Integrated Health Research Journal (IHRJ)

The Official Journal of the College of Health and Allied Sciences University of Cape Coast, Ghana

COMMENTARY

Documentation of medicinal plants of The Sudan, methods applied and future prospects

Gamal E.B. El Ghazali[1]*

[1] Medicinal and Aromatic Plants and traditional Medicine Research Institute, National Centre for Research, Khartoum, Sudan

*Correspondence should be addressed to Gamal E.B. El Ghazali (email: gamalelghazali@gmail.com)

Citation: El Ghazali G. E.B. (2026) Documentation of medicinal plants of The Sudan, methods applied and future prospects. Integrated Health Research Journal 3(1-Supp), 1-4. https://doi.org/10.47963/ihrj.v3i(1-Supp).2216
Received 16th April, 2026; **Accepted** 24th April, 2026; **Published** 1st June, 2026.

In an attempt to establish a national work plan or program for studying medicinal plants and their therapeutic uses, it is primarily important to identify and document all available information in the field. Documentation of medicinal plants is considered crucial in preserving the loss of orally transmitted indigenous cultural heritage, identifying new therapeutic compounds for further pharmacological studies, securing the intellectual property rights for local communities, and facilitating conservation processes to overwhelm overexploitation through sustainable utilization.

Sudan is located in northeast Africa, bordered by seven countries and has a substantial coastline along the Red Sea. It is bounded by Egypt to the north, the Red Sea to the northeast, Eritrea and Ethiopia to the east, South Sudan to the South, Central African Republic to the southwest, and Chad to the west and Libya to the Northwest. Such a location places the country at the intersection of sub-Saharan Africa, Middle East and stretches across the Red Sea.

The vegetation of the country follows a north-south moisture gradient and an east-west elevation gradient [1]. The north-south gradient, shifting from arid desert, semi-arid, Sahelian shrublands and further into Sudanian Wooded Savanna. These vegetation belts extend across most West African countries. The east-west gradient, transitioning from the Ethiopian Highlands towards the Nile.

Sudan with such characteristic location, diverse vegetation, climatic conditions and different ethnic communities retain a unique blend of indigenous cultures with East and West African, Arabian and Egyptian cultures. As a result, The Sudan harbours a high diversity of medicinal plants that will continue to play an important role in the health sector by providing natural sources for traditional remedies and modern pharmaceuticals.

Documentation of medicinal plants in The Sudan started early in the 19th century by "Wellcome Tropical Research Laboratories Reports (1906-1911)", followed by "Wellcome Chemical Laboratories Reports (1964-1960)" and Broun and Massey [2] working with the flora of The Sudan. Since then, great efforts were done to document the wealth of the country in the field of medicinal plants in a systematic way to cover all parts of The Sudan.

"Atlas of Medicinal Plants of The Sudan", is a project fostered by Medicinal and Aromatic Plants Research Institute, National Center for Research, Khartoum, Sudan. It is a long-term project proposed in 1972 with the establishment of the "Medicinal and Aromatic Herbs Research Unit, Medical Research Council, National Council for Research". The project was designed to document primary information on the medicinal plants and their folkloric uses in the different Regions/States of The Sudan. Medicinal plants of each Region/ State will be published in a separate part. In the last phase of the project, all published parts will encompass the "Atlas of Medicinal Plants of The Sudan". It was planned that this Atlas will follow recent scientific approaches in applying up-to-date Latin botanical names using the international online databases e.g. "International Plant Names Index" – IPNI (https://www.ipni.org) and "Plants of the World Online" – POWO (https://powo.science.kew.org). Habit and habitat of each plant, local/ vernacular names and

line illustrations are also included to attract a wide array of users. To permanently preserve the plants claimed to possess therapeutic activities, samples from all parts of the plants should be pressed, dried, mounted in sheets and deposited at the herbarium of the Institute in the form of voucher specimens. These specimens must be accompanied by detailed data including the collector's name, specific geographical location, date of collection and habitat information. The informants recruited in the semi-structured questionnaires should also be identified and included in subsequent publications and patents to prevent misappropriations of their intellectual property rights.

In over fifty years, wide areas of the country were surveyed including Erkowit (Red Sea State) [3], Eastern Nuba Mountains (South Kordofan State) [4], White Nile State [5], Northern Kordofan [6], Khartoum State [7], Ingassana (Blue Nile State) [8], Red Sea State [9], River Nile State 10, and Northern State [11,12].

At present, medicinal plants of Gezira State are understudy and will follow the same methodology applied in the previous parts of the "Atlas". An initial pilot surveys were already done to gather preliminary data and to establish base-line information for further field work. Literature surveys were conducted as well on geography, demography and flora of the State. Lists of the herbalists who will participate in the ethnobotanical studies involving interviews and questionnaires with local community were also prepared. Unfortunately, the process of the project was suspended by the present civil war in the country.

Besides the areas covered by the "Atlas of Medicinal Plants of The Sudan", a considerable number of researches were reported to document the medicinal plants of different regions of The Sudan. These regions include: West Kordofan [13], South Kordofan [14], Darfur [15], Fangoga area (Sennar State) [16].

Both wild native plants and exotic plants play an important role in herbal remedies and were put in consideration in the documentation of the medicinal plants of The Sudan. Wild plants are non-cultivated plants growing in natural habitats, contributing to biodiversity and ecological interactions, and are progressively threatened by climatic changes and habitat loss. Exotic plants on the other hand are alien, non-native highly valued plants introduced intentionally and mainly utilized for cultural purposes, food and agriculture, and as ornamental landscaping [17].

Exotic medicinal plants play an important role in the traditional primary healthcare, to treat different human and animal ailments alongside with wild species and to the management of their health. The use of exotic medicinal plants as an alternative source of medicinal remedies could alleviate harvesting pressure of wild indigenous plants thereby enhancing biodiversity [18]. In addition, although there is strong belief among indigenous population that wild plants have more effective therapeutic benefits, these exotic plants fill the gaps not met by wild plants, diversify the local repertoire of medicinal plants of the area [19], and address modern health challenges [20].

The use of exotic plants in traditional medicine by indigenous population is well accepted among local communities in many African countries e.g. Angola [21], Ghana [22], Ethiopia [23], Kenya [24], South Africa [18]. It is worth mentioning that the use of exotic plants accumulated wide acceptance in some communities in Angola (Songo City) and the majority of medicinal plants used as indigenous remedies are exotic (71 %) compared to native plants (29 %) [21].

In the Sudan, wild and exotic herbal medicines are widely used for treating and managing ailments by rural and urban populations with different frequencies. In Khartoum State, the capital city, accommodating urban population, exotic species represent about (67 %) of the total species claimed to possess therapeutic properties [7], whereas in Northern State, wild species represent (55 %) of the total species reputed to acquire therapeutic potentials [11,12], highlighting that urban inhabitants rely mostly on exotic species.

Members of the families Fabaceae (Leguminosae), Asteraceae, Euphorbiacae, Capparaceae and Cucurbitaceae, constitute major sources of indigenous remedies in Sudan. Although The Sudan has no formal pharmacopoeia, a number of wild plants were recorded in International "Herbal Pharmacopoeia". These plants include: *Abrus precatorius* L., *Boscia integrifolia* J.St.-Hil., *Calotropis procera* (Aiton) W.T. Aiton, *Citrullus colcynthis* (L.) Schrad, *Ricinus communis* L., *Senegalis senegal* (L.) Briton, *Senna alexandrina* Mill., *Tamarindus indica* L., *Terminalia leiocarpa* (DC.) Baill. and *Vachellia nilotica* (L.) P.J.H. Hurter & Mabb. In the absence of formal pharmacopoeia, traditional herbal practitioners rely mainly on indigenous knowledge, and various curative methods of preparation, administrative routs, specialized techniques (cutting, stripping/ scraping, uprooting, etc.) of therapeutic recipes are applied. These practitioners claim to be able to cure a wide range of conditions including: abdominal colic, arthritis, diabetes, diarrhea, dysentery, epilepsy, gallstones, hemorrhoids, jaundice, leprosy and nephritis. In a systematic bibliographic investigation on the medicinal plants of The Sudan [25], analyzing numerous publications covering diverse sources, websites and research engines, Sudanese medicinal plants have been documented to exert anticancer, antimicrobial, protozoal, insecticidal, molluscicidal, toxicological, physiological and pharmacological activities.

Various parts of the plant are used in the preparation of herbal remedies including whole plants, leaves, roots/ tubers/rhizomes, bark, seeds, flowers and fruits. Medicinal properties derived from plants can also come from specialized exudates. These exudates are plant derived natural bioactive compounds discharged externally to

their surfaces by specialized cells in different plant parts. They are categorized into resins, gums, mucilage and sap based on their physico-chemical characteristics. The main benefit of harvesting plant exudates is that the gathering is safe and can be utilized over the lifespan of the plant. Over-collection and harvesting of roots or whole plants in the preparation of herbal remedies presents great threat to viability of the plant and ecosystem, and will provoke unsustainable development of plant-based products. These potential threats could be addressed by cultivation, sustainable foraging, community engagement and the use of exotic plant to alleviate harvesting pressure on wild indigenous plants.

In The Sudan, numerous barriers are faced in utilizing and effective dissemination of indigenous knowledge due to certain traditional beliefs. This knowledge is regarded as family heritage or legacy and should be transferred only from fathers to sons. Others considered this knowledge as top confidential or tricks of the trade and worry if revealed it will lose its activities and become ineffective in remedies. Due to such attitudes, herbalism is recognized as a "stingy profession" by a wide array of ethnobotanical personals. They are encouraged to unveil their knowledge by referring to our affiliation to a "National Research Institute" and these knowledge if found genuine their intellectual property rights will be secured.

The present study showed that The Sudan is highly bio diverse and rich in ethnobotanical heritage and that herbal remedies, utilizing both wild and exotic plants, are widely used in different rural and urban populations with different frequencies. Documentation of such diverse medicinal plants is crucial in health sector by providing natural sources for traditional remedies and in identifying potential plants to be addressed for future investigations for novel bioactive compounds.

It is urgent to document the indigenous knowledge of all States/Provinces of the country before being perished by urbanization/ modernization and conservative strategies should be put forwards for sustainable harvesting. Future investigations should be carried out on all potential sources to provide quality standards by studying their phytochemistry, pharmacology, microscopic and macroscopic features, potential side effects, drug interactions, etc., and ultimately to adopt the long waiting "Sudanese Herbal Pharmacopoeia".

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