Ethnobotany of *Hyphaene thebaica* (L.) Mart. (Arecaceae) in the Afar depressions, Ethiopia

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Research

Abstract

Background: Hyphaene thebaica is a Palm tree or shrub often with dichotomous branching that is predominantly found in an open wet landscape, riverbeds/flood plains, and around river valleys. This study was conducted to document the ethnobotany of *Hyphaene thebaica* in the Afar depressions, Ethiopia.

Methods: A purposeful sampling method was used to select the informants. A total of 80 informants - 20 informants from each district and 15 of them in each district were women. Out of the selected informants 12 of them i.e., three from each district were considered key informants based on the recommendations from the administrators of different hierarchies who are believed to have sufficient knowledge about the plant and communities. The remainder (68 informants) were general informants. Direct matrix ranking was used to rank the preferred use of *H. thebaica*. Descriptive statistical analysis was performed using OriginPro 2022.

Results: Results revealed that *H. thebaica* has numerous importance as implied by the informants in the Afar communities. These include material culture and *Sennan Ari* (100%), Doma (45%), and medicinal value (32%). The use preference ranking of the species revealed that material culture and making *Sennan Ari* were ranked first with 100% of the key informants confirming the information.

Conclusions: The present study investigated the indigenous knowledge of the desert Palm, *Hyphaene thebaica,* and found the plant is multipurpose and is utilized for material culture production, temporary shelter/house (*Sennan Ari*) making, extraction of an alcohol/liquor, medicinal value, and income-generation. Advancing the material culture production by integrating current knowledge and phytochemical investigation on the alcohol extract and determining its efficacy is recommended.

Keywords: Desert palm, Herbal medicine, *Hyphaene*, Indigenous knowledge, Material culture, Pastoralism

Background

Hyphaene thebaica (L.) Mart. (Arecaceae) (Fig. 1) is a Palm tree or shrub often with dichotomous branching that is predominantly found in an open wet landscape, riverbeds/flood plains, and around river valleys. It is distributed dominantly in tropical north-east Africa for instance Kenya, Ethiopia, Eritrea, Egypt, Somalia, Sudan and Tanzania. However, it is also found in the western African countries (e.g. Mauritania and Senegal) as well as, found in some areas of the Arabian Peninsula (Abdel-Raman 2019). In Ethiopia, *H. thebaica* grows at elevations 100 m below sea level (Dallol) and up to 1000 m above sea level (Upper Awash) in different floristic regions namely Afar (AF), Gondar (GD), Gojam (GJ) and Illubabor and (IL) floristic regions. The *Hyphaene* is one of the most economically important

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genera globally. Some of the economic importance reported include material culture, food and liquor, medicine, firewood, fence, construction, making a raft, etc. (El-Seedi et al. 2013; Khalil et al. 2018; Stauffer et al. 2018; Abdel-Raman 2019; Sulieman & Mariod 2019; Bussmann et al. 2021).

Human beings have been using materials made from stone and plants since the stone age and afterward. The use of plants as artifacts plays a crucial role to understand the societal practices in the use and making process of objects or materials (Ryan 2011). Even in the twenty-first century, human beings are using numerous objects. These include basketry, shelter, rope, farming tools, fencing, etc. (Woodward 2007; Ryan 2011; Addis et al. 2013; Stauffer et al. 2018; Abdel-Raman 2019; Sulieman & Mariod 2019; Omire et al. 2020). Although the study of plant material culture received little attention than other themes (e.g. wild edible food and traditional medicine), some studies demonstrated the importance of material culture in Ethiopia (Bahru et al. 2012; Balcha 2013; Yassin et al. 2015). Despite its distribution in four floristic regions, in Ethiopia, the use of *H. thebaica* as material culture is reported only from Konso, southern Ethiopia (Addis et al. 2013).

Plants are widely utilized by societies across the globe to treat several human and animal diseases. In Ethiopia, herbal medicine serves nearly 80% of the population in remote areas who do not have access to modern medicine (Araya et al. 2015; Yirgu et al. 2019). They are also the principal components of modern drugs. Thus, the identification of herbal medicinal plants is a precursor to screening and extracting the target phytochemicals.

Figure 1. Mature Hyphaene thebaica from Elidaar, Afar.

Indigenous knowledge of the medicinal value of *H. thebaica* is reported by some studies (El-Seedi et al. 2013; Abdel-Raman 2019; Bussmann et al. 2021). In addition to the traditional medicinal value, experimental studies also confirmed that the plant extract is a remedy for several diseases such as diabetes (Salib et al. 2013), inflammation (Farag & Paré 2013), and anti-cancer (Bello et al. 2017).

Indigenous knowledge is being replaced by modern knowledge despite its valuable contribution. As a result, paramount indigenous knowledge related to material culture, herbal medicine, and associated knowledge is being lost before it's properly documented. Hence, documenting the ethnobotany of plants would have a significant contribution to the field. This research aimed to document the ethnobotany of *Hyphaene thebaica* (L.) Mart. (Arecaceae) in the Afar Depressions, Ethiopia.

Materials and Methods

Descriptions of the study area

The study was conducted in Zone one of Afar Regional State, Ethiopia. Afar Regional State has five zones and above 35 districts. The present study was conducted in Four districts of Zone one (Afambo, Aysaita, Dubti and Elidar), which are located at 11°00'00'' to 130000 N and 44°00'00'' to 42°00'00'' E (Fig. 2). These districts are found at about 700 km from the capital, Addis Ababa.

The elevation of the study area ranges from 56 meters below sea level to 1329 meters above sea level. The lowest elevation is dominantly found in Elidar and the highest elevation is dominantly found in Aysaita. At these elevation ranges Desert and semi-desert scrubland (DSS), *Acacia-Commiphora* woodland (ACW), Riverine vegetation (RV) and Saltwater lakes, lake shores, salt marshes and pan vegetation (SLV) vegetation types are recognized. Particularly, the DSS and SLV is dominantly found in the study area.

The population of the study area is 257, 931 (CSA 2007). The main stay of the majority of the population (70%) is agro-pastoralism and pastoralism. Even in some districts such as Elidar district, about 90% of the population's livelihood is agro-pastoralism and pastoralism.

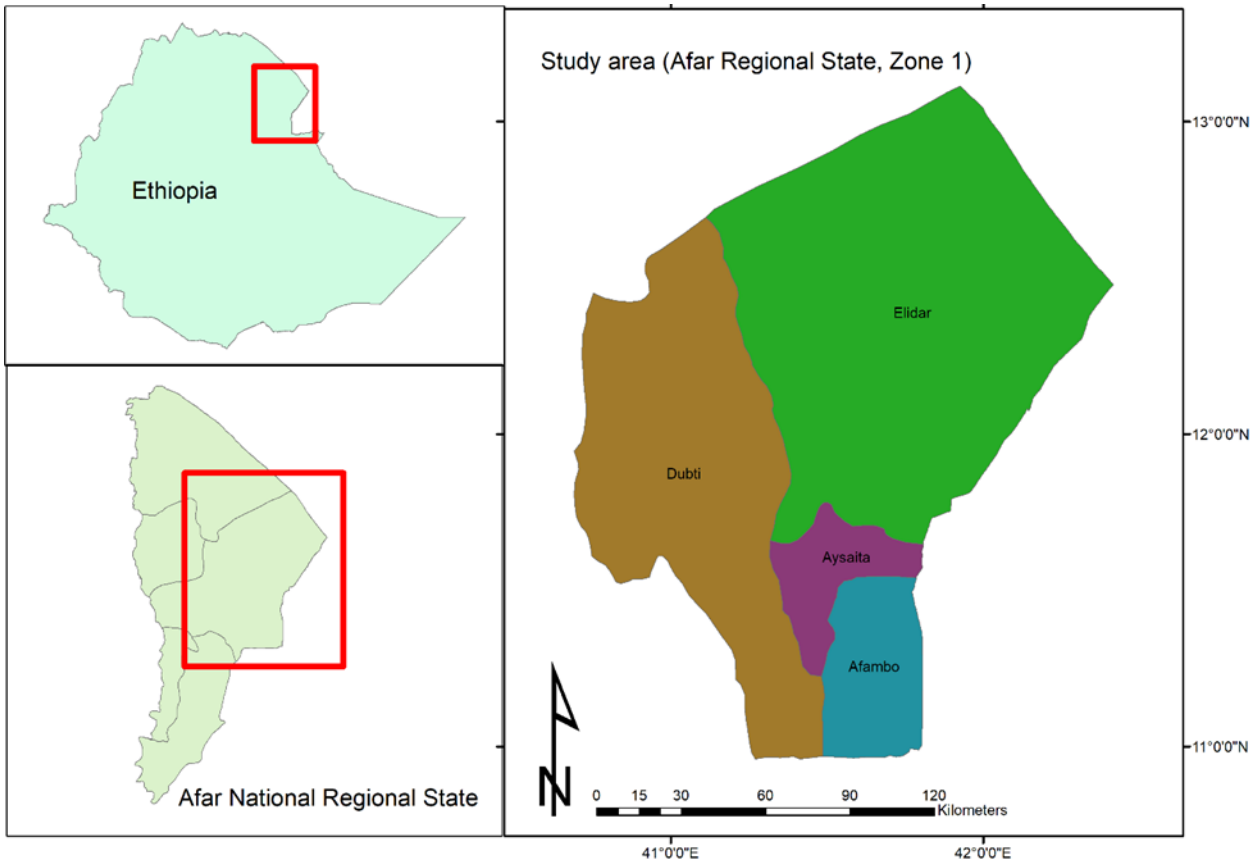

Figure 2. Map of the study area.

The climate of the study area is extremely harsh. It entertains unusually high temperature and receives the lowest precipitation in the country (Fig. 3). The annual rainfall of the study area is often below 200 mm. Whereas, the temperature could reach above 40°C during the dry seasons. Consequently, it is classified as a Hot desert climate (BWh) according to Köppen-Geiger Classification system (Beck et al. 2018).

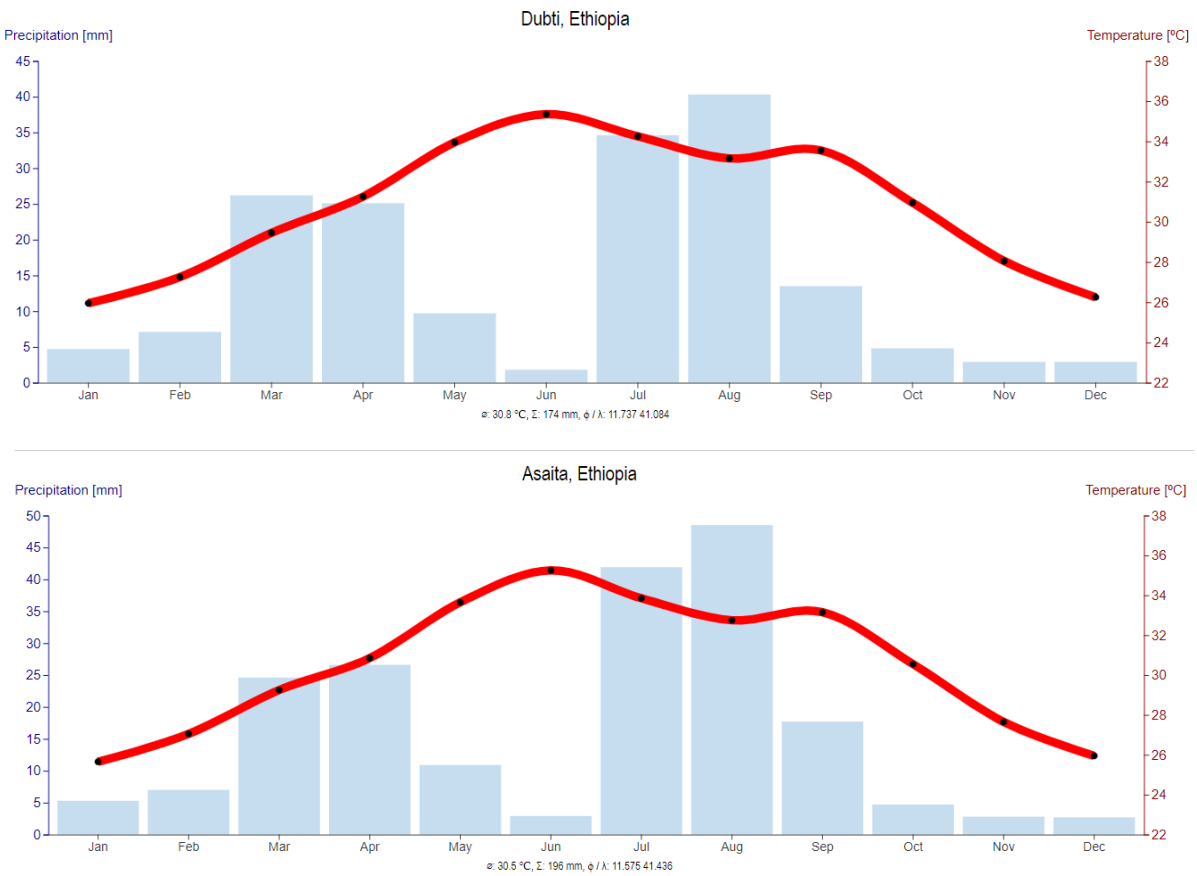

Figure 3. Climate diagram of the study area (blue bars = mean annual rainfall, red trend line = mean annual temperature) (1981-2010) (Karger et al. 2017). The x-axis shows the mean annual temperature and rainfall. Dubti (upper) and Asaita (bottom) are the districts around the study districts with climate information.

Sampling and informant selection

A reconnaissance survey was made in zone one of the Afar Regional State in January 2021 to obtain an overview of the distribution of the target species and its ethnobotanical importance in the community. Accordingly, four districts were purposely selected for the present study. The districts were selected for two reasons i.e., the presence of abundant *H. thebaica* (Elidar district) and the reliance of the communities on the species (Afambo, Dubti, and Aysaita districts).

Due to the unreachable nature of the study area, employing random sampling using the sample determination formula could not be possible. Hence, a purposeful sampling method was used to select the informants following literature (Cotton 1996; Martin 2010; Cunningham 2014). Because of the prior knowledge about the species and its utilization we had, the sample size was biased toward female. A total of 80 informants — 20 informants from each district and 15 of them in each district were women. Out of the selected informants 12 of them i.e., three from each district were considered as key informants based on the recommendations from the administrators of different hierarchies (kebele i.e., lowest administration level, districts, and extension workers), who are believed to have sufficient knowledge about the plant and communities. The remainder (68 informants) were general informants.

Data collection

The ethnobotanical data were collected using semi-structured interviews, field observation, and focus group discussion (Cotton 1996; Albuquerque 2019). A pre-tested semi-structured checklist of questions were prepared in the local language (Afaraf) and the responses were translated into English during data entry. Apart from the focus group discussions, the general informants had the freedom to respond independently. Furthermore, clarification of the questions and follow-up questions were entertained as per the request and consent of the informant.

The field observations were confined to two local sites. These were (1) Elidar district where *H. thebaica* is abundantly found unlike the other districts and (2) Small cooperative enterprises that produce material culture from the species

(Dubti, Afambo, and Aysaita districts). this created an opportunity to understand the ethnoecology and ethnobotany of the species as well as observe first-hand information about the multiple uses of *H. thebaica*.

In order to triangulate and validate the information collected through semi-structured interviews and direct observations, focus group discussions were held in each district. The focus group discussion included the key informants, health and agricultural extension workers, district administrators, kebele representatives. Both male and female were part of the focus group discussion.

Data analysis

Direct matrix ranking was used to rank the preferred use of *H. thebaica*. The key informants were requested to rank the importance of the species in the community based on their perceived knowledge and preference. The key informants ranked the uses of the species with respect to their personal preference, and perceived importance to the community. The scales range from 0 to 5 where 0 reveals and 5— is the highest value. The scores were summed-up and the use category with the highest score is depicted as the most preferred. The statistical analysis was performed using OriginPro 2022.

Results

Socio-demographic nature of the informants

Females dominated the sample population. Seventy-five percent of the samples were women while the remainder were men. The age range of the informants was 26 to 65. The age group 31-40 covered the highest proportion (53%). The highest age group i.e., is represented by a small proportion (4%). The educational background was categorized into four groups i.e. illiterate, 1-5, 6-8, and 9-12. About 51% of the respondents were in the second category (1-5) followed by the illiterate (34%) (Table 1).

Table 1. Demographic characteristics of the informants

Age group	**Gender**			
	Male	**Female**	**Total**	**Percent (%)**
20-30	4	10	14	17.5
31-40	13	29	42	52.5
41-50	3	18	21	26.25
above 50	0	3	3	3.75
Total	20	60	80	100
Educational background	Gender			
	Male	Female	Total	Percent (%)
Illiterate	3	14	27	33.75
1-5	14	27	41	51.25
6-8	9	3	12	15
9-12	0	0	0	0
Total	26	44	80	100

Ethnobotanical uses of *H. thebaica*

Results revealed that *H. thebaica* has numerous importance as implied by the informants in the Afar communities. Even though its distribution is restricted to one of the study districts, it is found in markets outside of the natural growing range. The multipurpose uses of the species are discussed in the following sub-sections.

Material culture

Numerous materials that serve different purposes are produced from *H. thebaica* leaves. Almost all the materials are made by the Afar women. The materials produced from the plant include Mawarah'a (Afaraf: *Mawarraca)* (Fig. 4a), Tae (Afaraf: *Taaqe*) (Fig. 4b), *Ayni* (Fig. 4c), *Gadbo* (Fig. 4d), *Sifaala* (Fig. 4e), and *Fiddima* (Fig. 3f & g). These materials are also available on the market for sale. The use preference ranking of the species revealed that material culture and making *Sennan Ari* were ranked first with 100% of the key informants confirming the information (Table 2). This was followed by a source of income and *Doma*.

Mawarraca:

The Afar region is known for its extremely hot weather. As a result, the Afars created this *Mawarraca*. The local people use this as a ventilating fan and cool their surroundings.

Taaqe:
Pastoralism and Agro-pastoralism are the main livelihoods of the Afar people. And livestock are primarily the wealth of the people. Traditionally, milk (cow, camel, or goat) is part of their daily nutrition. Hence, they use *Taaqe* to store a milk for short time. This material prevents the milk from spoiling easily.

Ayni:
Pastoralism and Agro-pastoralism are the main livelihoods of the Afar people. And livestock is primarily the wealth of the people. Traditionally, milk (cow, camel, or goat) is part of the Afar people's daily nutrition. Hence, they use *Taaqe* to milk a cow or camel.

Gadbo and *Sifaala*:
These materials are used for catering services. Food items put on the *Gadbo* (Fig. 4d) and are covered by the *Sifala* (Fig. 4e) to prevent food contamination and keep it fresh [hot].

Fiddima:
Fiddima (Fig. 4f & g) has two major uses in the Afar community. One, it's often used as a carpet or mat. Honorable guests are welcome to take a rest on the *Fiddima*. As can be seen from the picture below (Fig. 5), numerous honorable guests such as the Samara University president, officials from the Federal Democratic Republic of Ethiopia (FDRE) and Afar culture and tourism director are being served their meal over the *Fiddima*.
Second, Muslims use *Fiddima* for prayer.

Afar *Sennan Ari*
Afar *Sennan Ari* (Fig. 6) is the best innovative house that could withstand desert wind and sandstorm. It's mainly made from the leaves of *H. thebaica* and other plant stems that bends easily and create a curvature. The design is fascinating. The rolling doors (Fig. 6) are also made from this plant. It is a mobile house - the parts are detached and transported by camels. This is fundamentally due to the fact that most of the materials, particularly the *H. thebaica* couldn't be found in the place they are moving and to avoid the time and energy to build the *Sennan Ari*. The house is entirely constructed by women.

Doma and medicinal value
Unlike the materials produced from *H. thebaica* which was confirmed by nearly 100% of the informants and key informants, the production of *Doma* [alcohol] (Fig. 7) from the plant was only confirmed by 45% of the informants. The men informants, particularly from Elidaar, cited the production of *Doma* from *H. thebaica*. Considering the dominant Muslim population in the study area, the Doma is not utilized by all of the local residents. Rather, they sell it on the roadside for travelers across the Ethio-Djibouti highway. When they sell the product they often aware the buyer by telling them it's an alcohol and that if you are driving, you shouldn't drink too much of *Doma*.
Although most of them don't drink *Doma* publicly, some pastoralists and agro-pastoralists secretly drink it, responded 43.4% of the informants. The plausible reason provided was *Doma* provide them energy and help them cover long distance while moving with their livestock. Furthermore, about 32% of the informants implied that *Doma* heals some diseases. These include pneumonia or common cold and antibacterial importance. Furthermore, 27% of the informants stated that Doma is important for bone strength.

Source of income
About 67.3% of the informants acknowledged *H. thebaica* is source of income. The materials produced from the plant are sold on the market. And, the *Doma* is sold on the roadsides of the Ethio-Djibouti highway. Although the extraction process is time-consuming and tedious (Fig. 7), about 2 Liters of *Doma* is sold for about 180 Ethiopian Birr (USD 3.46).

Figure 4. Materials produced from *H. thebaica*. (a) *Mawarraca,* (b) *Taaqe,* (c) *Ayni,* (d) *Gadbo,* (e) *Sifaala,* and (f & g) *Fiddima*

Figure 5. A ceremony for honorable guests. Most of the materials described above are demonstrated in this figure.

Figure 6. *Sennan Ari*

Figure. 7 Preparation process of *Doma*. (a) A man tapping the apical meristem of *H. thebaica* and (b) a liquor or alcohol extracted after 24 hours

Materials produced from *H. thebaica* are being replaced by modern products

Almost all informants (98.5%) confirmed that most of the materials produced from *H. thebaica* are being replaced by modern products. About 57% of the informants prefer local products and are worried that the local products are being replaced by modern products whereas 43% of the informants stated that they are fine with the modern product as long as they served the required purpose.

Table 2. Key informants direct matrix ranking of the use preferences of H. thebaica

Use category	Key informants												Total	Rank
	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11	K12		
Material culture (*Mawarraca*, *Taaqe*, *Ayni*, *Gadbo*, *Sifaala*, and *Fiddima*)	5	5	5	5	5	5	5	5	5	5	5	5	60	1
Sennan Ari	5	5	5	5	5	5	5	5	5	5	5	5	60	1
Medicinal	1	3	4	4	3	2	1	1	3	4	2	3	31	4
Source of income	3	4	3	2	2	2	1	2	2	1	3	1	26	3

Discussions

Material culture

Material culture emphasizes how apparently inanimate things within the environment act on people and are acted upon by people, to carry out social functions, regulate social relations and give symbolic meaning to human activity (Woodward 2007). Plants can be a source of material culture in house construction, agriculture, preparation of mats, utensils, furniture, traditional musical instrument, art and can be mythic symbol too. Material culture is

culturally powerful because in practice they connect physical and mental manipulation (Woodward 2007). The importance of *H. thebaica* in material culture is reported elsewhere in the world. For instance in Konso, Ethiopia (Addis et al. 2013), Republic of Benin (Idohou et al. 2017), Ghana, Djibouti, Tanzania, and South Africa (Stauffer et al. 2018), and Egypt (El-Beltagi 2018), the plant is used to make different materials such as mat, baskets, brooming, thatching and ropes.

Women play a crucial role in the community in preparing plant material culture in Afar. Most activities in rural societies including among pastoral groups women participate in water collection for domestic use, grass cutting, hunting, cattle raiding and livestock herding, and fuel wood collection (Ridgewell et al. 2007). The Afar women particularly are engaged in processing mats, house construction, food, bed linings, and rope making (Ridgewell et al. 2007), in which most of them results from plant collections. The materials produced from *H. thebaica* are almost entirely made by the Afar women. A similar report revealed the same pattern in east Africa, particularly Djibouti (Stauffer et al. 2018; Omire et al. 2020).

Afar *Sennan Ari*

The majority of the Afar population leads either pastoral or agro-pastoral livelihood. Consequently, they built houses that are suitable for their livelihood and environment. *Sennan Ari* is a conspicuous house made from *H. thebaica*. This mobile or temporary house is built by Afar women and is also used for several purposes such as shelter for married couples (Reda 2011). A similar study is reported in Kenya (Omire et al. 2020).

***Doma* and Medicinal Value**

Alcohol or liquor is often extracted from the plant. Local community in other countries elsewhere also extract an alcohol from *H. thebaica* (El-Beltagi 2018). The medicinal importance of *H. thebaica* extract is widely reported. Congruent to the informants response in the present study, numerous studies implied that the species treats pneumonia (El-Beltagi 2018; Mohamed et al. 2019; Mohamed et al. 2020; Islam et al. 2022) and have antimicrobial activity (Farag & Paré 2013; Bello et al. 2017; El-Beltagi 2018). The medicinal value of *H. thebaica* dates back to the World War First (Wearn & Hudson 2018). Apart from pneumonia treatment, it's reported that the plant products could also heal other diseases. For instance, cancer (Reda 2011; Bello et al. 2017), sunburn, oral ulcers, asthma, skin diseases, premature aging, infertility (Sulieman & Mariod 2019), antihypertensive (Khalil et al. 2018), and anti-inflammatory, antioxidant, and antimicrobial (Farag & Paré 2013; El-Beltagi 2018) and anti-diabetic (Salib et al. 2013). The bone strength cited by the informants could be attributed to the high concentration of Calcium (Ca) found in the plant. Research from elsewhere reported that *H. thebaica* is rich in Calcium and other minerals (Aboshora et al. 2016; Abdel-Raman 2019; Aboshora et al. 2019).

Source of income

It is obvious that plants are a source of income for indigenous communities. In Ethiopia, *H. thebaica* is reported as an important source of income for women in Afar (Shumbahri & Idris 2021). The plant also creates an opportunity for income generation in Eritrea (Abel & Asghedom 2010). Products of the plant were also reported to be sold in the markets of South Africa (Stauffer et al. 2018). To boost the income obtained from the plant products need to be integrated with current knowledge and capitalized. Otherwise, irrespective of their sustainability, local products of *H. thebaica* could be overtaken by modern products. Consequently, the income-generation opportunity could be lost over time. This was reflected during the focus group discussion.

Conclusions

The present study investigated the indigenous knowledge of the desert Palm, *Hyphaene thebaica*, in the Afar Depressions, Ethiopia. It was found that the plant is multipurpose and is utilized for material culture production, temporary shelter/house (*Sennan Ari*) making, extraction of alcohol/liquor, medicinal value, and income generation. Advancing the material culture production by integrating current knowledge and phytochemical investigation on the alcohol extract and determining its efficacy is recommended.

List of abbreviations: Not applicable

Ethics approval and consent to participate: The study was approved after an official permission letter from Samara University, Department of Biology submitted to the study District and Kebele Administrative Offices. Verbal consent was also obtained from each and all informants who participated in the individual and group discussions after explaining the main objectives of the study with the assistance of local language translators. Furthermore, for the personal photographs used in the manuscript, a consent was obtained from the individuals.

Consent for publication: Not applicable in this section

Availability of data and materials: All necessary data are included in the manuscript.
Competing interests
The authors declare that they have no competing interests
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Author contributions: KG inception, study design, data collection and analysis, and write-up. AZ contributed to the project's inception, data collection and manuscript writing.

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