaluation of quality, safety and efficacy of herbal medicines with the goal of assisting national regulatory authorities, scientific organizations and manufacturers in assessing documentation, submissions and dossiers of such products. This approach provokes research community to undertake the task of documentation followed by pharmacological and clinical authentication of ethno-medicines from various tribal groups. In India, tribals constitute 8.61% of the total population of the country, numbering 104.28 million which reasserts use of traditional medicines and complementary traditional medicines (TM/CAM) as an important array in health management.[3-6] These tribes reside in different states among which Rajasthan forms the prime line.

In Rajasthan tribal make 13.5 % of total population and chief ethnic group includes Bhil, Garasia, Mina, Damor, Kathodi, Dhanka, Seharia, Patelia, Kukna etc. which still partially or largely depend on their prevailing traditional system of medicine.[7] Ethno-medicinal hunt to such ethnic pouches ensures least documentation of known therapeutic herbs or their absentia in health care system. Health care system of these tribal pockets are managed by various tribal healers viz. Bhopa (Ritual therapist), Jhankar/Jhangar (Herbalist), Devala (Grain diviner), Khoonth (Priest) and Guni (Herbal practitioner).[8] Ethno-medicinal uses from these ethnic pouches have been documented by many workers,[9-13] but certification as a drug cannot be desked on. Diabetes mellitus II ruins glorified lives and dumps the patient physically, psychologically and economically. DM II management in tribal pockets is carried out through local herbs in a form of drug/s and/or food supplement/s as prescribed by local healers.[14-17] Prior to extensive and expensive massive research for the transformation of such herbs to drugs require prelude screening of documented plant/s. Sailing on the same tide an attempt was made to clinically evaluate the documented plants for their hypoglycemic potentials. For the present study a survey was conducted during various seasons in different

localities and ethnic therapist were interviewed with respect to plants deployed for diabetes type 2.[18] During field studies many plants were reported to be used in diabetes and associated ailments from which 25 plants were selected for present study. These plants were selected according to % fidelity level,[19,20] i.e. frequent citation from different tribes, gender and age case. The plants already formulated as drug were ignored. Glibenclamide (GBS) stimulates insulin release by activating ATP-sensitive potassium channels (K_{ATP}) [21] and therefore, injestion of GBS reduces blood sugar levels within ablated time. Hence, GBS forms an ideal reference drug to compare the hypoglycemic efficacy of test plant/s. Oral glucose tolerance test (OGTT) signifies body's ability glucose levels over time. An enhanced concentration of insulin or insulinomimetic compounds diminishes glycemic loads and hence forms the important parameter to detect hypoglycemic potential of the plant/s.

MATERIALS AND METHODS

Ethno-medicinal studies

Ethno-medicinal surveys with special reference to hypoglycemic plants were carried out in different seasons and ethnic pockets of south east Rajasthan and field interviews were made with different herbal practitioners for the documentation of ethnically deployed plants. As per CBD guidelines prior informant consensus was obtained and information was cross checked with all specifications. Plants were identified; authenticated [22.23] and herbarium sheets were prepared as per standard protocol and deposited in Department of Biotechnology, B N P G College, Udaipur (Raj.) India.

Extract preparation

Respective fresh plant parts were collected from different localities of the south-east Rajasthan and were thoroughly rinsed to get rid off foreign particles and biotic moieties. Later on, they were dried in shade at room temperature for two weeks, followed by grinding and sieving to obtain fine powder. Aqueous extract was prepared by cold maceration of respective shade dried parts by soaking 100 g in 500 ml of distilled water for 5 days and followed up by filtration. The respective extracts were stored at 5-8 C.

Oral Glucose load (OGL)

Glucose (2 g/kg) was orally loaded with feeding syringe in all groups at 0 min**.**

Experimental design

For *in vivo* prelude screening of hypoglycemic activity, white albino rats of wistar strain were divided randomly in 27 groups with 8 rats in each group and experiment was designed as-

Group 1:	Control vehicle-Normal saline (5 ml/kg b.w.) + OGL (2 g / kg b.w.).
Group 2:	Reference groups- Glibenclamide (GBS) (5 ml/kg b.w.) + OGL (2 g / kg b.w.).
Group 3-27:	Phyto-extract treated groups- Aq. phyto extracts (200 mg/kg b.w. in 1% w/v
	CMC) + OGL (2 g / kg b.w.). Respective dose of the phyto-extract was orally
	administered 30 min prior to oral intragastical glucose dose.

The respective ethno hypoglycemic plants and their respective parts deployed for group 3-27 were assigned as Table1.

Table1: List of ethno-hypoglycemic plants selected for *in vivo* preliminary biochemical screening.

Gr. No-Botanical Name ; Family (Herbarium Acc. No - BNC/01/-) Plant part/s used	**% FL**
3-*Aegle marmelos* (L.) Correa ex Roxb.; Rutaceae (2011/41) Leaves & Bark	58.56
4-*Aerva lanata* (L.) Juss.ex Schult ; Amaranthaceae (2010/27) Whole plant	55.68
5-*Aloe barbadensis* Mill.; Liliaceae (2011/81) Leaf Pulp	66.24
6-*Andrographis paniculata* (Burma.f.)Wall.ex Nees ; Acanthaceae (2010/24) Leaves	62.40
7-*Annona squamosa* L.; Annonaceae (2010/01) Seeds	51.84
8-*Asparagus racemosus* L ; Liliaceae (2012/20) Tubers	62.40
9-*Boerhaavia diffusa* L.; Nyctaginaceae (2011/67) Leaves	49.92
10-*Caesalpinia bonduc* (L.) Roxb.; Caesalpiniaceae (2011/51) Seeds	55.68
11-*Cassia sophera* L.; Caesalpiniaceae (2010/102) Seeds & Bark	49.92
12-*Catharanthus roseus* (L.) G.Don.; Apocynaceae (2010/22) Leaves & Flowers	65.28
13-*Cayratia trifolia* (L.) Domin.; Vitaceae (2011/ 45) Roots	57.60
14-*Citrullus colocynthis* (L.) Schrad.; Cucurbitaceae (2010/16) Fruits & Seeds	59.52
15-*Costus speciosus* (Koen) Sm.; Costaceae (2012/ 124) Rhizome	48.00
16-*Cyamopsis tetragonoloba* (L.)Taub.; Fabaceae (2011/46) Seeds	65.28
17-*Dalbergia sissoo* Roxb. ; Fabaceae (2012/ 198) Leaves	57.60
18-*Feronia limonia* (L.) Swingle ; Rutaceae (2012/ 130) Fruits & Seeds	59.52
19-*Gymnema sylvestre* (Retz.) R.Br.ex Scultz; Asclepiadaceae (2011/ 59) Leaves	63.36
20-*Hemidesmus indicus* (L.) R.Br.; Asclepiadaceae (2012/ 114) Roots	55.68
21-*Mitragyna parvifolia* Korth ; Rubiaceae (2012/ 128) Leaves & Seeds	57.60
22-*Mukia maderaspatana* (L.) Cogn.; Cucurbitaceae (2012/108) Seeds	65.28
23-*Murraya koenigii* (L.) Spreng ; Rutaceae (2011/ 42) Leaves	57.60
24-*Phyllanthus emblica* L.; Euphorbiaceae (2011/ 60) Fruits	59.52
25-*Terminalia bellerica* Roxb.; Combretaceae (2010/ 14) Fruits	51.42
26-*Tridax procumbens* L.; Asteraceae (2011/ 57) Leaves	51.84
27-*Withania sominifera* L.; Solanaceae (2011/ 60) Leaves & Roots	51.00

Oral glucose tolerance test (OGTT)

Blood samples (1.5 ml) were collected from post anal tail region after 0, 30, 90 and 120 minutes and were allowed to coagulate for 30 min. Latter, transcend was centrifuged at 2500 rpm for 15 min and serum was subjected for the estimation of glucose level by glucose oxidase and peroxidase (GOD / POD) method using glucometer.[25] Percent variation of blood glucose [26] for each group was calculated as-

% variation of blood glucose with respect to reference drug GBS:

$$\%Gld = BGL_R - BGL_{PE} / 100$$

[BGL_R : Blood glucose level in group treated with reference drug at given time interval and BGL_{PE} : Blood glucose level in group treated with phyto-extract at given time interval]

% variation of blood glucose with respect to initial time i.e. 0 mins:

$$\%Gvt = (G_t - G_i) \times 100 / G_i$$

[G_i and G_t are the values of initial glucose concentration and after 30, 90 and 120 min respectively]

Statistical analysis

- The results are expressed as mean ± SEM and analyzed by one way ANOVA followed by Dunnett's test [27] at 0.1%, 1% and 5% level of significance.
- For statistical calculation 1/3rd of the data was utilized with significant minimum values as compared to reference drug for both %Gvt and %Gld i.e. 8 plants were selected from each array with close allies to GBS for intersection through venn diagram.

RESULTS

Oral glucose tolerance

Experimental induction of hyperglycemia in non diabetic rats by intragastric ingestion of oral glucose load results in elevated levels of glucose levels up to 90 mins and latter on followed by declivity (Group 1). In reference group (Group 2) the upgraded plasma glucose level was confined upto 30 mins only and latter on decreased sharply i.e. glucose load was directed towards normal plasma moiety through insulinomimetic action. Alike GBS, same rationalized trend was also observed in groups treated with *Catharanthus roseus*, *Costus speciosus*,

Cyamopsis tetragonoloba and *Gymnema sylvestre* (Table2).

Table 2 :*In vivo* preliminary screening of ethno hypoglycemic plants in wistar rats through oral glucose tolerance test (OGTT)

Gr. No	Blood Glucose level (mg/dL)			
	0 min	30 min	90 min	120 min
1	116.17±1.33	174.23±1.75	184.36±0.75	134.22±1.10
2	111.23±2.10	146.33±1.85	134.69±1.89	119.56±1.85
3	115.46±3.00[a]	166.65±0.75	170.45±2.00	140.34±1.15
4	129.78±1.90	158.88±2.33*	160.20±1.15**	138.15±2.50* [a]
5	120.69±0.34	167.45±0.80	171.88±1.35	140.15±0.80
6	114.34±1.55	153.60±1.89**	158.27±2.00*	123.45±1.80** [b]
7	118.36±1.60	179.34±1.10	184.34±1.65 [a]	162.34±2.10
8	121.28±2.10	168.17±2.10	180.35±1.89 [a]	156.80±1.85
9	117.46±1.00 [a]	159.15±0.75*	179.29±1.90	166.69±2.80
10	118.60±1.15	176.35±1.85 [a]	172.20±1.85*	148.35±2.10
11	120.65±0.34	172.17± 1.33 [a]	187.20±2.10 [a]	139.35±1.50**
12	113.33±2.10 [a,b]	148.35±2.00*** [b]	144.00±1.50**	122.27±1.00** [b]
13	119.35±1.15	159.46±1.89**	169.88±1.60	141.17±1.85
14	116.27±1.45 [a]	156.60±2.10**	159.35±1.10**	128.56±0.75** [b]
15	117.56±0.34 [a]	171.33±1.75 [a, b]	168.34±1.00* [a]	136.45±1.60 [a]
16	116.20±2.50 [a]	159.45±1.00* [b]	150.20±0.34** [b]	126.56±1.75** [b]
17	118.34±1.10	162.69±1.90	173.88±1.10	143.65±1.85
18	117.69±1.89 [a, b]	169.65±1.33*	171.15±1.50	138.34±1.90 [a]
19	115.20±1.50 [a]	161.20±0.34	158.46±2.00* [b]	124.60±0.34** [b]
20	119.20±0.75	169.56±1.66	183.65±2.10* [a]	144.27±1.90
21	116.65±1.00	166.34±1.60	171.60±1.90	149.17±1.15
22	117.56±1.90 [a]	174.69±1.85 [a]	177.17±1.50	141.33±1.00
23	116.45±1.15	172.33±0.34 [a]	179.15±1.00	139.46±1.89 [a]
24	117.27±0.75 [a]	171.34±1.00 [a]	184.45±1.15 [a]	129.60±0.75** [b]
25	118.33±1.30	169.65±1.66	181.45±0.75 [a]	141.34±2.00
26	118.45±1.60	169.46±2.10	180.56±1.15 [a]	140.88±0.34
27	119.88±1.60	171.17±1.85 [a]	193.33±1.00	147.60±0.75

[Normal (Control): OGL (2 g/kg b.w) ; Reference Group : OGL (2 g/kg b.w)+ GBS (10 mg/ kg b.w.) Group No 3 -27 : Aq. phyto extracts of EHP (200 mg/kg b.w. in 1% w/v CMC) + OGL (2 g/kg b.w) Values are mean ± SEM for 8 animals in each observation *P* *<0.05; **<0.01; ***<0.001; as compared to initial time. a:<0.05 compared with normal control; b:<0.05 compared with diabetic control(one way ANOVA followed by Dunnett's test)]

Percent variation of blood glucose with respect to initial time (% Gvt)

The comparison of % Gvt of groups treated with phyto extract and reference drug GBS after 30 mins reveals minimal difference in case of *Catharanthus roseus*, *Aerva lanata*, *Cayratia trifolia*, *Andrographis paniculata*, *Citrullus colocynthis*, *Boerhaavia diffusa*, *Cyamopsis tetragonoloba* and *Dalbergia sissoo*. After 90 the % Gvt with minimal values at par to reference drug were observed in *Catharanthus roseus*, *Cyamopsis tetragonoloba*, *Aerva lanata*, *Citrullus colocynthis*, *Gymnema sylvestre*, *Andrographis paniculata*, *Cayratia trifolia* and *Aloe barbadensis* while after 2 hours i.e. 120 mins, it was akin to *Catharanthus roseus*, *Andrographis paniculata*, *Gymnema sylvestre*, *Cyamopsis tetragonoloba*, *Phyllanthus emblica*, *Citrullus colocynthis*, *Aerva lanata* and *Cassia sophera* . Intersecting through venn circles the plants enlisted after each time interval projects *Aerva lanata*, *Andrographis paniculata*, *Catharanthus roseus*, *Citrullus colocynthis* and *Cyamopsis tetragonoloba* to possess hypoglycemic activity and show same array of glucose levels over time as evinced by GBS (Venn Diagram 1; Table 3).

Percent variation of blood glucose with respect to reference drug (% Gld)

Percent blood glucose level (%Gld) with minimum difference over reference drug after 30, 90 and 120 mins contrive *Aerva lanata*, *Andrographis paniculata*, *Boerhaavia diffusa*, *Catharanthus roseus*, *Cayratia trifolia*, *Citrullus colocynthis*, *Costus speciosus*, *Cyamopsis tetragonoloba*, *Feronia limonia*, *Gymnema sylvestre* and *Phyllanthus emblica* (Table 3). Group 6,12,14,16 and 19 ingested with *Andrographis paniculata*, *Catharanthus roseus*, *Citrullus colocynthis*, *Cyamopsis tetragonoloba* and *Gymnema sylvestre* respectively were at par with GBS (Venn Diagram 1; Table 3).

Venn diagram 1: Intersecting group performance for % Gld and % Gvt after 30, 90 and 120 min. Number encircled represents group number of % Gld whereas number without circles denote group number of % Gvt ; t_i= time interval

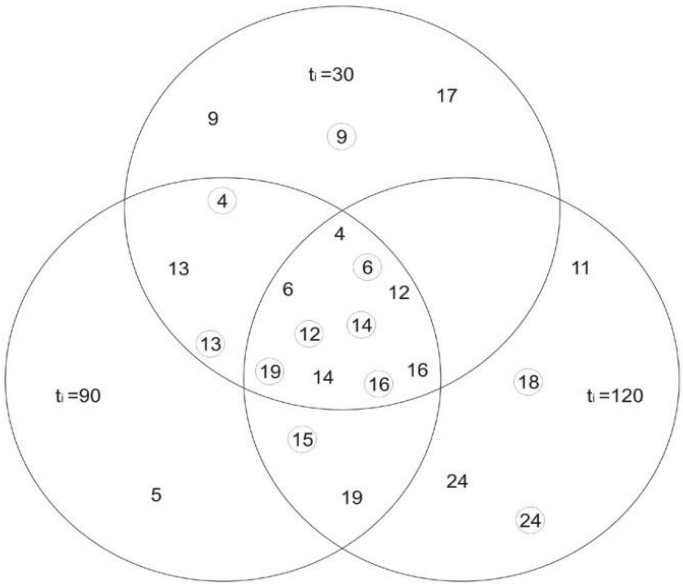

Table 3 : Comparative percent variation of glucose over initial time (%Gvt) and reference drug (%Gld) after 30,90 and 120 mins

Evaluated hypoglycemic plant	Blood Glucose level (mg/dL)					
	% Gvt 30	% Gvt 90	% Gvt 120	% Gld30	% Gld90	% Gld 120
Aegle marmelos	44.33	47.62	21.54	113.88	126.54	117.38
Aerva lanata	32.64*	33.74*	15.33*	108.57*	118.93*	115.54
Aloe barbadensis	38.74	42.41*	16.12	114.43	127.61	117.22
Andrographis paniculata	34.33*	38.42*	07.96*	104.96*	117.50*	103.25*
Annona squamosa	51.52	55.74	37.15	122.55	136.86	135.78
Asparagus racemosus	38.66	48.70	29.28	114.92	133.90	131.14
Boerhaavia diffusa	35.49*	52.63	41.91	108.76*	133.11	139.41
Caesalpinia bonduc	48.69	45.19	25.08	120.51	127.84	124.07
Cassia sophera	42.70	55.15	15.49*	117.65	138.98	116.55
Catharanthus roseus	30.90*	27.06*	07.88*	101.38*	106.91*	102.26*
Cayratia trifolia	33.60*	42.33*	18.28	108.97*	126.12*	118.07
Citrullus colocynthis	34.68*	37.05*	10.57*	107.01*	118.30*	107.52*
Costus speciosus	45.73	43.19	16.06	117.08	124.98*	114.12*
Cyamopsis tetragonoloba	37.22*	29.25*	08.91*	108.96*	111.51*	105.85*
Dalbergia sissoo	37.47*	46.93	21.38	111.18	129.09	120.14
Feronia limonia	44.14	45.42	17.54	115.93	127.06	115.20*
Gymnema sylvestre	39.93	37.55*	08.15*	110.16*	117.64*	104.21*
Hemidesmus indicus	42.24	54.06	21.03	115.87	136.35	120.66
Mitragyna parvifolia	42.59	47.10	27.87	113.67	127.40	124.76
Mukia maderaspatana	48.59	50.70	20.21	119.38	131.53	118.20
Murraya koenigii	47.98	53.84	19.75	117.76	133.00	116.64
Phyllanthus emblica	46.10	57.28	10.51*	117.09	136.94	108.39*
Terminalia bellerica	43.37	53.34	19.44	115.93	134.71	118.21
Tridax procumbens	43.06	52.43	18.93	115.80	134.05	117.83
Withania sominifera	42.78	61.26	23.12	116.97	143.53	123.45

Data with * represents significant declivity of phytoextract with reference to time and reference drug

DISCUSSION

Glucose is the reducing monosaccharide that serves as the principal source of cellular energy in the body. Its hypo- and hyper- levels can be the outcome of many metabolic anomalies but preliminary it is associated with insulin function and hence forms the base line of oral glucose tolerance test (OGTT).[28,29] Originally OGTT was developed to check carbohydrate tolerance but it also signifies the ability tissues to insulin and insulin resistance.[30] Oral intragastical glucose level diminishs over 120 mins and therefore, the capability to endure sugar level forms indices in DMII. The ability of a compound or formulation depends on the regularization of glucose levels and the time of glucose clearance from blood.Comparative analysis of blood glucose level of phyto-treated group with reference drug and its positive attribute is a promissory note for its efficacy as a potential hypoglycemic herb.[31,32] In the present study, OGTT in non diabetic wistar rats exposed to differential phyto-extract reveals substantial anti-hyperglycemic activity of *Aerva lanata, Aloe barbadensis, Andrographis paniculata, Boerhaavia diffusa, Cassia sophera, Catharanthus roseus, Cayratia trifolia, Citrullus colocynthis, Costus speciosus, Cyamopsis tetragonoloba, Dalbergia sissoo, Feronia limonia, Gymnema sylvestre* and *Phyllanthus emblica.* Although *Aloe barbadensis, Boerhaavia diffusa, Cassia sophera, Cayratia trifolia, Costus speciosus, Dalbergia sissoo, Feronia limonia* and *Phyllanthus emblica* showed insulinomimitic activity at one time interval or other but all these plants cannot be subjected for further investigation as on other tenures they didn't assured low blood glucose load. Decline in glycemic levels might had occur through one of the biochemical activity i.e. increased activity of pancreatic beta cells or increase in the inhibitory effect against insulinase enzyme or increase of the insulin sensitivity or insulin mimic activity.[33,34] Other mechanism such as increased peripheral utilization of glucose, increased synthesis of hepatic glycogen or decrease of glycogenolysis, inhibition of intestinal glucose absorption, reduction of glycemic index of carbohydrate and reduction of the effect of glutathione may also be involved.[35,36] Determining parameters viz. (1) %Gvt and (2) %Gld projects - *Aerva lanata, Andrographis paniculata, Catharanthus roseus, Citrullus colocynthis, Cyamopsis tetragonoloba* and *Gymnema sylvestre* as potent hypoglycemic plants. The values of blood glucose level in groups treated with *Aerva lanata* are comparative high and statistically not significant. Comparison of *in vivo* preliminary biochemical screening and outcomes of ethno-medicinal survey reveals that all plant deployed for regulation of diabetes mellitus II does not carry substantive hypoglycemic potential. % FL bespeaks the usage practice among the community and hence is an index of

importance. Generally it is considered that plants with high % FL values possess significant therapeutic properties but in present study it does not implies to all documented plants.[37] Usage of *Aloe barbadensis* marks highest % FL (66.25) but *in vivo* screening does not depicts any significant hypoglycemic potential. As ethnic practices mark its efficacy, it can be suggested that it may either act through any other metabolic entity or scavenges free radicals responsible for promoting insulin insensitivity. *Catharanthus roseus*, *Cyamopsis tetragonoloba* and *Mukia maderaspatana* are equally used (% FL-65.28) in DMII but *Mukia maderaspatana* does not show significant declivity of sugar levels at both the arrays neither after time interval nor it can be compared to reference drug GBS. Therefore, *Mukia* cannot be recommended for blood sugar regulation. *Andrographis paniculata* and *Asparagus racemosus* are equally used in tribal pockets, *Andrographis paniculata* is nearly at par to GBS whereas *Asparagus racemosus* has no notable hypoglycemic effect. Tribal's depend on their immediate vicinity for treatment of various ailments and practice exploring habits rather exploiting and hence storage of herbs/drugs is scarce. Availability of therapeutic herb resources depends on climate / seasons and in turn affects frequency of usage. Rajasthan is a state of climatic diversity i.e. from range of Aravallis to deciduous forest, arid to semi arid regions and hence distribution of vegetation is not uniform. *Aloe barbadensis, Asparagus racemosus* and *Mukia maderaspatana* grow throughout the south east region and fetch therapist all round the year, due to which they might have high percent fidelity level whereas *Citrullus colocynthis* with significant glycemic regulatory properties is restricted to semi rid zone and fruits are confined only in winter season which has led to low citation.

Availability effects fidelity therefore, mere on the basis of documentation and citation, ethno medicinal herbs cannot be utilized in the specified ailments rather they have to be tested along pharmacological and clinical parameters. Present study discloses all practiced herbs cannot be attributed for diabetes but *Andrographis paniculata*, *Catharanthus roseus*, *Citrullus colocynthis*, *Cyamopsis tetragonoloba* and *Gymnema sylvestre* serve as an elite antihyperglycemic plants and are therefore recommended for further complete clinical investigation for complete DM II profile so that they can be utilized for the formulation of safer novel herbal drug with least consequences.

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