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Original Article

CANDIDATE MEDICINAL PLANT SPECIES OF DJIBOUTIAN PHARMACOPEIA FOR TESTING PHARMACOLOGICAL ACTIVITIES ON COMMON MICROBIAL DISEASES

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ABSTRACT

Objective: The aim of the study was to conduct an ethnobotanical study focused on the medicinal plants used in Randa (Djibouti) for testing pharmacological activities on common microbial diseases.

Methods: Plant Ratio (PR), Index of Performance (IP) and the high Informant Consensus Factors (ICF) were calculated to select candidate medicinal species with a pharmacological potential.

Results: From this previous work, it was found that the high Informant Consensus Factors, ICF (0.82) for the category of microbial diseases turned out to merit further perusal. The findings particularly gave an imminent insight that stimulated additional investigations and analyses. Different factors, including Plant Ratio (PR) and Index of Performance (IP) were employed for comparison leading to the selection of 18 candidates species, for subsequent pharmacological screening, and testing for antimicrobial activities. Comparison of the information with that accessed from the literature implicitly hinted that the Djiboutian traditional medical system shares much in common with other traditional medical systems. At least six out of the 18 species have not been pharmacologically tested before.

Conclusion: The comparison of differents factors (IP2, PR and FL') of plants screening have showed that 18 plants species of Randa region, have good healing potential for infectious diseases. This may inspire continued research to build a comprehensive ethnobotanical and ethnopharmacological profiles of the species anticipated to be of the most promising potential for Djibouti and beyond.

Keywords: Traditional medicinal plants, Djibouti, Randa, Statistical analysis

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INTRODUCTION

Many clinically useful prescription drugs have originated from traditional medicinal plants. Since there are many traditional medicinal plants widely used by the society in Randa (Djibouti), it is worth subjecting these plants to investigation for the discovery of drugs with an anticipation of obtaining new bioactive substances. Randa with its unique climate and vegetation [1] may disclose some endemic species which have not been tested previously.

Poorly developed prevention system and resistance to drugs are the two main factors aggravating microbial infections in Djibouti [2-4]. This is related to the high prevalence in Djibouti of infectious diseases, probably caused by poverty and the general unhygienic conditions observed in many parts of Randa region.

After identifying traditional medicinal plants in Randa (Djibouti) by interviewing and conducting discussions with informants, priority diseases/disease categories were screened [5, 6].

Almost 20% of the medicinal plants recorded were those used by the people against infections [1]. This study aims at a selection of medicinal plants used for the care of cases of infectious diseases, and which have pharmacology properties.

To further strengthen the validity of the present work, a critical literature review was made followed by a simple comparison of the selected medicinal plants with the previous data gathered from the literature.

MATERIALS AND METHODS

As mentioned previously [1], the ethnobotanical study was conducted in Tadjourah District of Randa region in Djibouti, where 184 informants were interviewed from July 2010 to February 2011.

In this first study, the Informant Consensus Factor (ICF) was calculated for each ailment category to identify the agreements of the informants on the reported cures for the group of diseases [7, 8] and the Fidelity Level (FL') Index shows the percentage of informants claiming the use of a certain plant for the same ailment. We introduced additional statistical analysis for identifying candidate plants.

Plant ratio (PR)

Plant ratios towards a disease indicating the top ranking plants for a given disease, was calculated as $PR = (Ip/It) \times 100$, where *Ip* is the number of informants who independently indicated the use of a species for the same ailment and *It* is the total number of informants who mentioned any plant for the same disease. Ratios were rejected if *Ip* (the number of informants) that mentioned any plant for a particular disease is less than 15 in order to make certain that plants with higher consensus among community members are used for the analysis.

Index of performance (Ip2) [9]

To illustrate the selectivity of a plant for a specific ailment, a comparison was made between the expected and the observed values of the proportion of citation of a plant for a specific disease. The difference (P1–P2) between the two proportions was then used to define an Ip2 performance index which ranged from 0 to 3 according to an arbitrary scale rationalized for the purpose. The calculation P1–P2 was made as follows:

$$P1 = C1/C2$$

$$P2 = C3/C4$$

C1 = number of citations of a plant A for treating a specific disease B,

C2 = number of citations of the same plant A in the global list,

C3 = total number of citations of the disease B,

C4 = a total number of citations for all ailments.

If 0<P1–P2<1/3, therefore Ip2 = 3, which denotes a very low performance.

If 1/3<P1–P2<2/3, therefore Ip2 = 2, which denotes an average performance.

If P1–P2>2/3, therefore Ip2 = 1, which denotes a very high performance.

If P1–P2<0, therefore Ip2 = 0, which denotes no performance.

The informant consensus factor (ICF)

The ICF was calculated for each ailment category, to identify the agreements of the informants on the reported cures for the group of diseases [7, 8]. The Fidelity Level (FL') Index shows the percentage of informants claiming the use of a certain plant for the same ailment FL' ranking was taken into account only if the index of performance (Ip2) is ≤ 3. The following scales were adopted for the purpose of comparing and prioritizing on the basis of the ranks of the different species: If FL' 0-33, Rank = 3: average performance; FL'34-66, Rank= 2: high performance; FL'>66, Rank = 1: very high performance. We introduced additional statistical analysis for identifying candidate plants.

Preference ranking

Preference ranking exercise was performed to assess the degree of effectiveness of certain medicinal plants against the most prevalent diseases in the area.

The data obtained were summarized through calculations of percentages and other values and presented in tables and fig. for further analysis and interpretation.

RESULTS AND DISCUSSION

Identification of candidate plants by FL' ranking

Fidelity Level (FL') was calculated for each Djiboutian medicinal plant. For each microbial ailment, each plant was ranked to find the appropriate candidate plant for the ailment. The results obtained are summarizing in table 1.

Table 1: FL' values indicating the top ranking plants for a given disease*

Scientific names	Local names	Diseases	Category	Number of uses	IP'	Iu	FL'	%	Rank
Ochradenus baccatus Delile	malboyta	diphteria	Microbial	16	16	16	100	100	1
Acacia tortilis (Forssk.) Hayne	eqebto	diphteria	Microbial	3	3	8	37.5	38	2
Acacia seyal Delile	qadgento	dysentery	Microbial	12	12	16	75	75	1
Ziziphus mauritiana Lam.	kusra	eye infection	Microbial	5	5	28	17.8	18	3
Boscia coriacea Pax.	aytinaba	jaundice	Microbial	4	4	10	40	40	2
Terminalia brownii Fresen.	wayboyta	jaundice	Microbial	95	95	113	84.1	84	1
Balanites rotundifolia (Tiegh.) Blatt	alayto	parasitic worms	Microbial	3	3	74	4.0	4	3
Orthosiphon pallidus Royle ex Benth.	abursaafiqi	parasitic worms	Microbial	6	6	16	37.5	38	2
Melilotus suaveolens Ledeb.	meclab	poliomyelitis	Microbial	3	3	6	50	50	2

*(FL' was taken into account only if IP'≥3. The following scales were adopted for the purpose of comparing and prioritizing on the basis of the ranks of the different species: If FL' 0-33, Rank = 3: average performance; FL'34-66, Rank= 2: high performance; FL'>66, Rank = 1: very high performance). Malboyta (*Ochradenus baccatus* Delile) for diphtheria, Qadgento (*Acacia seyal* Delile) against dysentery and Wayboyta (*Terminalia brownii* Fresen.) against jaundice are the top species to study according to the fidelity level FL'.

Identification of candidate plants by calculating plant ratios

The plants that are most interesting for antimicrobial tests are the following 3 species, which had 15 or higher mentions of any plant and a reasonably good proportion (about half and higher) informant consensus [10-14].

It can be seen that those diseases that received 15 and above mentions of any medicinal plant can be priority species. A few species that could be considered in the first priority group include: Malboyta (*Ochradenus baccatus*) with 50% reliability for use against diphtheria, Qadgento (*Acacia seyal*) with 80% reliability against dysentery, Wayboyta (*Terminalia brownii*) with 90% reliability against jaundice and Abursaafiqi (*Orthosiphon pallidus*) with 40% reliability against parasites. Likewise, the top three species of each category can be identified based on the ranks. Others plants species (including those that turned out receiving only one citation) could also be checked for their activities as long as resources are available, but it is noted that they were backed by minimal number of informants, notwithstanding the fact that even a plant mentioned by one person only could be effective for the particular disease. In other words, those plants with a reasonable number of citations can be compared amongst themselves rather than with those that were cited by few informants.

Identification of microbial candidate plants by calculating Index performance (IP2)

The Index of the performance of the microbial infection is presented in table 3. Galqaddo (*Tarchonanthus camphoratus*), Malboyta (*Ochradenus baccatus*) against diphtheria had an IP2 value of 0.97, 0.73 for Qadgento (*Acacia seyal*) against dysentery and finally Data-amqada (*Heliotropium longiflorum*) for infections.

Comparison of the different factors

Plant species that are widely used as remedies for treating microbial infections were compared using FL' (Fidelity Level), IP2 and PR ranking; and by judging the combined effectiveness. The species that ranked top and selected as priority candidates for testing are shown in table 5. Each of the 18 species in table 4, can be considered as good enough candidates for pharmacological testing for the diseases under which they are listed.

The FL' values of medicinal plants cited by three or more informants, for being used against the antimicrobial category were compared, and nine of them were selected. These nine plant species with high FL' values also had high PR ratios towards a given disease. Among them, the anti-dysentery claim for Qadgento (*Acacia seyal*) deserves special attention in the context of increasing the success rate in the search for anti-viral drugs. Another interesting finding is the use of Eqebto (*Acacia tortillis*) and Malboyta (*Ochradenus baccatus*) for diphtheria.

Other new information found in this analysis is the use of Aytinaba (*Boscia coriacea*) and Wayboyta (*Terminilia brownii*) as anti-jaundice agents. Despite their moderate average rank 3, 11 others plants species were also selected to be studied. Those 11 plants had already a selection criterion of 15 for plant ratios and were chosen to be included in the study.

A bibliographical research on the pharmacological properties and traditional uses was made [15-106]. The citations number was obtained by adding them for every plant. These data allow to define the degree of knowledge and to guide possible studies on medicinal plants cited in table 5.

Table 2: Plant ratios indicating the top ranking plants for a given disease*

Scientific names	Plant	Disease	Number of informants (*I*p)	Number of informants who mentioned any plant for the same disease (*I*t)	Plants ratio towards a disease	Plant rank
Ochradenus baccatus Delile.	malboyta	diphteria	16	32	50	1
Acacia tortilis (Forssk.) Hayne.	eqebto		3	32	9	2
Acalypha fruticosa Forssk.	darmuusa		2	32	6	3
Grewia erythreae Schweinf.	cedayto		2	32	6	3
Melilotus suaveolens Ledeb.	meclab		2	32	6	3
Indigofera oblongifolia Forssk.	xacanle baro-barbaré		1	32	3	6
Ruta chalepensis L.	sidaaba		1	32	3	6
Capparis cartilaginea Decne.	xaxaq laynota		1	32	3	6
Tarchonanthus camphoratus L.	galqaddo		1	32	3	6
Maerua triphylla A. Rich.	ruqaysi		1	32	3	6
Aristolochia bracteolata Lam.	suqsuuqi		1	32	3	6
Acacia seyal Delile.	qadgento		12	15	80	1
Ziziphus mauritiana L.	kusra	dysentery	2	15	13	2
Solanum somalense Franch.	garbaqaddoyta		1	15	7	3
Terminalia brownii Fresen.	wayboyta		95	105	90	1
Boscia coriacea Pax.	aytinaba		4	105	4	2
Balanites rotundifolia (Tiegh.) Blatt.	alayto	jaundice	2	105	2	4
Cymbopogon commutatus (Steud.) Stapf.	dambahu		1	105	1	5
Orthosiphon pallidus Royle ex Benth.	abursaafiqi		6	15	40	1
Balanites rotundifolia (Tiegh.) Blatt.	alayto		3	15	20	2
Terminalia brownii Fresen.	wayboyta	parasite	2	15	13	3
Buxus hildebrandtii Baill.	gaydarto		1	15	7	4
Ocimum basilicum L.	laynoyta		1	15	7	4

*****Ratios are rejected if Ip the number of informants that mentioned any plant for a particular disease is less than 15.

Table 3: Index of performance (IP2) of the plants from randa region within the microbial infection*

Local names	Scientific names	Disease name	Number of informants	C1	C2	C3	C4	P1	P2	D	IP 2
Xaxaq Laynoyta	*Capparis cartilaginea Decne.*	Dipheteria	1	1	2	32	920	0.50	0.03	0.47	2
Darmuusa	*Acalypha fruticosa* Forssk.	Dipheteria	2	0	24	32	920	0.08	0.03	0.05	3
Eqebto	*Acacia tortillis* (Forssk.) Hayne.	Dipheteria	3	3	8	32	920	0.38	0.03	0.34	2
Galqaddo	*Tarchonanthus camphoratus* L.	Dipheteria	1	1	1	32	920	1.00	0.03	0.97	1
Cedayto	*Grewia erythraea* Schweinf.	Dipheterie	2	2	14	32	920	0.14	0.03	0.11	3
Ruqaysi	*Maerua triphylla* A. Rich.	Diphteria	1	1	8	32	920	0.13	0.03	0.09	3
Sidaaba	*Ruta chalepensis* L.	Diphteria	1	1	27	32	920	0.04	0.03	0.00	3
Suqsuuqi	*Aristolochia bracteolata* Lam.	Diphteria	1	1	42	32	920	0.02	0.03	-0.01	0
Xacanle Baro-babaré	*Indigofera oblongifolia* Forssk.	Diphtheria	1	1	3	32	920	0.33	0.03	0.30	3
Malboyta	*Ochradenus baccatus* Delile.	Diphtheria	16	16	16	32	920	1.00	0.03	0.97	1
Meclab	*Melilotus suaveolens* Ledeb.	Diphtheria	2	0	6	32	920	0.33	0.03	0.30	3
Garbaqaddoyta	*Solanum somalense* Franch.	Dysentery	1	1	11	15	920	0.09	0.02	0.07	3
Kusra	*Ziziphus mauritiana* L.	Dysentery	2	7	20	15	920	0.10	0.02	0.08	3
Qadgento	*Acacia seyal* Delile.	Dysentery	12	12	16	15	920	0.75	0.02	0.73	1
Kusra	*Ziziphus mauritiana* L.	Eye infection	5	0	28	11	920	0.18	0.01	0.17	3
Data-amqada	*Heliotropium longiflorum* (A. DC.). Jaub and Sapch.	Infection	1	1	2	8	920	0.50	0.01	0.49	2
Gaydarceela	*Dodonaea angustifolia* L. f.	Infection	1	1	5	8	920	0.20	0.01	0.19	3
Kurbeyta	*Commiphora* erythraea (Ehrenb.) Engl.	Infection	1	1	8	8	920	0.13	0.01	0.12	3
Darmuusa	*Acalypha fruticosa* Forssk.	Infection	2	4	24	8	920	0.08	0.01	0.07	3
Dambahu	*Cymbopogon commutatus* (Steud.) and Stapf.	Jaundice	1	1	14	105	920	0.07	0.11	-0.04	0
Alayto	*Balanites rotundifolia* (Tiegh.) Blatt.	Jaundice	2	6	74	105	920	0.03	0.11	-0.09	0
Aytinaba	*Boscia coriacea* Pax.	Jaundice	4	4	10	105	920	0.40	0.11	0.29	3
Wayboyta	*Terminalia brownii* Fresen.	Jaundice	95	97	11	105	920	0.84	0.11	0.73	1

Alayto	*Balanites rotundifolia* (Tiegh.) Blatt.	Malaria	1	0	374	1	920	0.01	0.00	0.01	3
Abursaafiqi	*Orthosiphon pallidus* Royle ex Benth.	Parasite	6	6	16	15	920	0.38	0.02	0.36	2
Gaydarto	*Buxus hidelbrandtii* Baill.	Parasite	1	1	3	15	920	0.33	0.02	0.32	3
Laynota	*Ocimum basilicum* L.	Parasite	1	1	1	15	920	1.00	0.02	0.98	1
Alayto	*Balanites rotundifolia* (Tiegh.) Blatt.	Parasite	3	0	74	15	920	0.04	0.02	0.02	3
Wayboyta	*Terminalia brownii* Fresen.	Parasite	2	0	113	15	920	0.02	0.02	0.00	3
Meclab	*Melilotus suaveolens* Ledeb.	Polio	3	5	6	3	920	0.50	0.00	0.50	2
Qubaabulto	*Withania somnifera* (L.) Dunal.	Tuberculosis	1	1	10	4	920	0.10	0.00	0.10	3
Udda	*Balanites aegyptiaca* (L.) Delile.	Tuberculosis	2	2	7	4	920	0.29	0.00	0.28	3
Ayrobeya	*Indigofera articulata* Gouan.	Tuberculosis	1	1	9	4	920	0.11	0.00	0.11	3

*If D<0, IP2= 4: below average performance; if 0<D<0.33 IP2=3: average performance; 0.34<D<0.67 IP2 =2, high performance, If D>0.68 IP2 =1, very high performance.

Table 4: Important species in their rank order

Local name of disease	Disease category	Local name of plant	Scientific name	Rank		
				FL'	IP2	PR
Diphtheria	Microbial Infection	Malboyta	*Ochradenus baccatus* Delile.	1	1	1
		meclab	*Melilotus suaveolens* Ledeb.	ND*	3	3
		eqebto	*Acacia tortilis* (Forssk.) Hayne.	2	2	2
		darmussa	*Acalypha fruticosa* Forssk.	ND	3	3
		cedayto	*Grewia erythraea* Schweinf.	ND	3	3
		galqaddo	*Tarchonanthus camphoratus* L.	ND	1	ND
Dysentery	Microbial infection	Qadgento	*Acacia seyal* Delile.	1	1	1
		kusra	*Ziziphus mauritiana* L.	ND	3	2
		garbaqaddoyta	*Solanum somalense* Franch.	ND	3	3
Jaundice	Microbial infection	Wayboyta	*Terminalia brownii* Fresen.	1	1	1
		aytinaba	*Boscia coriacea* Pax.	2	3	2
Parasitic worms	Microbial infection	Wayboyta	*Terminalia brownii* Fresen.	ND	3	3
		abursaafiqi	*Orthosiphon pallidus* Royle ex Benth.	2	2	1
		alayto	*Balanites rotundifolia* (Tiegh.) Blatt.	3	3	2
Malaria	Microbial infection	Alayto	*Balanites rotundifolia* (Tiegh.) Blatt.	ND	3	ND
Tuberculosis	Microbial infection	Qubaabulta	*Withania somnifera* (L.) Dunal.	ND	3	ND
		udda	*Balanites aegyptiaca* (L.) Delile.	ND	3	ND
		ayrobeya	*Indigofera articulata* Gouan.	ND	3	ND
Other microbial infections	Other microbial infections	Kusra	*Ziziphus mauritiana* L.	1	3	ND
		darmussa	*Acalypha fruticosa* Forssk.	ND	3	ND
		gaydarceela	*Dodonea angustifolia* L. f.	ND	2	ND
		kurbeyta	*Commiphora* erythraea (Ehrenb.) Engl.	ND	3	ND
		Data-amqada	*Heliotropium longiflorum* (A. DC.) Jaub. and Spach.	ND	2	ND

*ND represents values that were out of the range.

Table 5: Comparison of information on medicinal plant species found in randa region, djibouti with the literature

Most cited species	Local name	Literature found in		
		Pharmacological	Traditional medicine	Number of citations
Acacia tortilis (Forssk.) Hayne.	eqebto	[15-22]	[15, 17, 18, 22]	8+4=12
Acacia seyal Delile.	qadgento	[23-25]	[23, 24, 26-28]	3+5=8
Terminalia brownie Fresen.	wayboyta	[29, 30]	[31, 30]	2+2=4
Ochradenus baccatus Delile.	malboyta	[32-34]	[35]	3+1=4
Boscia coriacea Pax.	aytinaba	[36]	[37-39]	1+3=4
Melilotus suaveolens Lebed.	meclab	[40]	[41-42]	1+2=3
*Balanites rotundifolia (*Tiegh.) Blatt.	alayto		[43-44]	0+2=2
Ziziphus mauritiana L.	kusra	[45-47, 43, 48]	[48-50, 44, 51-54]	5+8=13
Orthosiphon pallidus Royle ex Benth.	abursaafiqi	[55]	[55]	1+1
Acalypha fruticosa Forssk.	darmussa	[56-58]	[6,14,37,40,45,54,56, 66]	3+15=18
Grewia erythraea Schweinf.	cedayto	[66]	[66, 67]	1+2=3
Solanum somalense Franch.	Garbaaqaddoyta	[68]	[14, 68]	1+2=3
Withania somnifera (L.) Dunal.	Qubaabulto	[69-76]	[71, 72, 77-79]	8+5=13
Balanites aegyptiaca (L.) Delile.	udda	[80-89]	[62, 81, 82, 90-95]	10+10=20
Indigofera articulata Gouan.	ayrobeya			0
Dodonaea angustifolia L. f.	gaydarcela	[96-98]	[96, 99-103]	3+6=9
Heliotropium longiflorum (A. DC.) Jaub. and Spach.	data amqada		[104]	0+1=1
Comniphora erythraea (Ehrenb.) Engl.	kurbeyta	[79, 105, 106]	[79, 105]	3+2=5

CONCLUSION

By simple comparisons of the different factors (IP2, PR, and FL') of plant screening, 18 plants species were selected to be the most potent with good healing results. Most of these recorded plants in our study of Randa region of Djibouti were also used in other countries where traditional medicine still contributes to healthcare services. This indicates the medicinal potential of these plants and their ability to have curative properties. Few medicinal plants used in Djibouti as having antimicrobial properties were not found in the literature. The first selected plants to be further involved in scientific studies would be those which have not been tested before against bacteria. The list included: Meclab (*Melilotus suaveolens*), Alayto (*Balanites rotundifolia*), Abursaafiqi (*Orthosiphon pallidus*), Garbaqaddoyta (*Solanum somalense*), Ayrobeya (*Indigofera articulata*) and Data-amqada (*Heliotropium longiflorum*). Confirmation of the data by simple bioassay analysis and further on by isolation of the active principles could lead to templates to the synthesis of modern drugs.

CONFLICTS OF INTERESTS

Declared none

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