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Floral Diversity and Community Structure in Fifa Nature Reserve Abdullah Al-Oshoush*

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ABSTRACT

The vegetation cover at Fifa nature reserve was studied in the reserve during the period from January to April of 2019. It's aimed to updating floral species checklist and establishment of plant herbarium. During this study, random route transect method was used and interviews with the local community to determine plants uses in the region. In addition, specimen for all recorded plants were collected to prepare herbarium of the reserve. The results documented existing of 123 species that belonging to 29 families and 96 genera in the reserve. According to their status at the national level, this survey recorded four critically endangered (RC) plants and four Vulnerable species (VU) and six Endangered plants (EN). Asteraceae, Brassicaceae, Chenopodiaceae and Fabaceae families recording the highest number of individuals recorded. In addition, the vegetation components in the reserve is distributed on three strata, trees, shrubs and herbs. This variation of floral elements within such habitat of harsh environmental conditions, confirmed the healthy stand of vegetation cover at Fifa nature reserve and the priority to protect it.

Keywords: Flora; Fifa nature reserve; Ramsar site; Diversity; Ghor

Introduction

Jordan geology comprises three main features that are the Rift valley, the Mountain highlands and the eastern desert (locally known Badia) and considered as a milestone of the different ecosystems and environments [1]. In addition, the country has a wide variation of physical characteristics as altitude, with more than 1800 m above sea level in the Southern Mountain, to 424 m below sea level at Dead sea, which is the lowest point on Earth. Likewise, the temperatures and annual rainfall are highly variated in the country from region to another, created a gorgeous wildlife status as a reflection of its varied physical characteristics, which have yielded an unusual case of richness in landforms and biodiversity in terms of ecosystems and species.

Geographically, the strategical location at the crossroads of Africa, Asia and Europe has made Jordan as a linkage for enrich of natural resources where the Rift valley provides a globally critical land bridge between the three continents that supports a large variety of ecologically diverse habitats of international importance and funnels millions of migrating birds each year [2,3]. Furthermore, Jordan located in the extreme southwestern part of the Fertile Crescent, which is the center of diversity and botanic regions due to the presence of various climatic conditions that create different ecosystems [4]. As a result, Jordan encapsulates four bio-geographical regions: Mediterranean, Irano-Turanian, Saharo-Arabian and Sudanian (sub-tropical). Because of climatic and geographic variations among the biogeographical zones, the country comprises 13 vegetation types [1]. These distinguishing features of vegetation types and distribution among the country, contributes to record more than 2,500 plant species, which comprises 1% of flora of the world. Al-Eisawi records about 2,543 plant species that belongs to 142 families and 868 genera in Jordan [5].

As an effective tool of *In-situ* conservation, Jordan was a pioneer of establishing network of protected areas. The Royal Society for the Conservation of Nature (RSCN) had the governmental mandate to establish and manage the natural reserves to conserve the biodiversity components and insure sustainability of wildlife.

Fifa nature reserve was declared as a protected area in 2010 and was described as the lowest natural reserve on Earth.

The reserve established to protect both the sub-tropical and Saline vegetation basically, as well conserve all related species either flora or fauna. Since the reserve contains the best representation of Toothbrush tree (Salvadora persica), in addition to other indicator species as Acacia (Acacia tortilis and A. raddiana), Date Palm (Phoenix dactylifera), and Syrian Christ-thorn (Ziziphus spina-christi).

Moreover, Fifa nature reserve embedded within Fifa-Safi Important Bird Area (IBA) that identified by birdlife [6]. Also, different faunal species recorded in the reserve such as Spiny-tailed Lizards (Uromastyx aegyptia) which considered vulnerable species at the global level and mentioned as important indicator species in Fifa nature reserve [7,8]. In addition, Dead Sea Toothcarp fish (Aphanius richardsoni) described as globally endangered species that found in restricted springs as Fifa area [9]. Recently, Fifa nature reserve declared as "Ramsar site" in 2017, under Ramsar convention, which is a treaty of an intergovernmental importance that provides base of responsible use of wetlands resources, as well, support the conservation framework of such sites worldwide.

As other protected areas in Jordan, Fifa nature reserve is under different harmful threats that causing losses of wildlife components. These deteriorated factors are derived by either ecological- or human-induced factors. The ecological factor is represented by existing of invasive plants (Prosopis juliflora), whereas human-induced factors including expansion of agricultural land and using pesticide, chemical fertilizer as well ground water pumping. In addition, other human activities as illegal hunting, overgrazing, and Army activities which leading to habitat destruction and fragmentation as well, losses of wild species either flora or fauna.

Vegetation cover at Fifa nature reserve has been studies by RSCN flora team in different years, as a priority to prepare the management plan of the site. First survey was implemented in 2009 through an ecological rapid assessment, where the results recorded only 19 plant species belonging to 17 families, with five medicinal, one ornamental, six edible, five woody and five palatable plants.

The next survey has been implemented in 2011, total of 80 species were recorded during the survey that belonging to 60 genera and 30 families, with 46 palatable, 13 medicinal, six woody, five edible and three poisonous plants. In addition, the last updated of plant checklist was in 2014 with recording about 94 plant species within the reserve. All surveys that have been conducted in the reserve resulted with preparing a plant checklist, but not any distinctive survey was implemented to assess the actual status of flora in the reserve. Such information will be very valuable in term of its importance as a Ramsar site -as mentioned before-, as well as, preparing long term monitoring programs for ecologically indicator species that are of local and global importance for conservation purposes.

Materials and Methods

Physical description

Fifa nature reserve is located at the southwestern part of Jordan within Karaka governate with smaller portion on the southeastern part within Tafilla governate. It is about 33.5 km South-Southeast of the Dead Sea and about 157 km North of Aqaba city, and form the international border of Jordan with occupied Palestine (Figure 1). The reserve characterized with being at the lowest elevation on Earth at 424 m below sea level. It is characterized by warm winter with a minimum average temperature of 10°C and hot summer with a maximum average temperature of 40°C, which is the hottest degree recorded in the country. The annual average precipitation is between 50 ml-100 ml, which is the lowest records in Jordan.

Vegetation cover description

Fifa nature reserve located within the Sudanian (sub-tropical) bio-geographical zone, which characterized with lowest annual rainfall recorded in Jordan and highest summer temperatures recorded also. Soils are mostly alluvial, saline, sandy and granitic types. The vegetation is with tropical element of small trees and shrubs as (Zizphus spinachristi) and annual herbs. There are two vegetation types dominating the reserve including:

Saline vegetation

It is in the north and southwestern part of the reserve with around 78% of the total area and characterized by high level of soil salinity that appears as distributed patches of light and dark color on soil surface. Dominant plants are Halophytes and succulent's species as Tamarix tetragyna, T. aphylla, and Suaeda monica.

Tropical vegetation

It is restricted in the southeastern part with about 22% of the reserve total area. The soil present with this vegetation is alluvial with a light color and deficient of organic matter [1]. The leading plant species are Salvadora persica, Calotropis procera and Zizphus spina-christi, and Ochradenus baccatus (Figure 1).



Figure 1: Location of Fifa nature reserve on Jordan's map.

Random route transect

The random route transect method was chosen, to cover the total area of the reserve –as far as possible- since it is a suitable method of recording plants in this open habitat. To cover whole reserve area, five transects were chosen to cover tropical vegetation, and three route transects to cover saline vegetation. The transects were carried out during 22^{nd} Feb to 15^{th} March.

All plants that founded while walking randomly in the route transect were recorded on the Data sheet. A representative specimen was collected so it can be added later to the final checklist after been identified. Furthermore, any threats or human activities within the reserve were recorded. Because almost all the reserve is located in the buffer of international border, and thus the security issue is very strict (Figure 2).



Figure 2: Layout of transects methodology of the survey.

Plant specimens collections

Representative specimens for all recorded plants in the checklist were taken at time of survey (vegetative, flowering, or fruiting). The team collaborates to collect, identify, and preserve each specimen. Each sample was pressed and dried to preparing reserve herbarium purposes.

During specimen's collection, all information was documented greatly facilitated by the GPS unit, which uses satellite signals to calculate current geographical coordinates and altitude (Figure 3).



Figure 3: Plants samples pressed to preparing Herbarium.

Interviews

Interviews with local communities adopted for documentation the botanical knowledge of Fifa village, since traditional farmers have ancient experience of species to be used for medicinal purposes. A total of 90 questionnaires have been used to collect data from local communities. Collected data was analyzed. Sample of used questionnaire is listed in Appendix 1.

Results

Species checklist

The following table is showing the total number of flora in Fifa nature reserve with total number of 123 species that belonging to 29 families and 96 genera (Table 1). According to Royal Botanical Garden (RBG) [10], the current list of Fifa nature in term of plant status at the national level includes four critically endangered plants that are Anthemis zoharyana, Launaea procumbens, Medicago ciliaris and Asphodelus refractus. In addition, four vulnerable species were recorded including Haloxylon persicum, Suaeda monoica, Acacia raddiana, and Acacia tortilis. In addition to six endangered plants Picris asplenioides, Atriplex holocarpa, Equisetum ramosissimum, Monsonia nivea, Calligonum comosum and Salvadora persica. Its worthy to mention that majority of listed plants are classified as Least Concerned (LC), whereas some species hadn't enough information about their status and thus classified as Not Applicable (NA).

From other hand, the current results recorded plant species that have been thought to be lost from the area as Horse Tail (Equisetum ramosissimum).

Vegetation families

The results show that 29 plant families were recorded. As shown in Figure 4, there are three categories of families recorded in this survey. i) Category A: Three and less species with about 18 family, ii) Category B: Between four and eight families with seven records, and iii) Category C: More than nine species with four records that are Asteracaeae, Brassicaceae, Chenopodiaceae, Fabaceae descendingly (Figure 4).



Figure 4: Distribution of individuals in each family.

	Scientific name		Arabic Name	Synonum	Status*
	Aizoaceae				
1		Aizoon canariense L	قدح		LC
	Amaranthaceae				
2		Aerva javanica (Burm.f.) Juss. ex Schult.	ةجعنلا ةر جش	Aerva persica	LC
	Asclepiadaceae				
3		Calotropis procera (Aiton) Aiton f.	ريشعلا		LC
4		Leptadenia pyro- technica (Forssk.) Decne.	نابسيس	Cynanchum pyro- technicum	LC
	Asteraceae				
5		Aaronsohnia facto- rovsyi Warb et Eig	عرقا ناوحقا		LC
6		Anthemis zoharyana Eig	ناوحقا		CR
7		Centaurea sinaica DC.	يئانيس رارم		LC
8		Ifloga spicata (Forssk.) Sch.Bip.	يلبنس فطرق	Chrysocoma spicata	LC
9		Koelpinia linearis Pall.	ةبالك	Koelpinia latifolia	LC
10		Launaea angus- tifolia (Desf.) O. Kuntze	رارم	Launaea arabica	LC
11		Launaea procum- bens (Roxb.) Ra- mayya & Rajagopal		Ammoseris patens	CR
12		Launaea capitata (Spreng.) Dandy	ينبل رارم	Sonchus capitatus	LC
13		Launaea mucronata (Forssk.) Muschl.	رارم	Leontodon mucro- natus	LC
14		Launaea nudicaulis (L.) Hook.f	دامحلا ءابدنه	Ammoseris nudi- caulis	LC

15		Leontodon lacini- atus (Bertol.) Wid- der	يوارحص نايبر	Leontodon arabicum	LC
16		Picris asplenioides L.	ناذوح	Picris radicata	EN
17		Senecio leucanthe- mifolius Poir		Senecio apulus	LC
18		Senecio vernalis Hoppe ex DC	هريفص	Senecio leucan- themifolius supsp. vernalis	LC
	Boraginaceae				
19		Arnebia decumbens (Vent.) Coss. and Kralik	عجضم لحك		LC
20		Arnebia linearifolia DC	قاروألا قيض لحك		LC
21		Gastrocotyle hispida (Forssk.) Bunge	سمن	Anchusa deflexa	LC
22		Heliotropium bac- ciferum Forssk.	ديبل	Heliotropium bac- ciferum var. erosum	LC
23		Lappula spinocar- pos (Forssk.) Asch. ex Kuntze	ر امثلا ةكناش ةليفن	Anchusa spinocar- pos	LC
24		Trichodesma ehren- bergii Boiss.			
	Brassicaceae				
25		Brassica nigra (L.) W.D.J.Koch	دوساً لدر خ		LC
26		Diplotaxis acris (Forssk.) Boiss.	ةرقم		LC
27		Diplotaxis harra (Forssk.) Boiss.	مقارح	Sinapis harra	LC
28		Eremobium aegyp- tiacum (Spreng.) Asch. and Schweinf. ex Boiss.	مَسْيِبغ		LC
29		Eruca sativa Mill.	ريجرج		LC
30		Erucaria rostrata (Boiss.) Greuter and Burdet	ءارغ	Erucaria boveana	LC
31		Farsetia aegyptia Turra	ءاربغلا ةرجشلا	Farsetia aegyptia var. aegyptia	LC
32		Lobularia libyca (Viv.) Webb and Berthel.		Alyssum canariense	LC
33		Matthiola parviflora (Schousb.) R.Br	ريشق روثنم تالتبلا	Matthiola parviflora	LC
34		Morettia parviflora Boiss.		Morettia canescens var. parviflora	LC
35		Morettia philaeana DC.		Diceratella saha- riana	LC
36		Plantago weldenii Rchb.			
37		Savignya parviflora (Delile) Webb		Savignya parviflora	NA
38		Schimpera arabica Hochst. and Steud.	يرافص	Schimpera arabica var. arabica	LC

	Capparaceae				
39		Cleome arabica L	شحو لا ةر جش	Cleome trinervia	LC
	Caryophyllaceae				
40		Gymnocarpos sclerocephalus (Decne.) Dahlgren and Thulin		Paronychia sclero- cephala	LC
41		pergularia marina (L.) Besser	بيرث مأ	Spergularia salin	
42		Polycarpon suc- culentum (Delile) J.Gay		Alsine succulenta	
43		Polycarpon tet- raphyllum subsp. alsinifolium (Biv.) Arcang		Polycarpon alsini- folium	
44		Polypogon adscen- dens Guss.		Polypogon adscen- sionis	
45		Pulicaria crispa Sch. Bip.	ثاجثج	Pulicaria undulata	LC
46		Silene villosa Forssk.	ةلحك		
47		Telephium sphaero- spermum Boiss.			
	Chenopodiaceae				
48		Anabasis articulata (Forssk.) Moq	مرجع		LC
49		Anabasis syriaca Iljin			LC
50		Arthrocnemum macrostachyum (Moric.) K.Koch	نانثعلا		LC
51		Atriplex holocarpa F.Muell.			EN
52		Atriplex halimus L	يحلم فطق		LC
53		Atriplex leucoclada Boiss	عورفلا ضيبأ لغر		LC
54		Bassia muricata (L.) Asch.	ةيربالا ءايللا		LC
55		Chenopodium album L.	بلكلا بنذ		LC
56		Chenopodium murale L.	مارمر		LC
57		Haloxylon persi- cum Bunge	اضغلا	Anabasis saxaul	VU
58		Suaeda aegyptiaca (Hasselq.) Zohary		Chenopodium aegyptiacum	LC
59		Suaeda monoica Forssk. ex J.F.Gmel.	ةداوسلا	Lerchia monoica	VU
60		Traganum nudatum Delile	نارمض	Traganum nudatum var. acuminatum	LC
	Cucurbitaceae				
61		Citrullus colocyn- this (L.) Schrad.	لظنحلا		LC
	Equisetaceae				

62		Equisetum ramosis- simum Desf.	سرفلا بنذ	Equisetum gigan- teum	EN
	Fabaceae				
63		Acacia raddiana Savi	يعاعش حلط	Acacia tortilis subsp. raddiana	VU
64		Acacia tortilis (Forssk.) Hayne	رمس		VU
65		Alhagi graecorum Boiss	لوقاع		LC
66		Astragalus tribuloi- des Delile			LC
67		Hippocrepis areo- lata Desv.		Hippocrepis bicon- torta	LC
68		Lotus halophilus Boiss. and Spruner			LC
69		Medicago ciliaris (L.) Krock.		Medicago intertexta subsp. Ciliaris	CR
70		Medicago laciniata (L.) Mill.	لفن	Medicago laciniata subsp. laciniata	LC
71		Medicago littoralis Loisel.		Medicago littoralis subsp. cylindracea	LC
72		Polycarpaea rob- bairea (Kuntze) Greuter and Burdet		Robbairea delileana	
73		Prosopis farcta (Banks & Sol.) J.F.Macbr		Lagonychium farctum	LC
74		Prosopis juliflora (Sw.) DC.	ماسلا	Mimosa farcta	INVASIVE
75		Pteranthus dichoto- mus Forssk.	ةموسب	Camphorosma pteranthus	LC
76		Trigonella stellata Forssk.	ةيلمخم ةبلح		LC
	Frankeniaceae				
77		Frankenia pulveru- lenta L.	ةر محلا	Franca nodiflora	LC
	Geraniaceae				
78		var. pulverulentum (Cav.) Boiss.	ةمسقم ةونرق	Erodium bovei	
79		Erodium touchya- num Delile		Erodium deserti	LC
80		Monsonia nivea (Decne.) Webb		Erodium niveum	EN
	Juncaceae				
81	Liliaaaa	Juncus rigidus Desf.		Juncus arabicus	LC
82		Allium papillare Boiss			
83		Androcymbium palaestinum Baker	ةليصب		LC
84		Asphodelus refrac- tus Boiss			CR
85		Dipcadi erythraeum Webb and Berth.			LC
	Malvaceae				

86		Abutilon pannosum (Forst.f.) Schltdl	قاول		
87		Malva nicaeensis All.	ةزيبخ	Althaea nicaeensis	LC
88		Malva parviflora L.	ةز يبخ	Malva parviflora var. parviflora	LC
	Neuradaceae				
89		Neurada procum- bens L.		Figaraea aegyptiaca	NA
90	Plantaginaceae	Plantago cylindrica Forssk.	يناوطسأ لبر		NA
91		Plantago ovata Forssk.	يوضيب لبر		NA
	Poaceae				
92		Aeluropus littoralis (Gouan) Parl			LC
93		Hemarthria al- tissima (Poir.) Stapf and C.E.Hubb.		Andropogon altissi- mus	
94		Phragmites australis (Cav.) Trin. ex Steud.	بيصق	Phragmites australis var. altissimus	LC
95		Schismus barbatus (L.) Thell.	ةميعن	Schismus barbatus subsp. arabicus	LC
96		Stipagrostis plu- mosa Munro ex T.Anderson		Stipagrostis plu- mose var. aethiopica	LC
	Polygonaceae				
97		Calligonum como- sum L'Her.	هطرع		EN
98		Emex spinosa (L.) Campd.	ناذبحلا	Rumex spinosa	LC
99		Rumex cyprius Murb.	ضيمح	Acetosa cypria	NA
100		Salsola imbricata Forssk		Caroxylon geatulum	LC
101		Salsola vermiculata L.	اثور	Salsola vermiculata var. brevifolia	LC
	Resedaceae				
102		Ochradenus bac- catus Delile	ردنلعلا		LC
103		Oligomeris subulata "Webb,"		Oligomeris subulata	
104		Reseda arabica Boiss.		Reseda praetervisa	LC
105		Retama raetam (Forssk.) Webb	مترلا	Retama raetam	LC
	Rhamnaceae				
106		Ziziphus spina- christi (L.) Desf.	ر دسلا	Rhamnus spina- christi	LC
	Salvadoraceae				
107		Salvadora persica L.	كارألا	Salvadora persica var. persica	EN
	Scrophulariaceae				

108		Linaria joppensis Bornm.			
109		Linaria haelava Delile	ةو الح	Antirrhinum haelava	NA
110		Veronica anagallis- aquatica L.		Veronica anagallidi- formis	LC
	Solanaceae				
111		Hyoscyamus de- sertorum (Asch. & Boiss.) Täckh	ناركس	Hyoscyamus albus var. desertorum	LC
112		Lycium depressum Stocks	جسوع	Lycium turcomani- cum	LC
113		Lycium shawii Roem. and Schult.	جسوع	Lycium albiflorum	LC
	Tamaricaceae				
114		Tamarix aphylla (L.) H.Karst.	ةيلصفم ءافرط	Tamarix aphylla	LC
115		Tamarix tetragyna Ehrenb.	لثا	Tamarix tetragyna var. deserti	LC
	Urticaceae				
116		Forsskaolea tenacis- sima L.		Caidbeja adhaerens	LC
	Zygophyllaceae				
117		Fagonia bruguieri DC.		Fagonia bruguieri var. ehrenbergii	LC
118		Fagonia glutinosa Delile		Fagonia glutinosa var. chevalieri	LC
119		Fagonia scabra Forssk.		Fagonia sinaica	
120		Nitraria retusa (Forssk.) Asch.	دقرغلا	Berberis africana	LC
121		Tetraena simplex (L.) Beier and Thulin		Zygophyllum simplex	
122		Tribulus bimucrona- tus Viv.			NA
123		Tribulus pentandrus Forssk.		Tribulus longipeta- lus	

Table 1: List of recorded plant species in Fifa nature reserve

Vegetation strata

The current survey confirmed the diversity pattern of vegetation cover in Fifa nature reserve, including three strata that are trees, shrubs, and herbaceous of both annuals and perennials (Figure 5). Its worthy to mention that every stratum includes number of species of high conservation status as found in table 1 above.



Figure 5: Structure of vegetation strata of Fifa nature reserve.

Medicinal uses of plants

In this survey, 17 plant species belonging to 14 families have been used to treat different diseases in the South Ghor area (including Safi and Fifa). It can be notice that just four species that used for medicinal uses by local communities are plants from sub-tropical region species and found in the nature, whereas the other 13 plants are introduced either from other parts of Jordan or outside the country and both of them are cultivated unfortunately.

The results of plant medicinal uses showed sharp decline in local knowledge and use of natural species in traditional medicine. Nevertheless, this social heritage of plant uses still essential source of medicinal knowledge nowadays [11-14].

Description of vegetation cover

The number of recorded plants in the current survey is higher than all previous prepared lists that mentioned before. Recording distinctive number of plants in habitat of harsh environmental conditions mainly corroborates the importance of vegetation cover as essential pillar in ecological issue of the reserve. Furthermore, one of the most important outcomes of this survey that 13% of recorded plants are of important status at the regional level especially from woody species (This value comprises percentage of 14 out of 105 species that are evaluated). Such ecological features of Fifa nature reserve confirmed its value as shelter of different floral and faunal species of global and national importance, as well as, its unique importance as lowest reserve on Earth and lowest Ramsar site. RSCN (2014b) reported that Fifa Nature Reserve holds the largest population of Nubian Nightjar (Caprimulgus nubicus) in Jordan and in the region, as well Dead Sea Sparrow (Passer moabiticus) population has healthy representative in Fifa area, since appropriate habitats of Tamarisk (Tamarix spp.) are existed.

From other hand, obvious variation of vegetation layers at Fifa nature reserve is represented obviously. Figure 5 shows structure of vegetation strata, where herbaceous layer is dominating either with annuals or perennials species with 85 species, whereas shrubs were 29 plant and 8 trees. It is noticeable that major of shrub and tree strata are of halophytes such as Nitraria retusa, Juncus rigidus and Alhagi graecorum shrubs and Ziziphus spina-christi and Tamarix spp. trees. Also, number of these plants are of important conservation status as Salvadora persica as a tree, Calligonum comosum as a shrub, and Anthemis zoharyana as an herb. Meanwhile, Fifa nature Reserve encompasses 29 plant families that all recorded species belong to, or about 55% of these plants are belonging to 25 families otherwise. This distinctive structure of vegetation cover can provide wide variation of suitable habitats for different faunal species especially birds. Fifa-Safi Important Bird Area (IBA) is one of the 391 sites identified for their importance for birds in the Middle East, where it has been previously identified as Important Bird Area because it is an important stop over site for migratory birds.

Its worthy to mention that vegetation community map in Fifa nature reserve didn't change mainly through last years, since last vegetation communities map of the reserve was prepared in late of 2014 as shown in Annex 3.

Plant uses

This survey must ring the alarm of loss Jordanian knowledge about uses of natural plants in medicine. Many plants are widely used by local communities, since many of which are a source of robust medicine against several chronic diseases. Many reports have mentioned the traditional use of medicinal plants as an effective therapy against many ailments worldwide [15].

Conclusion

The results concluded that the local knowledge about plant species used in folk medicine in the southern Jordan valley area is lost gradually. During the study, 17 plant species with medical use were registered through 90 questionnaires that were filled from the population in the region, which shows a sharp decline in the use of this type of medicine especially in young people. Nevertheless, it can be concluded that plants of Fifa nature reserve are held great promise to be a source of different medicines, where it is hoped that ethno-medicinal studies (ethnobotany) will be implemented on medicinal plants in the area through academia and specialized medical centers.

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