



Ethnobotany and Nutritional Value of Two Domestic Yams (*Dioscorea* spp.) in Abaya Woreda, Southern Ethiopia

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Research

Abstract

Background: From a food security perspective, yam is an important crop in the tropics and subtropics, where it produced both as a subsistence crop and on a commercial scale. This study aimed to assess the ethnobotanical knowledge and nutritional values of two domestic yams in Abaya Woreda, southern Ethiopia.

Methods: Data were collected from sixty informants in three kebeles. From each kebele, the most productive top twenty farmers were selected by researchers based on their potential cultivation of yams with the assistance of Development Agency (DA). Ethnobotanical data were collected by semi-structured interviews and edible tubers and bulbils of these crops were collected for nutritional analysis at the Hawassa University Food Laboratory. The data were analyzed with descriptive statistics and Analysis of Variance (ANOVA) using MS-Excel and SPSS.

Results: The results showed that farmers of Abaya Woreda have indigenous knowledge about forms of consumption, meal preferences, medicinal use, storage mechanisms and propagation systems of yams. Significant variation was observed in knowledge of edible plant parts and methods of tuber preservation for propagation in the study area. Similarly, the nutritional content of the crops showed variation in some of the measured parameters. For instance, *Dioscorea bulbifera* had higher carbohydrate content and total energy although it was the lower in moisture content.

Conclusions: The present study has attempted to document ethnobotanical knowledge and nutritional values of two domestic *Dioscorea* species in Abaya Woreda, which should get attention by farmers, researchers, governmental and nongovernmental bodies in order to increase the food potential and indigenous knowledge in the study area. For the results presented here may help to conserve yam germplasm and create awareness about the importance of these crops to alleviate food insecurity.

Key words: ethnobotany, nutritional value, yam, Abaya woreda.

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Ethnobotany Research & Applications

18:8 (2019)

Axereeraa

Gosootaa midhaan wabii nyaataaf olan keessaa Booyinaan/qoccoon midhaan gammoojjiifi giddu gala gammoojjiitti argamu ta'ee nyaataaf akkasumas gurgurtaaf kan fayyadudha. Qorannoon kun kaayyoon isaa walitti dhufeenya namootaafi booyinaa gidduu jiru akkasumas qabiyyee nyaataa midhaan kun qabu aanaa Abbayyaa, kibba

Itiyoophiyaatti qorachuudha. Ragaaleen qorannoo kanaaf barbaachisan namoota jaatama ganda sadii keessaa fo'aman irraa fuudhame. Namootni kunis namoota digdama ogummaa qonnaatiin ganda sana keessatti addaduree ta'an irratti xiyyeeffateeti. Kunis gargaarsa hojjetaa misoomaa ganda sana keessa jiruun kan ta'edha. Ragaan hariiroo namootaaf midhaan kana gidduu jiru bifa aaf-gaaffiitiin yoo ta'u battaluma sana hundeeniifi balbiloonni (bulbils) midhaan kanaa fuudhamuun gara mana yaalii Hawaasaa Yuuniversityiitti geeffamee qabiyyeen nyaata isaatii sakatta'ame. Tooftaa Excel fi SPSS komputeraa fayyadamuun ragaan qo'annoo kanaa herregame. Argannoon argames kan agarsiisu qotee bultootni aanaa Abbayyaa beekumsaa fi aadaa akkataa ittiin midhaan kana nyaatan, akkaataa ittiin filatan, qorichummaaf, akkaataa ittiin yeroo dheeraa tursiisanif akkaataa ittiin oomishan haala gaariin beekuu isaaniiti. Akkasumas qabiyyeen nyaataa midhaan kana keessa jiru akkaataa garaagarummaa isaanii fi bakka oomisha isaanii irratti hundaa'uun garaagara. Haaluma kanaan booyinaa inni Diyaaskooriyaa bulbifeeraa jedhamu kaarboohaayidireetiifi annisaa walii gala guddaa qabaachuu isaati. Haata'u malee qabiyyee bishaaniitiin gadi aanaa ta'uu isaa qorannoon kun ni raggaasisa. Haaluma kana irratti hundaa'uudhaan dhaamsi qorannoo kanaa booyinaa/qoccoo qotee bulaan itti fayyadamaa jiru kun qaamni dhimmi isaa ilaallatu martuu midhaan kun akka hin badnee fi ilaalchi hawaasni midhaan kanaaf qabu irra caalmaa fooyya'u akka dandeessisanii fi kana caalmaa gadi fageenyaan qoratamuu akka qabu dabarsa.

Jechoota ijoo: hariiroo namaa fi biqilootaa, qabiyyee nyaataa, Booyinaa, Aanaa Abbayyaa.

Background

The genus *Dioscorea* comprises 633 species (Govaerts *et al.* 2007), and is distributed throughout the tropics and subtropics. In many parts of West Africa, edible tubers of *Dioscorea* spp. have been the main food source for tribal people, since prehistoric times because they are rich in essential dietary nutrients (Hladik & Dounias 1993). They are high in starch and contain the enzyme alpha amylase which converts starch to sugars as the tuber matures in storage (Ravindran & Wanasundera 1992). Cultivated yams (*Dioscorea* spp.) provide food security to many people in the tropics and subtropics, especially in West Africa (Mwenye 2009, Mwirungi *et al.* 2009). These crops serve as a source of food, medicine and income for many small-scale farmers in Africa.

Ethiopia is an isolated center of yam cultivation in East Africa (Norman *et al.* 1995), and the crop plays a vital role in local livelihoods, particularly in the densely populated areas of southern, southwestern, and western parts of the country (Hildebrand *et al.* 2002, Tamiru *et al.* 2008). Some yams are endemic to the country, and together with enset (*Ensete ventricosum*) and anchote (*Coccinia abyssinica*) are some of the most widely cultivated root and tuber crops (Addis 2005). Although they are culturally and economically very important, yams are rarely domesticated in some parts of Ethiopia (Wendawek *et al.* 2013).

In southern Ethiopia, large pools of yam accessions are available in farmers' fields and forested areas. Nevertheless, these crops are being lost owing to the replacement of root crops by cereals and lack of understanding of the nutritional value of yams. To date, only few studies (Aregahegn *et al.* 2013, Tamiru *et al.* 2008, Tamiru *et al.* 2011, Wendawek *et al.* 2013) have been undertaken concerning the diversity and selected minerals composition of *Dioscorea* spp. in south and southwest Ethiopia. In Abaya Woreda, although it is rich in domesticated and wild *Dioscorea* species, differ in ethnic composition and socio-cultural traditions from other yam cultivating regions of Ethiopia, its ethnobotany and nutritional composition of yams has not been investigated so far. Therefore, the current study has been designed to assess the ethnobotanical knowledge of two domesticated yams and to evaluate their nutritional content in Abaya Woreda, West Guji Zone, southern Ethiopia.

Materials and Methods

Study area

This study was carried out at Abaya Woreda, West Guji Zone, Oromia National Regional State, southern Ethiopia. The woreda is located in the West Guji Zone close to the Southern Nations, Nationalities and People Regional State (SNNPRS). The three kebeles of Gowangoa Badiya, Bochessa and Kelaltu were the representative study sites of agricultural biodiversity in the Woreda (Fig. 1). Note that "woreda" and "kebele" are the administrative demarcations which are equivalent to district and village respectively. The soil at the site is sandy clay loam with a pH of 5.68. The livelihoods of the people in the area are mostly pastoral and agro-pastoral (Dejene 2015). The Woreda has mid highland (*Woinadega*) weather conditions. Crop production is totally rain fed (there is no irrigation practice) mainly with the *Ganna* rain, which extend from March to May, being the most important for crop production (Teshome 2016).

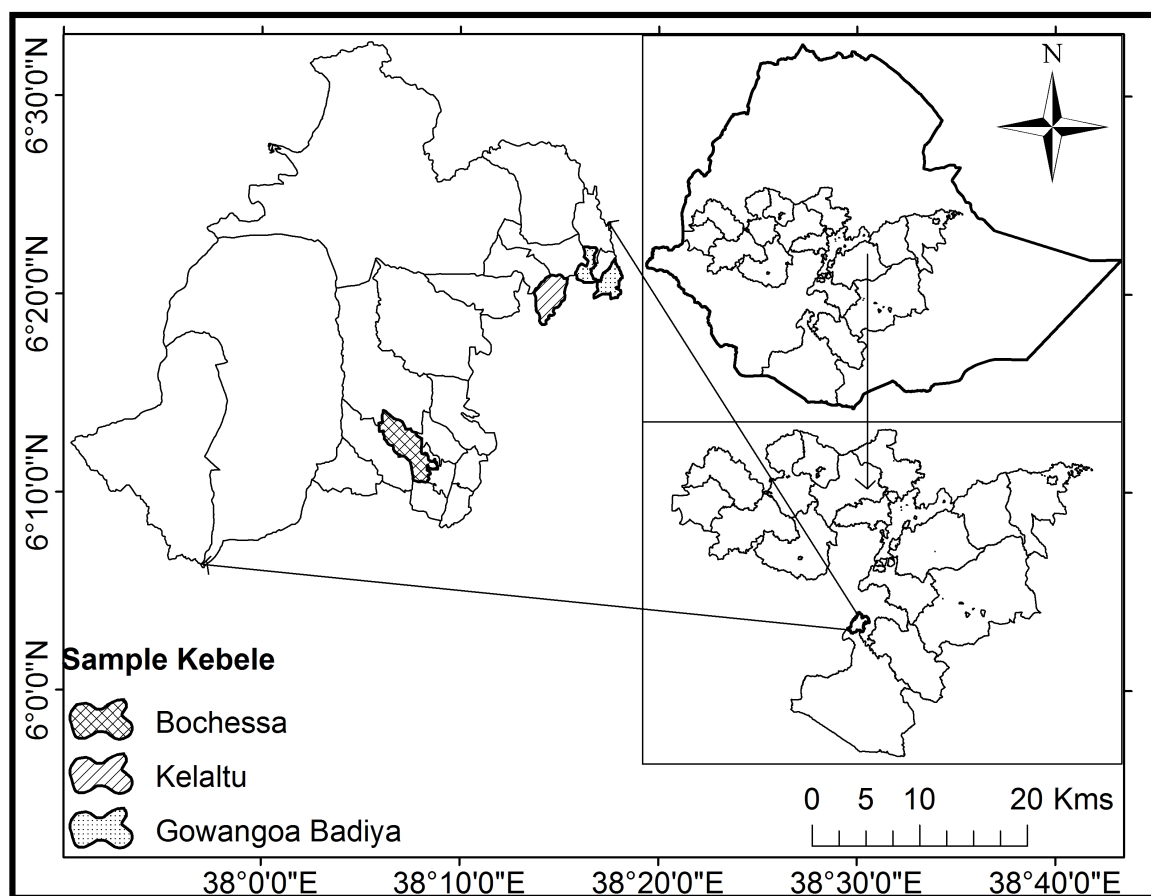


Figure 1. Illustrative map of the study sites.

Sampling techniques

Of the 21 kebeles of Abaya Woreda, three kebeles (Gowangoa Badiya, Bochessa and Kelaltu) were selected based on geographic (topographic) variation and the frequently cultivation of yams. The yam cultivating behavior of householders' in this area was identified by the suggestion of administrative leaders and Development Agencies (DA) in each selected kebele. Because administrative leaders and DA know about the frequency of yam cultivation, crop yield and the number of yam varieties in their area. Then, the researchers took sixty home gardens (top twenty farmers from each kebele) purposively based on the potential they have on yam farming by the guidance of Developmental Agencies. In each of the selected households, a semi-structured interview was carried out concerning the ethnobotany of these crops, with an equal proportion of male and female respondents. During the interview, the researchers took samples of the edible tubers and bulbils of cultivated *Dioscorea* species from each home garden for subsequent laboratory analysis of their nutritional content.

Data collection

The ethnobotanical data were collected using a semi-structured interview following the method used by Cotton (1996). Informants were interviewed either in Afaan Oromoo or Amharic, depending on which language the farmers spoke. The interview questions were concerned with the specific information like local names of plants, medicinal uses, parts used for food and/or medicine, and methods for cooking, harvesting and preserving the plants.

Experimental design

In preparation for nutritional content analysis, the samples were washed and packed in plastic bags and taken to Hawassa University. Edible parts were peeled, cut into small pieces and stored in a refrigerator until the extraction process. The experiment was carried out in two replications to minimize experimental error. Then, the result was obtained in average for further statistical analysis.

Data analysis

The ethnobotanical data were analyzed using descriptive statistics such as percentage and frequency. The variation in ethnobotanical use of domestic *Dioscorea* species was analyzed by using Analysis of Variance (ANOVA). Quantification of the ash, moisture, protein, lipid, crude fiber, carbohydrate and total energy contents of the samples were determined according to the methodology of The Association of Analytical Chemists' (AOAC 1990, AOAC 1995). The calorific value of each plant was obtained by summation of the mean values of protein, fat and carbohydrate which was multiplied by respective factors of 4, 9 and 4 following the methodology used by Bhandari *et al.* (2003). Later the nutritional analysis was carried out by using descriptive statistics. The computer programs MS-Excel and Statistical Package for Social Science (SPSS) were used for these analyses.

Results and Discussion

Ethnobotany of yams (*Dioscorea* spp.) in Abaya woreda

The indigenous communities of Abaya Woreda were found to be knowledgeable about the use of two cultivated species of *Dioscorea* (*Dioscorea alata* L. and *Dioscorea bulbifera* L.). This knowledge includes distinguishing of edible parts, traditional ways of preparation for consumption, routes of consumption, medicinal uses, identification of medicinal plant parts, methods of storage, etc. Similar to this result, the reports of Bukatuka *et al.* (2016), Dutta (2015), Kumar *et al.* (2013), Shanthakumari *et al.* (2008) and Sheikh *et al.* (2013) revealed the vital role of *Dioscorea alata* L. and *Dioscorea bulbifera* L. among the tribal communities by serving as a food and as a traditional medicine to cure different types of diseases.

Edible parts and preparation ways of *Dioscorea* spp. for consumption

Two cultivated *Dioscorea* species were documented in this study: *D. alata* L. (with edible tubers only) and *D. bulbifera* L. (with edible bulbils and rarely tubers). All respondents notified that only tubers are edible part of *Dioscorea alata*. However, 75% of respondents expressed the bulbils as the edible parts of *Dioscorea bulbifera* while 25% have reported as both the tubers and bulbils are edible (Fig. 2A). Likewise, Kumar *et al.* (2013) and Ogbuagu (2008) have reported bulbils of *D. bulbifera* as edible plant parts. This indicates the worldwide traditional Knowledge similarities among various human communities.

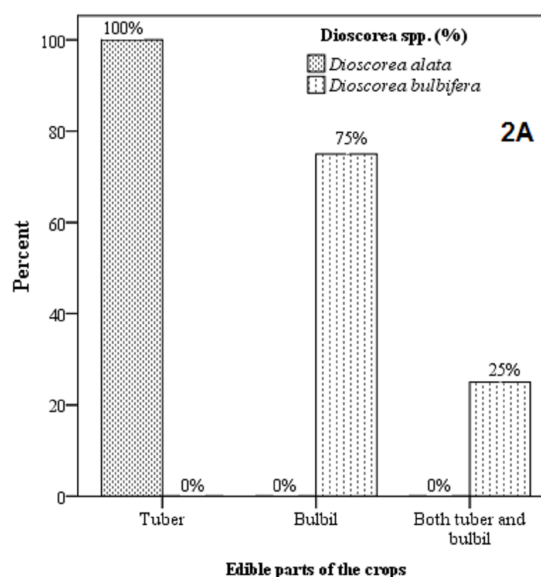


Figure 2A. Edible parts of *Dioscorea* species.

The indigenous people have traditional knowledge to prepare these crops for consumption. Accordingly, *Dioscorea alata* is prepared by digging, washing, boiling, and peeling, or by digging, peeling, washing, and boiling of the edible tuber. However, *Dioscorea bulbifera* is prepared by collecting, washing, boiling, and peeling of the edible bulbil, or by digging, washing, boiling, and peeling of the edible tuber as to *Dioscorea alata*. Few respondents only (5%) have revealed digging, boiling, and peeling of *Dioscorea alata* tuber for consumption (Fig. 2B).

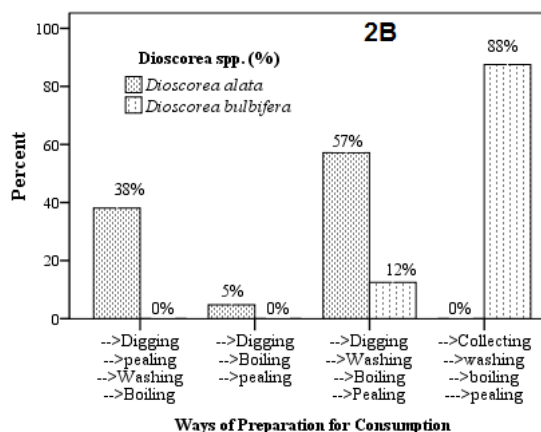


Figure 2B. Ways of *Dioscorea* spp. preparation for consumption.

This reveals that edible parts of *Dioscorea* spp. are only consumed after boiling. Boiling may be important to make these plants suitable for eating as well as for reducing toxicity. In line with this result, Maneenoon *et al.* (2008) and Shanthakumari *et al.* (2008) have reported the act of roasting or boiling *Dioscorea* spp. before consumption to minimize their

toxic effect. Moreover, the preparation method may be varied because of the variation in individual householders to care for food sanitation.

Routes of consumption and types of meal filled by *Dioscorea* spp. as food

Both *Dioscorea alata* and *Dioscorea bulbifera* can be consumed with hot pepper, coffee, milk, enset (*Ensete ventricosum*), etc. Only few respondents mentioned that these crops may be eaten alone (Fig.2C). In line with this finding, Dutta (2015) and Zinash (2008) have reported the consumption of *Dioscorea* species by mixing them with mushrooms, meat and other vegetables. However, this can vary depending on the variation in the eating habits of individuals, some of whom may prefer to consume yams alone, while others may eat them with additional foods. These crops can be consumed to fill the gaps of any meal types especially at breakfast time (Fig. 2D).

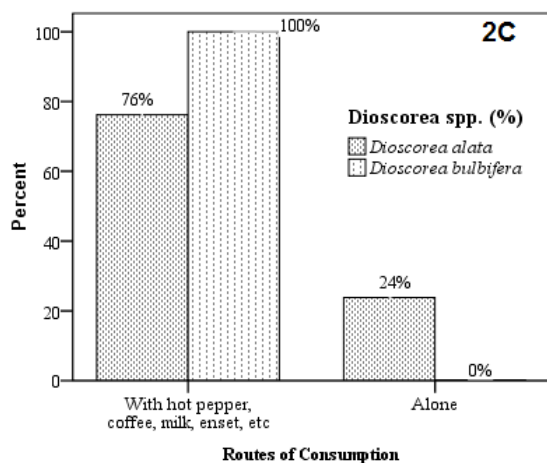


Figure 2C. Routes of consuming *Dioscorea* spp. as a food.

Medicinal uses and remedy parts of *Dioscorea* species

In the interviews, 43% of informants revealed that *Dioscorea alata* is used to treat post-partum abdominal pain in women. Also 33% of respondents revealed its use for the treatment of the fungal skin infection, *Tinea nigra*, which attacks the uppermost layers of skin (Fig. 3A). Similar to the current finding, Dutta (2015) has reported the application of *D. alata* paste for the treatment of skin diseases. However, 24% of respondents did not report any medicinal use of this plant in our study. Concerning *D. bulbifera*, except few respondents (12%), majority of them (88%) have not exposed its medicinal importance (Fig. 3A). However, the study conducted by Bukatuka *et al.* (2016), Dutta (2015), Shanthakumari *et al.* (2008) and Sheikh *et al.* (2013) revealed that both *D. alata* and *D. bulbifera* were among *Dioscorea*

species having maximum medicinal properties. This indicates the variation in ethno-medicinal knowledge between different parts of the world.

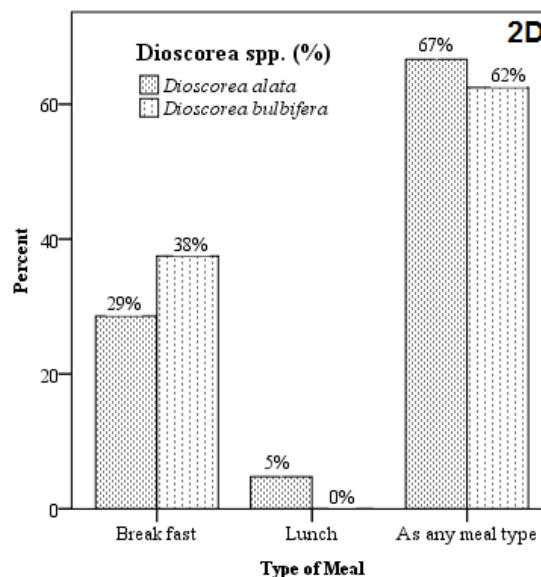


Figure 2D. Types of meal covered by *Dioscorea* spp. as a food.

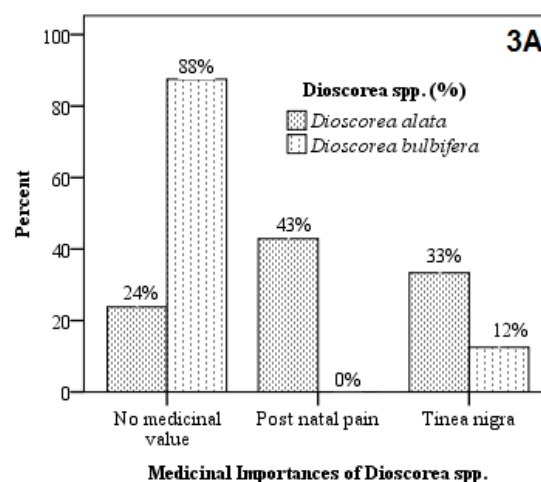


Figure 3A. Medicinal uses of *Dioscorea* species.

The plant parts of *Dioscorea alata* that are used medicinally are the boiled tubers (for treating abdominal pain), and tuber exudates, and young leaves (for treating *Tinea nigra*) (Fig. 3B). For the treatment of post-natal abdominal pain in women, the boiled tubers of *Dioscorea alata* are eaten orally. This may be due to the nutraceutical activity of the plant as “a functional food”. However, for treating *Tinea nigra* disease, the remedy parts of both plants painted directly on the infected portion of the skin. Such roles might be correlated with their antibiotic effects. Consistent with the present finding, Sheikh *et al.* (2013) have reported anti-bacterial and anti-

fungal function of *Dioscorea bulbifera* due to its flavanoid and saponin content.

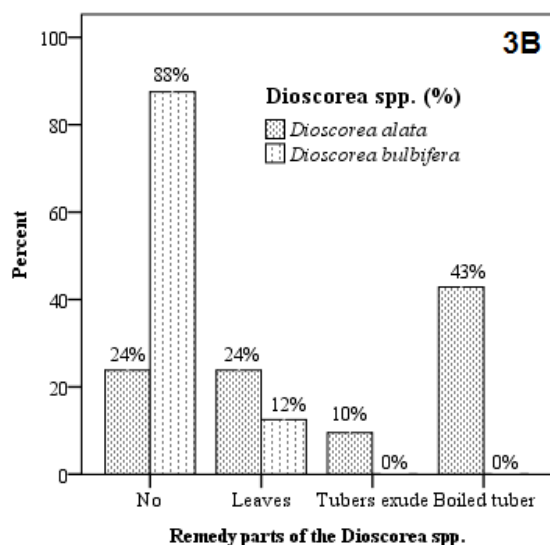


Figure 3B. Remedy parts of *Dioscorea* species.

The storing and preservation of *Dioscorea* species

This result reveals that *Dioscorea alata* can't be stored in container at a home for more than five days to consume. On the other hand, *Dioscorea bulbifera* can be stored at a home for more than three months (even for a year) and still be edible. The local people reported different numbers of days for storing *Dioscorea bulbifera* (Fig. 3C).

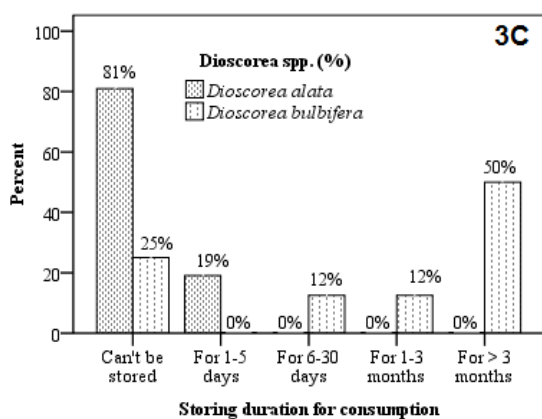


Figure 3C. Storing duration of *Dioscorea* spp. for consumption.

However, physiological activities such as sprouting, transpiration and respiration cause slight changes in the nutritional quality of yams during its storages (Zinash 2008). Therefore, fresh consumption is preferable in order to obtain all the necessary nutrients from *Dioscorea* species.

The native people have indigenous knowledge to preserve these crops for the purpose of propagation. Accordingly, *Dioscorea alata* could be preserved either underground at its growing place or in other prepared holes until the propagation time. However, the people in the current study area have been adapted to preserve *Dioscorea bulbifera* only at its growing place even if it can be preserved ex-situ (Fig. 3D). Likewise, Girma and Dereje (2015) has reported such traditionally in-situ storing mechanism of *Coccinia abyssinica* (Anchote) for propagation purposes. This indicates the application of similar characteristics in some root/tuber crops and the similarity in the indigenous knowledge in order to manage these crops.

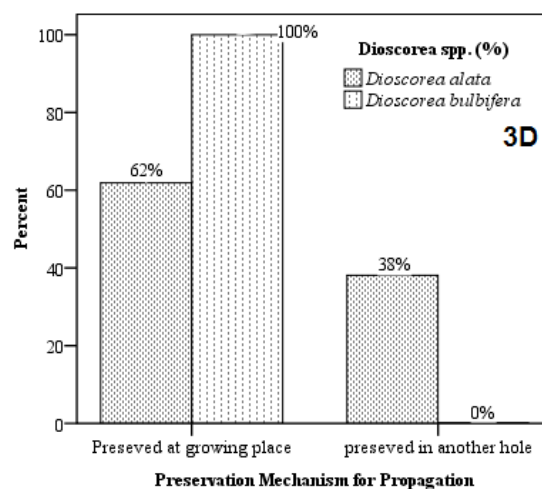


Figure 3D. Crop types; preserved at ITS growing place.

Moreover, these root/tuber crops are drought resistant because of their high food and water storage capacity. Hence, they play an important role to combat against food insecurity especially in developing countries like Ethiopia. Therefore, yams (*Dioscorea* spp.) are among the root/tuber crops which contribute to food security. In the line with this finding, Tamiru *et al.* (2008), Tamiru *et al.* (2011) and Zinash (2008) have reported the role of yams (*Dioscorea* species) to fight against food insecurity.

Ethnobotanical variation to use *Dioscorea* species

The current study shows the significant difference (at $p < 0.05$) between two species of *Dioscorea* in terms of ethnobotanical parameters such as edible crop parts, ways of preparation, medicinal importance, medicinally used plant parts, and preservation method for consumption and propagation. However, there was no variation in routes of consumption and the types of meal covered by *Dioscorea* species (Table 1).

Table 1: Ethnobotanical variation to use *Dioscorea* species in THE study area

ANOVA					
	Sum of Squares	DF	Mean Square	F	Sig.
Edible parts of the crops	9.05	1	9.05	162.93	0.00
Ways of preparation	24.71	1	24.71	15.13	0.00
Routes of consumption	0.33	1	0.33	2.33	0.14
Types of meal	0.17	1	0.17	0.08	0.78
Medicinal importance	4.14	1	4.14	7.30	0.01
Remedy parts of the plant	14.63	1	14.63	11.91	0.00
Preservation for consumption	34.34	1	34.34	36.92	0.00
Preservation for propagation	0.84	1	0.84	4.58	0.04

Note: DF = degrees of freedom, F = Ratio of variances (variation between sample means / variation within the samples), Sig. = Significance

Folk taxonomy

The current study tried to explore two domestic *Dioscorea* species. These crops have local names which derived from various sources. For instance, *Dioscorea bulbifera* is named locally as 'Feres Kotte', meaning that 'Horse Foot' in Amharic since its bulbils look like the hooves of horses. *Dioscorea alata* is named locally as 'Torabee or Gatticha' depending on the color of their tubers. Accordingly, those with white tuber are called 'Torabee' while those having purple color are known as 'Gatticha' in the Afaan Oromoo language. Therefore, in terms of ethnobotany, different plants may have various names derived from varieties of sources, and traditionally classified in various forms. Similar to this study, the folk taxonomies of different plants were revealed in the reports of Tamiru *et al.* (2011) and Tesfaye (2007).

Nutritional values of two domestic *Dioscorea* species in the study area

The current study has investigated two domesticated *Dioscorea* species for their nutritional contents. The investigated parameters include crude protein, crude fiber, mean moisture, crude lipid, total ash, total carbohydrate contents and calorific value of the crops. Accordingly, *Dioscorea bulbifera* is higher in crude protein, total ash, total carbohydrate content and calorific value than *Dioscorea alata* although it is relatively richer in crude fiber and moisture contents. However, the current study reveals that both crops are similar in crude lipid content (Table 2). In line with this result, Shanthakumari *et al.* (2008) reported that *Dioscorea bulbifera* was the second least in crude fiber content next to *Dioscorea tomentosa* from the seven *Dioscorea* species he has investigated. This indicates the scarcity of fiber in edible bulbils of *Dioscorea bulbifera* relative to edible tubers of other *Dioscorea* spp.

The calorific value of two domestic *Dioscorea* species in the study area

The current result revealed that the higher total energy (in kilocalorie) containing crop was *Dioscorea bulbifera* (100.4) than *Dioscorea alata* (88.4); although both crop species can be considered to have high nutrient values (Table 2). Also the comparison of the current study in nutrient composition with Maneenoon *et al.*'s (2008) study showed that *Dioscorea* species in the current finding are generally higher in crude protein, crude fiber, moisture and crude fat contents. However, they are lower in carbohydrate and total energy (Kcal) contents. In the other hand, *Dioscorea* species of higher moisture content are lower in total energy as exposed by both studies (Table 2).

Conclusions and Recommendations

Conclusions

The present study was conducted to assess the ethnobotany and nutritional value of two domestic yams (*Dioscorea alata* and *Dioscorea bulbifera*) in Abaya Woreda, southern Ethiopia. The study has involved the field survey of ethnobotanical investigation and laboratory of nutritional analyses. The result showed that farmers of Abaya Woreda have indigenous knowledge about food preparation method, routes of consumption, meal preference, medicinal use, plant remedy parts, storing mechanisms and propagation system of yams. However, there was significant variation in ethnobotanical knowledge of using *Dioscorea* species in terms of edible crop parts, ways of preparation, medicinal importance, plant remedy parts, and preservation method for consumption and propagation. Pertaining to nutritional content, *D. bulbifera* is higher in total energy and carbohydrate than *D. alata*. On the other hand, *D. alata* is higher in

fiber and moisture content than *D. bulbifera*. Generally, the present study has attempted to address general information about ethnobotanical knowledge and nutritional values of domestic

Dioscorea species in Abaya Woreda which is relevant for conservation to prevent germplasm loss over the next generations.

Table 2: Approximate composition of *Dioscorea* species (g/100 g fresh weight)

	Crop Name	Crude protein	Crude fiber	Moisture content	Crude fat	Total ash	Carbohydrate content	Total energy (Kcal)
	<i>D. alata</i>	6.6	2.5	71.2	0.5	4.7	14.5	88.4
Current study	<i>D. bulbifera</i>	6.6	2.0	71.0	0.5	4.8	17.4	100.4
Maneenoon et al. 2008	<i>D. calcicora</i>	2.65	0.38	61.79	0.00	0.83	34.35	148.00
	<i>D. daunea</i>	2.32	0.64	65.09	0.00	1.02	30.93	133.00
	<i>D. wallichii</i>	2.83	0.43	66.52	0.02	0.79	29.41	129.14
	<i>D. stemonoides</i>	0.94	0.72	75.57	0.06	0.73	21.98	92.22
	<i>D. glabra</i>	1.60	1.12	66.62	0.22	0.79	29.65	126.98

Recommendations

- Even though the study area is known for the availability of root and tuber crops, *Dioscorea* spp. are declining in cultivation due to replacement by other crops. Therefore, there should be increased education for farmers about conservation of these drought resistant crops since they can solve the problem of food insecurity.
- The indigenous knowledge of farmers concerning these crops, including traditional medicines, should be conserved for future generations and supported by education.
- Although nutrient analysis was carried out, analysis of essential minerals and heavy metals was not performed in this finding due to budget constraints. Therefore, further investigation should take place concerning essential minerals and heavy metal composition of these crops in the area.
- Both *Dioscorea alata* and *Dioscorea bulbifera* require additional cultivation and distribution for farmers since they are rich in energy and essential nutrients.
- The current study has emphasized only on the two domesticated *Dioscorea* spp. while the investigation of wild edible species will be important to conserve the wild plant resources.

Declarations

List of abbreviations:

ANOVA: Analysis of Variance
 AOAC: Association of Analytical Chemists
 DA: Development Agency
 Kcal: Kilocalories
 SNNPRS: Southern Nations, Nationalities, and Peoples Regional State
 SPSS: Statistical Package for Social Science

Ethics approval and consent to participate: The ethical issue in relation to this study was explained to interviewed community members and other concerned bodied in formal letter written from Academic and Research Vice President Office of Bule Hora University with Ref. No. BHU-02/4144/39. All participants provided oral prior informed consent.

Consent for publication: Not applicable.

Availability of data and materials: The data was not deposited in public repositories.

Competing interests: The authors do not have any competing interests.

Funding: This study was funded by Research and Publication Directorate Office of Bule Hora University for field data collection and laboratory work.

Authors' contributions: Both authors have engaged actively in proposal drafting, field data collection, laboratory exercise, data analysis and drafted manuscript.

Acknowledgements: We would like to thank Bule Hora University, Abaya Woreda Administrative Offices, all Development Agencies in Bochessa kebele, Gowangoa Badiya kebele and Kelaltu kebele, all respondents, our friends and our families, all of whom who contributed to the successful completion of this study.

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