IMPORTANT MEDICINAL PLANTS – SUDAN

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Contents

Summary

Medicinal plants have in use for centuries to cure diseases and ill conditions of people and their livestock. In spite of their importance in traditional and folklore medicine, there is no comprehensive review focusing on the major plants. The use of medicinal plants has been evolving and ramifying through generations in societies around the world. People are currently using plants for treatment as a natural process of empirical

lore of traditional medicine, i.e. based on experience and response. This article illustrates the use of 196 medicinal plants, belonging to 61 families, in the traditional herbal healthcare in the Sudan. Medicinal plants are classified in categories based on information from books and published ethnobotanical articles. The common types of medicinal uses that range from respiratory, abdominal etc. along with associated plants were presented. About 33 medicinal plants with special position in the Sudanese culture are presented with their botanical, chemical and pharmacological properties. Factors and challenges facing the existence of medicinal plants and traditional healing culture in Sudan were discussed. Also, strategies for improving and management the handling and use of medicinal plants are suggested.

1. Introduction

Medicinal plants were originally exploited by early humans for fuel, clothing, shelter and food. However, during plant evolutionary adaptive processes since time immemorial, human beings must have become aware of plants properties as fundamental entities for survival and health. The empirical lore in the use of plants for health extends far back in human history akin to plant adaptation and human-plant interaction through generations. In this process, people explored their indigenous flora for therapeutic and health purposes. The progressive exploration of plants culminated in isolation of vital compounds of specific action for certain diseases as evidenced in recent centuries and today. Thus, medicinal plants were established to refer to diverse plants characterized by medicinal properties. Medicinal plants are widespread and their use in traditional medicine is a significant cultural trait where the number of species used accounts for around ten up to fifty-three thousands plants. The functionality of these centered on plant phytochemicals components essential for plant survival, physiological activity and interaction with the environment. Plants produce their components by primary or secondary metabolic processes, yielding primary and secondary metabolites. Secondary metabolite components are typically diverse composite mixtures like alkaloids, flavonoids, essential oils and resins with directed mechanisms of actions. A benefit of their medicinal use, unlike pharmacological preparations, is the collective mechanisms of the substances act synergistically, resulting in an overall effectiveness. On another perspective, the enormity and variability in the chemical structure of secondary metabolites are apparently acting as vehicles for interaction with the environment. This is exemplified by development of features necessary for defense against parasites and predators, or as in some plant pollination processes that involve adaptations necessary for attraction of pollinators. A characteristic of medicinal plants is that they contain diverse potentially therapeutic elements but, most significantly, a number of these elements can accumulate in a single plant. In this respect, ingredients stimulating digestion for example could coexist with others like anti-inflammatory, antioxidants, antibacterial, antifungal, venotonic, diuretic, or psychoactive compounds. In view of this feature, it is tempting to consider the advantage of using whole extract instead of singly isolated refined phytochemicals that are currently in medical use. Accordingly, the use of crude and/or standardized extracts is gaining momentum in the scientific community.

Traditional medicine use ranks high among the world population, especially among rural communities where it is estimated at 75–90%. In Africa, the World Health

Organization (WHO) estimated that 80% of the population favors traditional medicine plants. The significant tendency to the use of traditional medicine in developing countries is attributed to cultural backgrounds and shortages in modern health services. The practice of traditional medicine in Sudan dates to ancient times. The country harbors diverse flora of 3137 documented species classified into 170 families and 1280 genera of which 15 % are endemic, featured over a wide spectrum of terrains and climatic zones. Notably, a significant number of these contributed largely in healthcare services in the country. Despite its role, traditional medicine falls far below world standard level of safety and efficacy.

Sudan is potentially poised to be an important source of natural products, especially that there is an increasing interest in the search for such products and plant-based drugs. Moreover, this will be supported by the diversity of plants and the rich traditional knowledge regarding their use as medicine. The natural vegetation is the major source of medicinal plants, but documentation is limited given the wide spectrum of diversity across flora and communities and noting that some species are endangered due to environmental changes and human overuse. Consequently, it is imperative to speed up documentation to facilitate conservation and sustainable utilization. Moreover, the capacity of pharmaceutical industries is to be augmented by propping up ethnobotanical research.

2. The Sudan

The Republic of Sudan spans over an area encompassed by latitudes 10° and 22° N and longitudes 22° and 38° E. It is bordered by the Red Sea at the east, with a coast line of about 750 km, extending from 18° N at the Eritrean border to 22° N at the Egyptian border. The population is estimated for 2020 at 43.75 million inhabiting a total area of 1,886,068 square kilometers. Life is dominantly rural with 11% being nomads and 60% rural settlers and most of the population lives close to or around the Nile River. Sudan accommodates more than 597 tribes communicating in more than 400 dialects and languages. Ethnically, these tribes include 39% who claim an Arab descent, 30% of African descent, 12% are Bejja, 15% are Nubian and 4% others. Faith somewhat overshadows ethnicity as dominance is for Islam among the population strata with few Christians and other believers. Regarding medium of communication, 51% of the population speaks Arabic whereas 49% speak other languages and dialects.

2.1. Geographic Profile and Soil Types

With its Basement rocks of the African continent, Sudan is characterized by a flat surface, while the Basement is being covered centrally and northward by the formation of the Nubian Sandstone. Southward there is Umm Ruwaba formation and in the eastern part of the country appears the long range of Red Sea Mountains as projections by virtue of its geographical location, and the soil can be categorized into the following:

1. West Nile basin sandy soils termed “goaz”.
2. Central and Eastern states and Nuba mountains heavy clay soil.
3. The Southern states with their red iron rich laterite soil.
4. The nutrient rich volcanic soil of Jebel Marrah.

In addition to these major classes of soil in Sudan, there is considerable contribution by alluvial deposits along the Nile, the delta of Gash and seasonal streams or "wadis" throughout the country.

2.2. Climatic Profile

Sudan climate stretches across a range of arid to savannah zones. On the desert side, annual rainfall extends between 0 – 100 mm whereas on the savannah zone it is between 200 – 850 mm. The average temperature is governed by latitude but does not vary greatly across the country, being in the range of 26°C and 42°C excluding high lands where it is cooler at 22.6° C in Nierteti in Jebel Marra in the west, and 22.8° C in Erkowit in the Red Sea Mountains.

2.3. Ecological Zones

Extending through different climatic and geographical zones, Sudan ecological zones supports diverse types of medicinal plants. Accordingly, Harrison and Jackson (1958), described these zones as:

1. Desert zone:

In this zone, there is utter scarcity of vegetation except for occasional herbs and some grasses (gizzue grazing) rising along watercourses formed by scarce precipitation.

2. Semi-desert zone:

This part is characterized by sparse vegetation composed of different mixtures of grasses and herbs. It may also be littered with some bushes and woody vegetation.

3. Woodland Savannah zone:

The main determinants of vegetation in this zone are soil and amount of precipitation but, generally, vegetation include trees beside varied bushes and grasses. Accordingly, this zone comprises vegetation in two subdivisions: drier and wetter parts woodland Savannah.

i. The drier part comprises small thorny trees, the dominant being *Acacia* spp. This part extends across most of Central Sudan.
ii. The wetter part displays dominantly trees described as deciduous with broad leaves. According to soil in this part, there are two main divisions; low rainfall savannah on clay and low rainfall savannah on sand but there are also additional separate zone specifications that include; Flood region which comprise swamp, intermediate and highland; and Montane region which includes two main mountainous areas, the Red Sea in the East and Jebel Marra in the West. Vegetation in these regions differs from the surrounding by virtue of altitude and amount of rainfall.

3. Traditional Medicine in Sudan

Medicinal plants are at the core of primary healthcare for humans and their livestock in Sudan as in many developing countries. This comes at the backdrop of inadequate

health services as well as traditional faith of communities in traditional medicine, especially rural communities. It was estimated that only 11 % of the population get access to formal healthcare where basic pharmaceuticals are unaffordable. As previously mentioned for cultural traits associated with traditional medicine, Sudan has its uniqueness relevant to traditional concoction bringing factors like spiritual, physical, and psychological together. In line with this is the exchange of traditional medicine experience with Africa, Middle East and Asia, which is facilitated by the geographical position of Sudan at a crossroads.

3.1. Medicinal Plants in Urban Communities

Medicinal plants are widely used in Sudan with some differences between urban and rural populations. Urban populations are getting more inclined to plant medicines due to growing awareness about side effects of pharmaceutical drugs and their cost. Other than culinary ingredients highlighting women's domain in this respect, medicinal plants are favored as home remedies for minor and common conditions. The type of plants used in this case is of herbs, spices and food plants. These are over-the-kitchen shelf preparations that often come into rescue at home. Common plants at hand for some ailments include Fenugreek (*Trigonellla foenum–gracem*), arghel (*Solennostemma argel*), or mint (*Mentha spicata*) for stomachache and commonly administered as an infusion. Flatulence is another condition managed at home using aniseed (*Pimpinella anisum*) and karawia (*Carum carvil*). More on digestive problems are constipation and diarrhea which are treated with calyx of roselle (*Hibiscus sabdariffa*) and baobab fruit pulp (*Adansonia digitata*) respectively. Of the parasitic diseases, malaria is treated with Godaim (*Grewia tenax*) whereas infections causing flue and cough are controlled by garad (*Acacia nilotica*), calyx of roselle and baobab fruit pulp as well as clove (*Syzygium aromaticum*). Moreover, in any ailment with headache symptom, the treatment recipe will include inhalation of crushed black cumin (*Nigella sativa*) for the relief of that. Medicinal plant use extends to chronic and metabolic conditions. For rheumatism, a mixture of black cumin and sesame oil are applied as massage. For diabetes, the aromatic spice cinnamon (*Cinnamomum zeylanicum*) is used for its sugar lowering effect. As for hypertension, people are getting more inclined to use plant recipes with or without pharmaceutical drugs. Plants used as anti-hypertensive include garlic, Laloub (*Balanites aegyptiaca*) and the desert palm fruit (*Hyphaene thebaica*).

Herbal preparations are procured by users from the so called 'Attarin' shops which are repositories and outlets where sellers and healers dispense and advise on usage. One series of these shops has a long history and goes by the name of "Altaiman" family (Figure 1). The sources of herbs here is wild plants stretching along different locations in Sudan, some are imported from India, Ethiopia and Egypt. Regarding usage, customers trust the sellers about herbs and their curative qualities. Moreover, there are healers in big cities whom people resort to for complicated health cases. Treatment protocols are usually executed by healers, at affordable prices, at their homes as they do not have defined treatment locations though some healers may have official permission for practice of traditional healthcare.

(a) **(b)**

Figure 1. (a) Altaiman shops in Omdurman Market; (b) Attarin shop in Nyala market.(Photographs by Sakina Yagi)

3.2. Medicinal Plants in Rural Communities

Traditional herbal healthcare is the major and in some cases the sole option for treatment, given the inadequate health system in rural areas. By virtue of being raised in countryside, rural people are well familiar to the ecology of their locations and medicinal plants. The usage of medicinal plants is underlain by traditional knowledge, linguistic and cultural background. Similar to urban communities, rural people procure herbs from traditional markets where herbal products are sorted and displayed on carpets on the ground (Figure 2). The healers selling herbs are well aware of the quality of their plants based on their knowledge and belief that harvest at specific time is crucial to the level of therapeutic effect of the plant. Furthermore, treatment protocols are not confined to herbs as therapy may involves a ceremonial part including rituals and religious acts to complement the treatment.

Figure 2. Healers selling herbs in Elobeid Market, Western Sudan. (Photographs by Mr. Yahya S. Mohamed, MAPTMRI, National Centre for Research)

3.3. Traditional Knowledge

Traditional healers in most African countries, including Sudan, have neither scholastic achievements in medicinal plants classification nor formal pharmacopoeia knowledge at any level. Instead, men and women healers are furnished with traditional knowledge *viva voce* in which case information is passed privately to posterity through generations. In a move to enlighten healers, the Medicinal and Aromatic Plants and Traditional Medicine Research Institute (MAPTMRI) in Sudan organizes training sessions and workshops blending ethno-herbal medical knowledge and pharmacology. Nonetheless, traditional healers in general, particularly in rural areas are complacent with their practice among their communities without formal or legal recognitions. Interestingly, the practice of traditional healing is shrouded by some secrecy lest the potency of the plants drops if is administered otherwise as believed by healers and accepted by their community.

4. Classification and Categorization of Sudan's Medicinal Plants

The classification is facilitated by a valuable and comprehensive reference, Atlas for Medicinal Plants of the Sudan, published by MAPTMRI. The Atlas is a compilation of books through many years documenting medicinal, aromatic and poisonous plants in Sudan. Included in this Atlas are the following books:

i. Medicinal plants of Erkowit.
ii. Medicinal plants of Eastern Nuba Mountains.
iii. Medicinal plants of the White Nile provinces.
iv. Medicinal plants of Northern Kordofan.
v. The medicinal plants commonly used in Khartoum State (in Arabic).
vi. Medicinal plants of Ingassana area.
vii. Aromatic plants of the Sudan.
viii. Poisonous plants of the Sudan.

For clearer presentation of medicinal plants and their use, Tables 1 to17 were constructed based on information from the above books supplemented by studies on medicinal plants presented in ethnobotanical articles on Sudan. Ailments are categorized system-wise and plants are matched to corresponding conditions based on traditional practice and handling of cases. A summary of these categories is described below and plants with most popular use are highlighted.

4.1. Respiratory System Diseases

Common respiratory conditions in Sudan include tuberculosis, cough, flu, asthma, upper respiratory infections, tonsillitis, throat infections and pneumonia (Table 1). Most people are inclined to resort to medicinal plants as their first means of combating these ailments. The commonly used plants belong to 36 genera and 26 families, with high representation in Leguminosae (eight species), Capparaceae (four species), Combretaceae, Euphorbiaceae and Malvaceae (three for each family). For treatment, there are twenty-one plants used to sooth cough, flu, and cold and the most prized plant for these is *Acacia nilotica*. Its therapeutic effect is believed to come from inhaling the smoke of pods burned in an incense burner. Additionally, a small part of the pod is

sucked and left overnight in the mouth or under the tongue. Moreover, to ward off a cold, the calyx of roselle (*Hibiscus sabdariffa,* Karkadeh) is prepared as a hot drink, and similarly used is the fruit pulp of *Adansonia digitata* (baobab). Asthma in traditional treatment is somewhat different where the leaves of *Calotropis procera* are prepared as a potion in animal oil for oral administration to the patient. Traditional medicinal plant for treating pneumonia is *Acacia mellifera*, and that for tonsillitis is *Xeromphis nilotica* whereas *Abutilon figarianum* is reserved for throat infections. Of the diseases one that is rampant in impoverished regions of Sudan is tuberculosis. For the treatment of this disease, three plants are used: the stem of *Cissus quadrangularis*, the leaves of *Balanites aegyptiaca* and *Agrimonia eupatoria* used as a whole plant.

Plant	Family	Vernacular name	Part used	Treated Disease
Abutilon figarianum Webb	Malvaceae	Tagtaga	Leaf	Throat infections.
Acacia etbaica Schweinf.,	Leguminosae	Garad	Fruit	Cough
Acacia mellifera (Vahl) Benth.	Leguminosae	Kittir	Stem bark	Pneumonia
Acacia nilotica (L.) Delile	Leguminosae	Garad	Fruit	Cold and flu; Pharyngitis
Acacia sieberiana DC.	Leguminosae	Kook	Stem bark	Cough
Adansonia digitata L.	Malvaceae	Tabaldi /fruit; gongolaise	Fruit	Cold and flu
Agrimonia eupatoria L.,	Rosaceae	Shokran	Whole plant	Tuberculosis
Albizzia amara (Roxb.) Boiv.	Leguminosae	Arad	Leaf	Chest pain
Anogeissus leiocarpus (DC.) Guill. & Perr.	Combretaceae	Sahab	Bark	Cold
Balanites aegyptiaca (L.) Delile.	Balanitaceae	Laloub/Shashut	Leaf	Tuberculosis
Bauhinia rufescens Lam.	Leguminosae	El Bigiel	Bark	Cough
Boscia salicifolia Oliv.	Capparidaceae	Tella	Stem bark	Malaria
Boscia senegalensis (Pers.) Lam.	Capparidaceae	Mukheit	Fruit/leaf	Tuberculosis, Cold
Boswellia papyrifera (Caill. ex Delile) Hochst.	Burseraceae	Tarag tarag Resin luban mur	Resin Bark	Respiratory infection
Brassica nigra (L.) K.Koch	Brassicaceae	Kardal	Fruit	Cold, Respiratory infection
Cadaba farinosa Forssk.	Capparaceae	Surreh, El Sarha	Whole plant	Tonsilities
Calotropis procera (Ait) Ait.f.	Apocynaceae	Ushar	Leaf	Anti-asthmatic
Cissus quadrangularis L.	Vitaceae	Sala sala	Stem	Asthma, Tuberculosis.
Croton zambesicus Muell.Arg.	Euphorbiaceae	Umm Gleila	Fruit	Cold

Dicoma tomentosa Cass.	Asteraceae	Um showaika, Um shoak, Um sinaina	Whole plant	mumps
Euphorbia candelabrum Tremaux ex Kotschy	Euphorbiaceae	Zagoum	Stem	Tuberculosis
Euphorbia hirta L.,	Euphorbiaceae	Ataib	Whole plant	Asthma
Fagonia cretica L.	Zygophyllaceae	Umm showeika, Sholib, Umm Shok	Whole plant	Heart burn
Forsskaolea tenacissima L.	Urticaceae	Halak Anabaik/ lussaig	Leaf	Asthma
Geigeria alata Benth. & Hook.f. ex Oliv. & Hiern.	Asteraceae	Gadad	Whole plant	Cold
Grewia tenax (Forssk.) Fiori	Malvaceae	Gudaim	Root	Throat infection, Tonsilities
Hibiscus sabdariffa L.	Malvaceae	Karkady	Calyx	Cold and flu
Hydnora johannis Becc. (Syn. *H. abyssinica* A.Br.)	Hydnoraceae	Dumbo dumbo/ Tartous	Rhizome	Tonsilities
Indigofera hirsuta L.	Leguminosae	Serbel	Root	Asthma
Khaya senegalensis (Desr.) A. Juss.	Meliaceae	Mahougany	Bark	Asthma
Maerua angolensis DC.	Capparaceae	Gemwa	Stem	Cough
Nauclea latifolia Sm.	Rubiaceae	Karmadoda	Stem bark, Fruit	Cold and flu
Ozoroa insignis Delile	Anacardiaceae	Tugul	Root	Pharyngitis
Phoenix dactylifera L.	Arecaceae	Nakheel	Fruit	Tonsillitis, Tuberculosis
Pimpinella anisum L.	Apiaceae	Yansoon	Fruit	Cough and flu, Tuberculosis
Psidium guajava L.	Myrtaceae	Gwava	Leaf	Tuberculosis, Cough
Salvadora persica L.	Salvadoraceae	Araak	Fruit	Cough
Sesamum indicum L.	Pedaliaceae	Simsim	Seed	Cough and flu
Solenostemma argel (Delile) Hayne	Apocynaceae	Hargal	Leaf	Cough
Stereospermum kunthianum Cham.	Bignoniaceae	Khash kash abiad	Root	Tonsillitis
Tamarindus indica L.	Leguminosae,	Aradaib	Fruit pulp	Cold and flu
Terminalia brownii Fresen.	Combretaceae	Shagarat el sobagh Darout; Subaraya	Bark	Cough
Terminalia laxiflora Engl. & Diels	Combretaceae	Darout	Bark	Cough

Xeromphis nilotica (Stap.f.) Keay.	Rubiaceae	Shagarat elmurfaein	Aerial part	Tonsillitis

Table 1. Medicinal Plants for Treatment of Respiratory System Diseases.

4.2. Blood System Disorders

Traditional knowledge in Sudan includes awareness about conditions involving the circulatory system. For such ailments, there are thirty three plants classified under 27 genera and 21 families with more species in the families Leguminosae and Malvaceae (Table 2). Hypertension is one of the disorders well known to people, and though some may have the possibility to get clinical treatment yet they may not follow the prescribed medicine for long. They believe that natural products are safer and cheaper, so they seek medicinal plants. For the treatment of hypertension and hypotension, *Hibiscus sabdariffa* is the most commonly used plant among fifteen others. When *Hibiscus sabdariffa* calyx is macerated for 2-3 hours and taken as a cold drink is effective for treatment of hypertension whereas a hot drink infusion is good for hypotension. Also for hypertension there is the fruit pulp of *Balanites aegyptiaca*, *Guiera senegalensis* leaves and roots and *Nauclea latifolia* fruit. Another blood disorder is hemophilia which is a rare disease but runs in some families and is characterized by bleeding for the slightest injury. For bleeding problems *Datura stramonium* leaves serve as the ingredient for healing a potion. A similar potion is also prepared using *Acacia seyal* stem bark. Anemia is rampant in rural areas of Sudan and many other African countries due to endemic diseases and malnutrition. Through their traditional experience and knowledge of their environment, people in Sudan resorted to plants to fight anemia. Among six plants used for anemia, *Grewia tenax* was realized to be the most nutritious and effective in relieving the condition. For treatment, the fruit of *Grewia tenax* is softened by soaking, maceration straining and sweetening with sugar to make a revitalizing drink offered to patients. A number of studies indicated the hematinic effect of *Grewia tenax* by virtue of a remarkable content of iron in the fruit.

Plant	**Family**	**Vernacular name**	**Part used**	**Treated Disease**
Acacia nilotica (L.) Delile	Leguminosae	Garad	Fruit	Hypertension
Acacia polyacantha Willd.	Leguminosae	Kakamoat	Stem bark	Haemorrage
Acacia seyal Delile	Leguminosae	Talih	Stem bark	Bleeding
Aristolochia bracteolata Lam.	Aristolochiaceae	Umm galagl/ Yahemyay	Leaf	Hypertension
Balanites aegyptiaca (L.) Delile	Zygophyllaceae	Laloub	Fruit pulp	Hypertension
Bauhinia reticulata DC.	Leguminosae	Khroob	Fruit	Hypertension
Blepharis linariifolia Pers.	Acanthaceae	Bagail	Aerial part	Hypertension
Boswellia papyrifera (Caill. ex Delile) Hochst.,	Burseraceae	Tarag tarag	Bark	Anaemia
Cissus quadrangularis L.	Vitaceae	Sala sala	Root	Hemorrhoid
Corchorus depressus (L.) Stocks	Malvaceae	Hayaoyanyet	Leaf	Anaemia

Coriandrum sativum L.	Apiaceae	Kasspara	Fruit	Hypertension
Cymbopogon schoenanthus (L.) Spreng	Poaceae	Mahraib	Aerial part	Gout
Dalbergia melanoxylon Guill. & Perr.	Fabacae	Babanous/ Abanous	Leaf	Heart pain
Datura stramonium L.	Solanaceae	Datura/ Shokaleeb	Leaf	Hemophilia, Bleeding
Geigeria alata Benth. & Hook.f. ex Oliv. & Hiern.	Asteraceae	Gadad	Aerial part	Hypertension
Grewia flavescens Juss.	Malvaceae	Hilo/khakasan	Fruit	Anaemia
Grewia tenax (Forssk.) Fiori.	Malvaceae	Gudaim/Moat	Fruit	Anaemia
Grewia villosa Willd.	Malvaceae	Gargadan	Fruit	Anaemia
Guiera senegalensis J.F.Gmel.	Combretaceae	Gubaish	Leaf/root	Hypertension
Hibiscus sabdariffa L.	Malvaceae	Karkady	Calyx	Hypertension Haemorrhoids
Hyphaene thebaica (L.) Mart.	Arecaceae	Dom	Fruit	Hypertension
Kigelia africana (Lam.) Benth.	Bignoniaceae	Um shotoor	Fruit	Hypertension
Lavandula coronopifolia Poir.	Lamiaceae	Sedam	Whole plant	Bleeding
Maerua pseudopetalosa (Gilg & Gilg-Ben.) DeWolf	Capparaceae	Kurdala	Root	Hypertension
Moringa oleifera Lam.	Moringaceae	Moringa, Rawag	Leaf	Anaemia
Nauclea latifolia Sm.	Rubiaceae	Karmadoda	Fruit	Hypertension
Nigella sativa L.	Ranunculaceae	Kamoon aswad	Seed	Hypertension
Oxalis anthelmintica A.Rich.	Oxalidaceae	Homaid	Whole plant	Anaemia
Senna occidentalis (L.) Link	Leguminosae	Soreib	Seed	Hypertension
Sterculia setigera Delile.	Sterculiaceae	Tartar	Stem bark	Hypertension/ Haemorrage
Strychnos spinosa Lam.	Loganiaceae	Umm bekhesa	Fruit	Hypertension
Vangueria madagascariensis J.F.Gmel.	Rubiaceae	Kir kir	Fruit	Hypertension

Table 2. Medicinal Plants for Treatment of Blood System Disorders.

4.3. Digestive System Disorders

Digestive problems are rampant in Sudan but irrespective of the underlying cause, the first line of treatment for common digestive disorders is usually medicinal plants. This is in addition to instructions by healers regarding food and daily life activities. The number of plants for alleviation of symptoms of digestive system diseases is 136 medicinal plants classified under 125 genera and 44 families (Table 3). The highest

number of species belong Leguminosae (23 species). Lesser number of species are found under Malvaceae, Cucurbitaceae, Capparaceae, Combretaceae and Lamiaceae with five species under each. Plants are differentiated to target digestive conditions. The repertoire includes 26 plants for jaundice beside those for other ailments where 31 plants target stomach ache, 17 plants are a stock for diarrhea in addition to fewer ones for ulcer, acid reflex and constipation. Though healers advise on the use of plants, some of these became a sort of household items that people turn to immediately as in the case of diarrhea. Diarrhea is managed by *Adansonia digitata* macerated fruit pulp or the roots of *Hydnora johannis*, the latter being well known in western and eastern parts of Sudan where it is used as a decoction. Similarly, people are well aware of the laxative effect of *Senna alexandrina* pods which are usually taken for constipation. It is pertinent to mention that the plants used for diarrhea have high concentrations of tannins that are known for their astringency which alters the permeability of intestinal mucous membranes thereby limiting influx of water into the intestinal tract resulting in control of loose stool. Such a mechanism also results in antimicrobial activity and neutralization of toxins produced by microorganism which are causative agents of diarrhea. Moreover, a probe into the activity of *Senna alexandrina* revealed that the laxative effect is mediated through sennosoides A and B which are diathrone sennosides (hydroxyanthracene glycosides), being the active cathartic ingredients of the plant. Other common digestive disorder are flatulence and stomach ache that people would not worry much about as they have knowledge of *Mentha spicata* from which an infusion of the leaves is given to patients. Interestingly, the use of plants in treatment may reflect regional difference in approach as in the case of managing digestive order in western Sudan. Here, *Guiera senegalensis* as one-for-all where an infusion from roots or leaves is administered to treat digestive conditions including whether stomachache, diarrhea, acid reflux or jaundice. Additionally, jaundice is managed by the stem bark of *Hyphaene thebaica* given as an infusion. Notably, *Hyphaene thebaica* use targeting jaundice gave positive results in clinical trials conducted by MAPTMI in collaboration with Khartoum hospital, indicating the efficacy of ingredients within the plant stem bark.

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Biographical Sketches

Sakina M.A. Yagi completed her undergraduate degree at the Faculty of Science, Khartoum University in 1982. She completed her doctorate in Botany at Khartoum University in 1998. She spent a short postdoctoral period in 1999 at the Institute of Biomedicine at Bonn University, Germany. She completed another doctorate degree in phytochemistry in 2011 at Nancy University, France. She was awarded The Palme Académique Française (order of Chevalier) by the government of France in 2013. Currently, she is a full professor at the Department of Botany, Faculty of Science, University of Khartoum, Sudan. Her research interests include ethnobotany, phytochemistry and biological activities of medicinal plants. She published 65 articles in peer-reviewed journals. Hirsch (h)-factor: 19; total number of citations: 1238 (according to Google Scholar). Recent publications include papers in *Journal of Food Biochemistry*. (2019), *Biodiversitas* (2020), *South African Journal of Botany* (2020), *Microorganisms* (2020) and Process Biochemistry (2020).

Ahmed I. Yagi completed his undergraduate degree at the College of Veterinary Science, Khartoum University in 1973. He practiced veterinary medicine in the field then started research at the Central Veterinary Research Lab in Khartoum. He proceeded to complete his doctorate in pathology at Khartoum University in 1985. He completed another doctorate degree in cell biology in 1995 at Turku University, Finland. He spent a short postdoctoral period in 1995 at the Institute of Biomedicine at Turku University; the project was investigation on molecular receptors and histopathology of prostate and breast cancer. He worked at the Institute of Dental Material in 1996, University of Turku. Then he moved to the Department of Biochemistry, Oulu University, Finland (1996 – 2001). There he worked on molecular biology and electron microscopy, investigating subcellular changes in disease settings related to genetic mutation and protein targeting. He took the opportunity to join the University of Sharjah, UAE (2006-2007), where he surveyed diabetes for a short period. He was offered a position at Nizwa University, Oman, and moved there (2006-2016). Working at Nizwa University, he was involved in a project for surveying medicinal plants used in Salalah region in Oman. The project was not completed due to shortage of funding. He joined Khawarizmi International College, Department of Medical Lab Analysis, UAE (2016 – to date). He is currently collaborating with Professor Sakina Yagi on investigation of medicinal plants in Sudan and co-authored some publications with her.