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Ethnomedicine and ethnobotany of *Maerua subcordata* (Gilg) DeWolf

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Abstract

Background: Wild edible plants are valuable resources for improving food and nutritional security. Besides, they may provide important health benefits since the health-promoting components of plant-based foods usually exist at higher levels in wild plants. As a result, they are being sought as under-exploited potential sources of a health-promoting diet or a possible strategy to develop novel foods. In such exploration, ethnobotanical and ethnomedicinal data offer a fundamental step. The present study provides ethnomedicinal data on *Maerua subcordata* (Gilg) DeWolf (Capparidaceae).

Methods: The ethnomedicinal data was collected from the Kunama ethnics of northern Ethiopia via focus group discussion and oral interview. Supporting ethnobotanical data from relevant literature was also compiled and systematically reviewed.

Results: The results show that *M. subcordata* tuber is used by the Kunamas to manage malaria, malaria symptoms (fever, pain, gastrointestinal disorders), and seasonal cough while leaves are used for wound healing. In east Africa, its triple potential use as water purifying agent, food item, and herbal medicine was specified. As a herbal medicine, the tuber is used to manage a wide range of disorders including pain, infections, wounds, diabetes, blood pressure, and loss of appetite. Its use as laxative and abortifacient was also indicated. Leaves are used to treat wounds and ophthalmic and respiratory problems. As a food item, fruits are eaten during times of both food scarcity and food abundance while the tuber is used as a famine food.

Conclusion: In East Africa, *M. subcordata* represents a wild food and medicinal plant, which may be developed into a functional food.

Keywords: Ethnobotany, Ethnomedicine, Kunamas, *Maerua subcordata*, Wild edible plants

Introduction

Ethnicity refers to shared cultural practices, perceptions, and distinctions that differentiate one group of people from another. The most common distinctive features of several ethnic groups include heritage, a sense of history, language, religion, and dressing norms. Ethnic differences are not inherited; they are learned [1, 2]. The underlying truth of ethnicity is that it is a product of self and group identity that is formed in extrinsic/intrinsic contexts and social interaction. It is not equal to culture but it is in part the symbolic representation of an individual or a group that is produced, reproduced, and transformed over time. Likewise, an ethnic group refers to a group of people who are set apart from others on the basis of their perceptions of cultural diversity and/or common heritage [1]. In the present study, the Kunama ethnic group was approached to collect ethnobotanical data. The Kunama ethnic group consist of Nilotic people living in Eritrea and Tigray regional state of Ethiopia. They live in remote and isolated areas both in Eritrea and Ethiopia. They are rich in medicinal plant species and the associated indigenous knowledge and are well known for treating human and livestock diseases using herbal medicines In Tigray, the Kunamas live in two main districts near the border with Eritrea [3]. They represent a minority ethnic community with a distinctive language, culture, and tradition including ethnic custom–based food preparations and traditional healthcare practices.

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Among others, food is a powerful ethnic and cultural signifier of a given society. Food not only is a nutritional and physiological necessity but also has cultural and symbolic meaning. Multiethnic societies appreciate their food diversity and flag it as a marker of inclusiveness [4]. Some traditional foods are claimed to represent an extraordinary food heritage of certain ethnic groups [5] while others have widespread use among different cultures and countries [6].

Besides their nutritional attributes, many ethnic and traditional foods from plants are thought to contribute to the health and wellbeing of humans. For example, the emergence of diet-related non-communicable diseases has been linked, at least partly, to dietary changes from traditional diets to "westernized" diets implying that encouraging ethnic foods can help to promote human health and wellbeing. Equally, the traditional African diet was largely plant-based, containing different grain cereals, mainly millet and sorghum; leafy vegetables; fruits; legumes; starchy stems; and root tubers. However, the general pattern seems to be shifting towards a more "westernized" diet at the expense of traditional diets and common staples. Such changes in diets are related to a rise in chronic diet-related non-communicable diseases, which many developing countries are already experiencing [7]. Indeed, the Mediterranean diet has long been promoted for its health benefits, especially in the prevention of chronic diseases [8].

Nowadays, the crucial health attribute of traditional foods is well recognized. While advances in the understanding of the relationship between nutrition and health have led to the concept of functional foods, the advent of non-communicable diseases tempted the shift from conventional medicines to functional foods [9]. Indeed, early human inhabitants were dependent mainly on plants and plant parts to satisfy their hunger. Many medicinal plants known today constitute our major part of food, and the majority of them are loaded with ingredients of nutritional and medicinal values. Consequently, the healthy food concept has been evolved, maintained, and transferred over hundreds of generations. Today, it is well established that phytochemicals (chemicals from food and medicinal plants) have a wide range of pharmacological applications. Most of these phytochemicals have the properties of preventing and curing various diseases [10]. In this regard, wild edible plants are given special emphasis owing to their high content of nutritional and bioactive ingredients compared to domesticated counterparts. Thus, domestication of wild species seems to be a promising approach for exploiting them as new functional foods [11]. The present report is in line with such scientific notion which attempts to describe the potential food and medicinal applications of wild edible plants based on their traditional/ethnic uses.

Plants are irreplaceable food resources for humans and virtually all human foods are plants or organisms that eat plants [12]. Ethnobotany is the study of the interrelations of man and plants [13] while ethnomedicine is especially concerned with the cultural interpretations of health and disease, which also addresses the traditional health care–seeking process and healing practices [14, 15]. In traditional medicines, mainly wild gathered food plants are often reported in different ethnic societies of local and popular traditions to have pharmacologic activities and are often associated with beneficial effects [13, 16]. Wild food plants refer to all plant resources outside of agricultural areas that are harvested or collected from the wild for the purpose of human consumption [13].

Wild edible plants (WEPs) represent a category of foods that are virtually unexplored and usually consumed in times of famine and scarcity, have neglected role as foodstuffs for regular intake during times of sufficiency, and are often categorized as emergency or famine foods [17–19]. WEPs, though underutilized, are still consumed by different societies and are gaining keen scientific interest owing to their nutritional and medicinal values that may broaden the diversity of the human diet and the connection between food and health [11, 19, 20]. WEPs remain an ignored facet of food supply, which may improve food security and promote health since many of them possess rich nutritional composition and higher levels of health-promoting components [9, 17, 18, 21, 22]. Thus, it was suggested that some of these "neglected" species, sometimes considered as weeds in extensive major crop cultivation, may potentially become "new functional crops" [11].

WEPs are an integral part of the cultural and genetic heritage of different regions of the world [19]. Chiefly, indigenous dwellers in the rain forests of Africa and South America utilize WEPs as a food source, who gather and consume WEPs as snacks and at times of food scarcity. Likewise, the rural populations in Ethiopia have a rich knowledge of WEPs and consumption of such plants is still an integral part of the diverse cultures in the country [18]. Many WEPs in Africa are highly adapted to harsh growing conditions and are available when other sources of food fail or are out of season. They are often rich in macro and micro nutrients and health-promoting components. They may provide vital options to promote food security and wellness owing to their availability and affordability, higher nutritional values, and health-promoting properties [23, 24]. However, the current research and agricultural development agenda, especially in Africa, still appear to focus on the popular and commonly used food crops, ignoring these important WEPs [23]. Thus, despite their high biodiversity, rural populations in developing countries often face

food insecurity and malnutrition [25, 26]. WEPs may contribute a great role in meeting global attention on addressing malnutrition in all its forms: undernutrition, including micronutrient deficiencies; overweight; and obesity [27]. Indeed, epidemiological and clinical studies advocate the use of plant-based diets, including WEPs, as a viable option for the treatment and prevention of overweight and obesity [28].

Typical examples of health-promoting components that have been reported to have reduced levels in cultivated crops while higher levels in wild counterparts include glucosinolates (GLs) [29, 30]. Also, despite their potential health benefits, GLs impart poor palatability to the plants containing them and are thought to be responsible for some nutrient-rich wild crops to remain wild. Likewise, certain species in the Capparidaceae/Capparaceae (the caper family) that are adapted to harsh dry climate including *Boscia*, *Cadaba*, *Crateva*, and *Maerua*, which form part of a long and deep food tradition in some Sahara regions and which may afford nutritious food, have remained wild as they contain bitter tasting GLs [31]. Such plants may play a vital role in improving food security and promoting health. Plants of the caper family are tropical relatives of the Cruciferae of temperate regions [32], both families being characterized by GLs [33–35]. The caper family is a tropical and subtropical family, which is well represented by woody species in Africa [36] plus a high number of wild edible [37] and medicinal [38] species in Ethiopia. The genus *Maerua* comprises about 80 species distributed in the tropical and subtropical areas confined to shrubby savanna and semi-desert regions [36], embracing species of trees or shrubs bearing edible, larger fleshy fruits [39]. *Maerua subcordata* (Gilg) DeWolf, a wild food and medicinal plant with a large tuber adapted to low-input agriculture and occurring in the dry parts of East Africa, belongs to the caper family [36]. Therefore, considering the above viewpoints, the present work attempts to provide data on the ethnomedicinal claims of *M. subcordata* by the Kunamas of Northern Ethiopia along with relevant literature claims elsewhere supporting its further scientific investigation tailored to reveal its potential utilization as a functional food and/or alternative herbal remedy.

Methodology

Description of the study area

Data was collected in Tahitay Adiyabo district, northwest of Tigray, Northern Ethiopia, from the Kunama communities who are Nilotic people living in Ethiopia and Eritrea. In Tigray, the Kunamas form a minor ethnic community who live in the Kafta Humera and Tahitay Adiyabo districts near the border with Eritrea. They are well known for treating human and livestock ailments using herbal medicine and live in remote and isolated areas. In the Tahitay Adiyabo district where data was collected, the Kunamas mainly reside in two sub-districts called Lemlem and Shemblina.

Ethical statement

The ethical aspects of the study were reviewed and received an expedited ethical approval (ERC 1046/2017) by the Health Research Ethics Review Committee of the College of Health Sciences, Mekelle University.

Ethnomedicinal data collection and plant authentication

Focus group discussions (FGDs) and oral interviews were used to collect ethnomedicinal knowledge and practice by the Kunamas about the study plant locally called "Ashkulebya." The FGDs included mainly traditional healers of both men and women, few local guides, and translators that formed a total of twelve to fifteen individuals. To arrange the FGD, ethnic representatives were first approached who described us that the Kunamas in the Tahitay Adiyabo district mainly reside in two sub-districts (Lemlem and Shemblina) and helped us to arrange FGDs in the two sub-districts during the weekend in places where the local people discuss their social issues. Volunteer participants were selected by peer recommendations, and oral consent was obtained from each participant before starting the FGD. Interviews were made with selected traditional healers to further enrich the information obtained from the FGD. A plant specimen was collected for authentication from Lemlem sub-district, pressed on a paper, and then taken to the National Herbarium at Addis Ababa University, Addis Ababa, Ethiopia, where it was authenticated as *Maerua subcordata* (Gilg) De Wolf (Capparidaceae) and a specimen (Voucher number MG001/2007) was deposited.

Literature review

Data on ethnomedicinal use by the Kunama community was collected referring to its local name, "Ashkulebya." To retrieve further data on this plant, it was authenticated and assigned a scientific name. Then online literature resources accessible via the Library of Wageningen University and Research Centre and/or Google databases with the search term "*Maerua subcordata*" were retrieved and systematically reviewed.

Results

Ethnomedicinal use of *M. subcordata* by the Kunamas

M. subcordata produces a large tuber (Fig. 1) which is well adapted to dry areas. It was also observed in the field that some of its ripe fruits, unless protected by co-grown spiny shrubs such as *Acacia* spp., were found pierced by birds implying that birds may feed on either the fruit mesocarp or seeds of the plant. Informants of the Kunamas stated that *M. subcordata* is among

Fig. 1 Different parts of *M. subcordata*. On the left, it shows the whole shrub showing ripe fruits pierced by birds (shown by arrows). The center shows how the plant bears fruits, which are edible. On the right, it shows that the plant produces a big tuber and numerous small tubers (not shown) that can grow to independent shrubs

the herbal medicines commonly used by the healers. Their traditional practice follows a local custom–based disease perception and management. That is, members of the community may acquire ethnomedicinal knowledge but only healers are empowered to prescribe remedies because they perceive that herbal remedies are effective when they are collected, prepared, and dispensed by the traditional healers, and if done by others, the herbal preparations may not work as remedy or may even be disease aggravating. Variation in traditional knowledge and practice among the healers was also reflected in the two data collection localities as will be described later.

Traditional use of M. subcordata by Kunamas at the Lemlem sub-district

The informants described that *M. subcordata* tuber is used for the treatment of malaria. As per their diagnostic specification, malaria symptoms include fever, pain, headache, muscle pain (myalgia), abdominal disturbance (nausea, vomiting, and diarrhea), and abdominal swelling (distended abdomen). Someone with one or more of these symptoms is diagnosed as malaria patient and is given *M. subcordata* tuber or other herbal remedies. They also indicated that the use of this plant as a remedy is preferred (i) if the malaria symptoms include muscle pain and (ii) if there is a fear that other medicinal plants may harm children or pregnant women. In other words, it is the preferred remedy for children and pregnant women. Its preparation and usage as an anti-malarial remedy are that first, the healer collects the tuberous root, dries, and stores it in pottery or wooden containers. Dry season but not rainy season was mentioned as the preferred collection time. When the healer is visited by a patient, an amount (variable and determined by the healer depending on the situation, such as age and gender of patients) of dried root is powdered and mixed with melted clarified butter (traditional ghee). The mixture is then taken orally or applied topically (whole body of patient smeared with the mixture) daily for four days.

Traditional use of M. subcordata by Kunamas at the Shembilina sub-district

The Kunamas at the Shembilina use *M. subcordata* tuber to manage acute respiratory problems that are usually manifested as a seasonal cough epidemic while the leaf is used for wound healing. As per the informants' description, typically in autumn, there is a high possibility of getting illnesses, a cough epidemic being quite common and children being more susceptible. They described this period as characterized by flowering and fruiting of crops and other wild plants as well as several insects hovering over the flowers and wet areas. They perceive that pollen from the flowers or insect-borne rubbles are the cause of the cough epidemic, and mainly during such situations, the Kunamas practice various traditional preventive and curative measures including the use of herbal medicines, of which one is *M.*

subcordata. To manage a cough epidemic with this plant, either of the two options of preparation and usage is followed. In the first approach, the fresh tuber of the plant is dug out, washed with water to remove soil, and then soaked in drinking water in a pot. Every member of the household, with and without cough, drinks the water while the tuber is soaked in. This is done for about a week starting from the time of soaking. After a week, if the epidemic continues, the root tuber is replaced by another fresh one. In a second approach, alternatively, the washed tuber is soaked in a dough (usually made from sorghum flour, but flour from other cereals can also be used) for a week. After a week, the tuber is taken out of the dough and the dough is baked into a local bread called "enjera" which is eaten by the patients and all household members. Again this procedure may be repeated for another week, if the epidemic continues. Moreover, the healers and elderly people advise children not to expose themselves to pollen dust and not to eat unripe or uncooked fruits. For wound healing, dried leaves are thoroughly powdered and a paste is made with water and the paste is smeared on the wound.

Literature review on *M. subcordata*

In addition to the FGDs and oral interview approaches to collect ethnomedicinal data from the Kunamas, literature was searched on its possible health claims and related ethnobotanical reports elsewhere, which became possible after its authentication. The literature showed that *Maerua subcordata* (Gilg) DeWolf (Syn: *Courbonia subcordata* Gilg, *C. tubulosa* Gilg and Bened) occurs in the dry parts of East Africa, constituting one of 16 *Maerua* species in the flora of Ethiopia and Eritrea [36, 40, 41]. Its ethnobotanical data were related to three main claims: water purifying agent, food item, and herbal medicine which are detailed in the discussion part. Also, despite scarce phytochemical studies, the quaternary ammonium compounds like stachydrine and 3-hydroxystachydrine were identified in *M. subcordata* [42].

Discussion

In the study area, malaria, acute respiratory infections, acute febrile diseases, diarrhea, helminthiasis, infections of the skin and subcutaneous tissue, pneumonia, and dyspepsia (impaired digestion) are common illnesses [3]. *M. subcordata* is used to manage malaria and acute respiratory problems. The Kunamas at the Lemlem subdistrict used *M. subcordata* root powder mixed with clarified butter to relief malaria. Stachydrine, identified in the root of this plant by an earlier study [42], was shown to exhibit anti-malarial [43] and anti-inflammatory [44–46] activities which may partly support the antimalarial use of the plant. Besides, looking into the detailed practice of the herbal preparation may indicate that active ingredients might also come from the clarified butter that was used to prepare a herbal mixture for antimalarial use. This is because, the clarified butter (traditional ghee) is generally prepared by melting and boiling of butter with different herbs and spices, and then all the ingredients allowed to separate by density. The clarified butter, which may extract some of the constituents of the herbs and spices used to prepare it, is then decanted into another container leaving the curd material in the boiling pan [47]. Therefore, any associated health benefit might come from the constituents of *M. subcordata* and/or constituents of the herbs and spices used to prepare the clarified butter. Such preparations may help to relieve symptoms of malaria.

Similarly, the Kunamas at the Shembilina use *M. subcordata* fresh tuber as a component of drinking water or as part of food preparation to manage acute respiratory problems manifested as a cough epidemic. The practice seems to intend to help the body's defense system and to be used for a dual purpose of prevention and curative because all household members with or without cough take the remedy. Further, they advise children not to expose themselves to pollen dust and not to eat unripe or uncooked fruits as they associate the cause of the cough with insect-borne infections and/or plant allergens. This claim may make sense since pollen allergens are causes of seasonal cough [48] and the season in which cough epidemics may happen in the study area is a season of flowering and fruiting, which is often accompanied by breathing air loaded with pollen allergens [49, 50]. They also mentioned that children are more susceptible indicating the remedy may help to boost the immune system since both potential causes (infection and plant allergens) of the cough interact with the immune system and children have a relatively immature immune defense [49, 51]. Similar use of the root for purposes of improving general body strength and health is reported in Kenya [52] implying a possible effect as an adaptogen: a herbal preparation or natural compound that increases adaptability and survival of organisms under stress [53]. Considering that glucosinolates are characteristic constituents of many species of the caper family including *Maerua* species [29, 33] and that glucosinolates are implicated to promote immune responses [54], which were suggested to be responsible for the adaptogenic effect of certain herbs [55], it may be expected that the herbal preparation may increase the body's ability to resist the damaging effects of stress from infections or plant allergens. Moreover, stachydrine which was detected in this plant part [42] was shown to act as antitussive [56] and hence may have a possible contribution to support the claimed effect.

In line with the practice by the Kunamas, the literature data also show a widespread use of the tuber as an element of drinking water. Its use to clarify turbid water is well documented, mainly in Ethiopia and Kenya [36, 57–61]. In Ethiopia, its use as a water purifier is well known over the plain of the Omo river basin and the adjacent areas where the plant is widespread. The whole tuber or slices from it are mixed with turbid water to clarify it. Its water clarifying efficacy was proven by laboratories that revealed its ability to flocculate clay particles of muddy water and its ability to reduce turbidity and microbial load both as primary coagulant and as coagulant aid to alum [57, 62]. This practice may imply possible health benefits of the tuber, at least, via improving the quality and sanitation of drinking water. Likewise, the literature data show that root and leaf parts of *M. subcordata* are used in ethnomedicine. In Somalia, paste from fresh root is applied on wounds to improve healing and to relieve pain; root powder boiled with cow milk and water is taken to treat tonsillitis; water extract of root is used as filtered drops to treat infections of the eye or ear; crushed root mixed with water and honey is taken as abortifacient; and an infusion of the root is used as a laxative [40, 41]. In Kenya, root boiled in water is used as anti-helminthic [63] and to treat diabetes, high blood pressure, allergic disorders, and microbial infections of blood; to improve appetite; and to induce sleep when taken at a high dose [60]; broth from root is used for purposes of general body strength and health [52]; and leaves are used to treat ophthalmic diseases [64, 65] and pneumonia [66]. Also, use of the plant as wild food is reported. In Kenya, Uganda, Sudan, and Ethiopia, fruits are boiled for a meal or part of a meal [67]. In the case of Ethiopia, ripe and raw fruits (excluding peel) are used as wild food, both as supplementary and famine food [18]. In Kenya, the plant is a source of edible fruits [64] and root tuber is a famine food which is also chewed to quench thirst in the dry season [52].

So far, very few scientific studies exist that attempt to justify the traditional claims on *M. subcordata*. An aqueous extract of the root was shown to exhibit guinea pig ileum-contracting effect that was associated with its quaternary ammonium salts and was suggested to support the traditional use of the root in wound healing [40, 42]. Likewise, little work has been done to characterize the nutritional attributes of *M. subcordata*. A report on its root showed high amounts of proteins, polysaccharides (mostly amylopectin), high levels of sodium, potassium, and magnesium, but trace levels of iron, manganese, nickel, zinc, and practically no aluminum [68].

Last but not least is the safety issue. While considering the potential benefits of *M. subcordata*, safety issues should also be taken into account and possible hazard and exposure need be considered to check if the use may present a risk. Uncooked fruits are perceived as toxic, and boiling and re-boiling them several times was suggested to render them non-toxic and edible [64]. An additional concern could be that unlike the claim in the study area that *M. subcordata* tuber is relatively safe and hence a preferred remedy for children and pregnant women, reports from Somalia indicate its use as abortifacient [40, 41], which if the latter claim is true, may point at a possible adverse effect. On the other hand, despite a claim on quaternary ammonium compounds in the root which, if excessively used, may cause a slight intoxication (stomach pain, dizziness, vomiting), these problems were not detected along the area of the Omo river, maybe because the quantities ending up in the water when used to clarify it were obviously too small to cause negative side effects [57].

Therefore, the above discussions point out that there seems ethnomedicinal support to suggest further scientific investigations into *M. subcordata* aimed to reveal its potential utilization as a functional food and/or alternative herbal medicine. At the same time, scientific investigations should put equal weight to address safety aspects when considering the health benefits of the plant.

Conclusion

Existing ethnobotanical and ethnomedicinal data on *M. subcordata* indicate that especially its fruit and roots may have agricultural or medicinal values if developed as a functional food or alternative medicine. Therefore, research into the potential nutritional attributes, health benefits, and possible health risks of the plant is recommended so as to verify its potential importance as a viable agricultural and/or medicinal resource.

Abbreviations

FGDs: Focus group discussions; GLs: Glucosinolates; WEPs: Wild edible plants

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Authors' contributions

MGH designed the study, collected the data, performed data interpretation, and wrote the manuscript. IMCMR supervised and helped the study starting from the proposal up to writing up and editing of the manuscript. JL and LH contributed to the literature part and reviewed and contributed to improving the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

All relevant data are fully available without restriction within the manuscript and supporting data.

Competing interests
The authors declare that they have no competing interests.

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