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INDIGENOUS KNOWLEDGE-BASED EVALUATION OF *AMBACHI* TUBEROUS PLANT AS A FUTURE FAMINE FOOD CROP FOR DARFUR STATE, SUDAN

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ABSTRACT

Malnutrition and associated diseases are major challenges in the semi-arid Sahelian zone of Africa, where rainfall is <600 mm per *annum*. The objective of this study was to document indigenous knowledge on the significance and management of *Ambachi* (*Dioscorea hispida*) in East Darfur State, Sudan. A total of 101 respondents was interviewed using a semi-structured questionnaire in Bahr Alarab Locality, located in East Darfur State. Additionally, key informants and group discussions were held with local leaders to supplement data collection. The results revealed that *Ambachi* plant is fairly plentiful in East Darfur state, and grows naturally in the wild. All respondents were knowledgeable about *Ambachi* plant's appearance, growth cycle, usage and storage processes. Generally, *Ambachi* tubers are stored in various types of natural and synthetic containers, and for varied periods of time. However, up to 78% of the respondents reported Shawwal (made of plastic material), as the most preferred container for storage of dry tubers. Virtually all households (99%) attested to consuming *Ambachi*-based foods particularly during famine periods. Up to 98% of *Ambachi* plant tubers are soaked before cooking to remove the bitter taste; and two thirds of interviewees were familiar with the cooking process of *Ambachi* foods. Lastly, *Ambachi* plant tubers are tradable in different local markets across the region; although it was mainly sold in Abu matareg market located in Bahar Alara locality.

Key Words: Bitter taste, *Dioscorea hispida*, famine food

RÉSUMÉ

La malnutrition et les maladies associées sont des défis majeurs dans la zone sahélienne semi-aride de l'Afrique où la précipitation est inférieure à 600 mm par an. L'objectif de cette étude était de documenter les connaissances autochtones sur l'importance et la gestion d'*Ambachi* (*Dioscorea hispida*) dans l'État du Darfour oriental, au Soudan. Au total, 101 répondants ont été interrogés à l'aide d'un

questionnaire semi-structuré dans la localité de Bahr Alarab, située dans l'État du Darfour oriental. De plus, des informateurs clés et des discussions de groupe ont été organisés avec les dirigeants locaux pour compléter la collecte de données. Les résultats ont révélé que la plante *Ambachi* est assez abondante dans l'État du Darfour oriental et pousse naturellement à l'état sauvage. Tous les répondants connaissaient l'apparence, le cycle de croissance, l'utilisation et les processus de stockage de la plante d'*Ambachi*. Généralement, les tubercules d'*Ambachi* sont stockés dans divers types de contenants naturels et synthétiques, et pendant des périodes de temps variées. Cependant, jusqu'à 78 % des répondants ont indiqué que Shawwal (fait de matière plastique) était le conteneur le plus préféré pour le stockage des tubercules secs. Pratiquement tous les ménages (99%) ont attesté de consommer des aliments à base d'*Ambachi*, en particulier pendant les périodes de famine. Jusqu'à 98 % des tubercules de la plante d'*Ambachi* sont trempés avant la cuisson pour éliminer le goût amer ; et les deux tiers des personnes interrogées connaissaient le processus de cuisson des aliments d'*Ambachi*. Enfin, les tubercules de la plante d'*Ambachi* sont commercialisables sur différents marchés locaux de la région ; bien qu'il ait été principalement vendu sur le marché d' Abu Matareg situé dans la localité de Bahar Alara.

Mots Clés : Goût amer, *Dioscorea hispida*, aliment de famine

INTRODUCTION

Malnutrition and associated diseases are major challenges in the semi-arid Sahelian zone of Africa, where rainfall is <600 mm per *annum* (Harrison, 1987; FAO, 1995). In a drought free year, up to 150 million Africans in this arid zone live in a semi-continual state of starvation (Rinaudo, 1992). Fortunately, there exist a range of traditional food sources in the wild whose potential to cater for food security during such drought off-seasons, remains unexploited.

In Darfur of the Sudan, a glaring example is that of *Ambachi* (*Dioscorea hispida* Dennst), which is common in people's diets during drought periods (Mohammed, 2019). The edible plant tubers are large, deeply lobed, but covered with masses of fibrous roots (NRI, 1987). The plant grows wild in tropical rain forest conditions, usually at elevations lower than 500 m, though it has been reported to grow at altitudes up to 1200 m in the Himalayas (NRI, 1987).

Despite the growing significance of the crop in Darfur, dismal research efforts have been made to augment and formalise *Ambachi* tuber utilisation and commercialisation in Darfur. The objective of this study was to

document indigenous knowledge on the significance and management of *Ambachi* (*Dioscorea hispida*) in East Darfur State, Sudan.

MATERIALS AND METHODS

Study area. The study was carried out in Bahr Alarab Locality, which is located in East Darfur State. It is located between latitude 10° - 13°N and longitude 25° - 27°E. The locality is characteristic by a tropical climate, with rainfall ranging between 200 and 500 mm. Sandy soil dominates (about 70%) in the northern and eastern parts of the locality; while the middle and south of the locality is characterised by heavy clay soil (MPPED, 2016). *Ambachi* (*Dioscorea hispida*) is a wild plant, widely distributed in the low altitude area "Khieran" in Bahr Alarab Locality, especially during the rainy seasons.

Field survey. A survey was conducted in Bahr Alarab Locality in East Darfur, during the rainy season of 2019. A total number of 101 respondents were randomly selected and interviewed, with a focus on households men and women. A semi-structured questionnaire was designed according to Neumann *et al.*

(2003), and used to collect data during the survey. The thrust of the questionnaire was on the social characteristics of the respondents, and indigenous knowledge of *Ambachi* growth habits and consumption under various conditions in the locality. Group discussions and key informant interviews were held in order to supplement the information sourced from the survey.

Data analysis. The different types of datasets collected were subjected to descriptive statistics using the Statistical Package for the Social Sciences (SPSS 16.0., Chicago, SPSS Inc; 2007). The associations between variables were evaluated using a Chi-square test at 0.05 level of significance. In addition, the relationships between the dependent and independent variables were examined using Logistic Regression analysis.

RESULTS AND DISCUSSION

Indigenous knowledge. All the respondents interviewed confirmed being knowledgeable about *Ambachi* plant and having sufficient experiences on its usage as food. The majority knew the plant as *Ambachi*, except one respondent who knew it as *Angna*. It was generally believed that *Ambachi* plant typically grows naturally in the wild (Table 1) and is

rarely cultivated or domesticated. This observation concurs with that of Mohammed (2019) that *Ambachi* is typically a wild plant, though useful as a food crop among various ethnic groups in sub-Saharan Africa.

A dismal 8% referred to *Ambachi* plant as *Om gaja* (*Bambi* like) and *Ablayla* (its fruits are very small like lemon). The varied nomenclature of this plant by the communities in East Darfur may be attributed to the tribal descriptive culture and local languages.

A few cases of cultivation of *Ambachi* especially in May was revealed by up to 63% of the respondents; although up to 21% contended that the plants was grown in June. Majority of the respondents (76.6%) concurred that *Ambachi* plant takes about 1-3 months to mature. However, the rest claimed that the plant matures in 4-10 months. This variation in the harvesting time between the respondents may be linked with the different agro ecological zones in the region; the length of the rainy season and the moderate temperature that control the completion of the plant life cycle (Mohammed, 2019). In Cameroon, the planting season of a similar root crop, yam (*Dioscorea* spp.), ranges from November to May with a harvesting time of 6 to 10 months depending on the agro-ecological area and the types and species of the plant (Acquah and Evange, 1991).

TABLE 1. Indigenous knowledge about *Ambachi* as a food plant and inhabitants in East Darfur, Sudan. The answer is yes, but varied and diverse.

Area	Locality	Frequency (No)	Percent (%)
Albroya	Bahar Alarab	12	32.4
Bahar Alarab	Bahar Alarab	14	37.8
Abu Matareg	Bahar Alarab	1	2.7
Golal	Bahar Alarab	1	2.7
Dheel Dabi	Bahar Alarab	2	2.7
Abu Gabra	Abu Gabra	4	5.4
Alfardos	Alfardos	2	10.8
Samaha	Bahar Alarab	1	5.4
Total		37	100

With respect to physical appearance of *Ambachi* plant tubers, 96% described the tubers as having eyes similar to potato tubers. Indeed, the *Ambachi* plant root crop belongs to the genus *Dioscorea* together with Dioscoreaceae (like yam), (Sefa-Dedeh, 2003).

Ambachi-based food, preparation, consumption and storage. Virtually all respondents (99%) were fully experienced in consuming *Ambachi*-based foods in their diets. Two thirds of the interviewees attested to eating the non-delicate part of *Ambachi* plant; while the remainder consumed the delicate part in their menus. The key informants attributed the high levels of household consumption of *Ambachi* plant to their knowledge as a source of starch contained in the tubers (Jiang *et al.* 2012).

Preparation of *Ambachi*-based food. Up to 98% of the respondents treated the tubers before use for eating in order to suppress the bitter taste. This was achieved by soaking the tuber slices in plentiful water. This type of pretreatment has been reported in different countries, by way of soaking in ordinary water (34.48%) or using boiling water (18.95%) (Bukhari, 2014).

In general, the preparation of flour or starch from tubers is done in the following order: washing of the tubers, pulping, treating with lime water containing potassium permanganate, and finality isolating the flour (Kay, 1973). *Dioscorea* tuber is known to contain anti-nutritional materials such as all free phenolics, tannins, hydrogen cyanide, total oxalate, amylase and trypsin inhibitor. However, these substances can be inactivated using humid heat treatment and soaking; followed by cooking before consumption (Shajeela *et al.* 2011).

Two thirds of the interviewees described the traditional method of *Ambachi* food (meal) preparation as follows: they boil and peel the tubers of the *Ambachi* plant; cut it into small portions; put it in water for three days; spread

it under the sun light to dry; add onion, meat, water and oil and left to be cooked. In different countries, yam is consumed in different forms; mostly boiled and eaten with soup, and pounded yam (fufu), roasted, parching, or pancake in wheat flower, and as chips (Agbor-Egbe and Treche, 1995; Leng *et al.* 2016).

Significance of *Ambachi* plant as a famine crop. Almost all the respondents (99%) considered *Ambachi* plant as a famine crop. It is nutritively rich and yet affordable to majority of households in the surveyed area (Abu matareg, Darfur); where famine occurs frequently (Ngo Ngwe *et al.*, 2015).

Only 7% of the respondents asserted to other uses of *Ambachi* plant mostly as medicine to treat throat pain, tumors, snake and scorpion bites (Fig. 1). *Dioscorea* genus is tuberous plant which consists of approximately 600 types; of which there are about 50-60 species have been cultivated and utilised as food and for medicinal purposes (Coursey, 1976). Tubers were also utilised by the community to treat leprosy, ulcers, diabetes, heat dilution, anti-rheumatic, phlegm thinners, eliminating menstrual pain, and animal poisons. On the other hand, sap is utilised to treat snake bites, and tubers for therapy of open injuries particularly in Asia (NRI, 1987).

Marketing of *Ambachi*-based food. All of respondents agreed that the *Ambachi* plant tubers are marketable commodities in different local markets across different localities (Table 2). The majority of the respondents (61.4%) agreed that Abu matareg market, located in Bahar Alara locality, was the main local market for *Ambachi* tubers in East Dafur. However, there were a number of other local markets, spreading across different localities, where small quantities of *Ambachi* tubers were traded.

It was clear that the price of *Ambachi* dry tubers varied widely depending on the local market (Fig. 2); with an average price per kg of 0.33 USD.

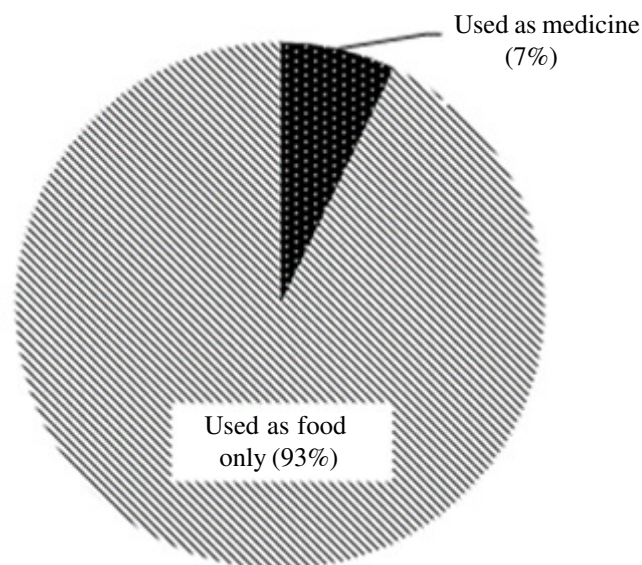


Figure 1. Frequency distribution of the respondent according to uses of *Ambachi* plant.

TABLE 2. Markets where dried *Ambachi* tubers are sold in East Darfur, Sudan

Name of market	Locality	Frequency distribution of the respondents	Percent (%)
Abu matareg	BaharAlarab	62	61.4
Adein	Adein	3	3
Golal	BaharAlarab	18	17.8
Totoloto	BaharAlarab	3	3
Hebael	Alfardos	3	3
Asalaya	Asalaya	2	2
Boro	BaharAlarab	2	2
Abu gabra	Abu gabra	2	2
Alfaid	BaharAlarab	2	2
Alfardos	Alfardos	2	2
Korgi	BaharAlarab	2	2
Total		101	100

Storage of *Ambachi* tubers. Virtually all respondents concurred that *Ambachi* tubers were storable in different storage containers made from either natural or synthetic materials (Fig. 3). Seventy eight percent of the respondents contended that *Shawwal* (made of plastic material), was the preferable container for storing *Ambachi* dry tubers (Fig. 3). This is probably because it is available,

accessible and affordable to majority of households and yet simple to maintain. It also reportedly produced good quality *Ambachi* tubers characterised by extended shelf-life. Another preferable container was Bucket (11%) made from iron material. Other storage containers included cartons (4%) (made of paper); Sein (3%) (made of goat skin); Gorab (2%) (made of Goat skin); Racooba (1%)

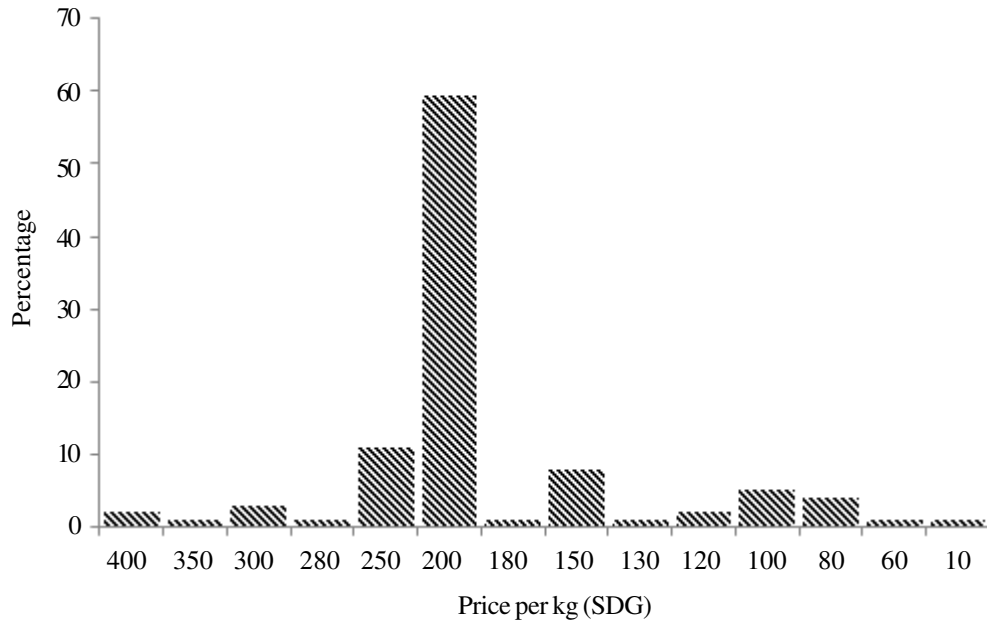


Figure 2. Frequency distribution of the respondents according to the price of the *Ambachi* dry tubers in the local markets in East Darfur.

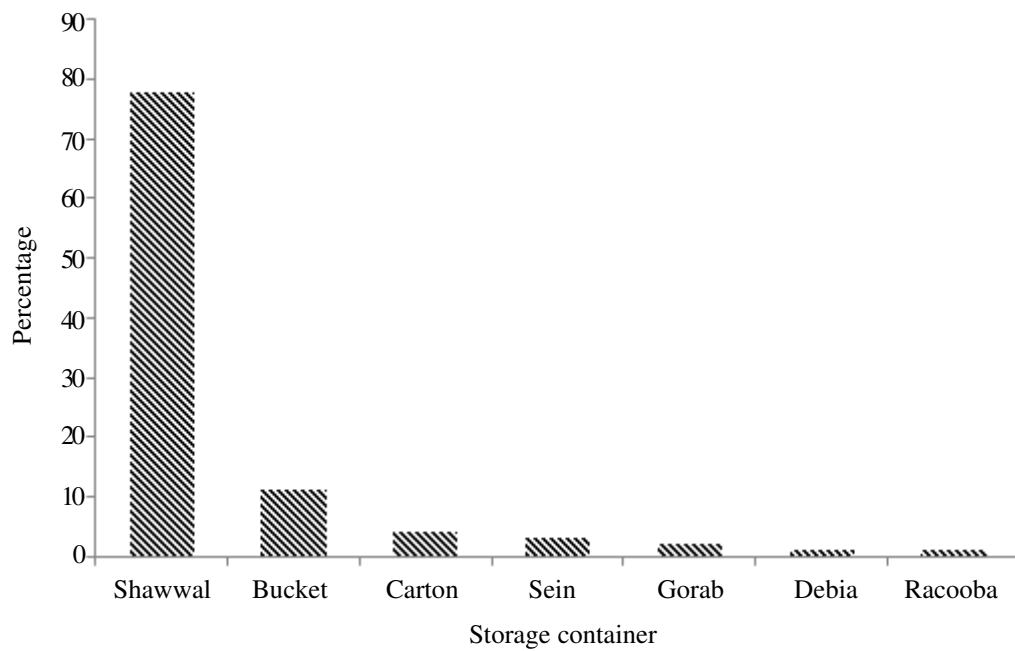


Figure 3. Frequency distribution of the respondents according to the containers used for storage of *Ambachi* dry tubers in East Darfur.

(made of wood); and Debia (1%) (made of Sheep hair) (Fig. 3). Polymers were the most used plastic raw materials for people in the food packaging industry. More detailed advantages of plastic containers have been described in earlier reports (Amni *et al.*, 2015; Heincke *et al.*, 2017).

The longest storage period for *Ambachi* tubers ranged from >12 months (43.6%), to exactly 12 months (40.6%) (Fig. 4). On the other hand, 15.8% of the respondents said *Ambachi* tubers can be stored for less than 12 month (Fig. 4). This storage attribute underscores the potential for this crop to serve as a food security crop, particularly during extended drought periods.

The few constraints revealed by the survey (7%) included drying and storage of tubers of *Ambachi* plants. These principally emanated from attack by storage weevils that can lead to loss in the nutritive value of the tubers, when the storage is for a long time period. However, regardless of the type of the storage container used, 93% of the respondents did not experienced problems during storage of the tubers of *Ambachi* plant. This is possibly

because the stuff was kept dry and away from moisture conditions in the storage facilities. It is well known and fully documented that food with high moisture content is at high risk and more favourable for microbial contamination, compared to the food with low moisture content (Alegbeleye *et al.*, 2018; Otegbayo *et al.*, 2018).

However, the majority of the respondents agreed that the stem was the most edible part compared to the roots. The *Ambachi* plant is a root crop which belongs to the genus *Dioscorea* with *Dioscoreaceae* (like yam), (Sefa-Dedeh, 2003). Similar results of Chi-square test obtained for the social characteristics Main job ($\chi^2=1.128$, $df = 4$, $P = 0.762$), Second job ($\chi^2 = 5.451$, $df = 4$, $P = 0.091$), Educational level ($\chi^2 = 3.296$, $df = 5$, $P = 0.978$), and Family size ($\chi^2 = 0.482$, $df = 1$, $P = 0.431$), revealed that no significant association between these social characteristics and the edible part of *Ambachi* plant. However, 65.3% of respondents, whose main job was agriculture, indicated that the stem was the more edible part of *Ambachi* plant (Table 3).

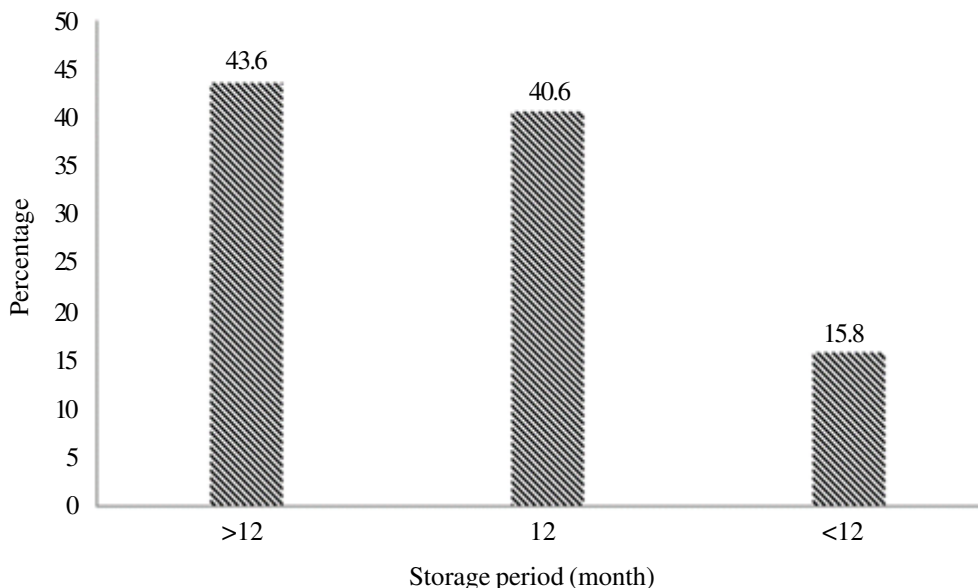


Figure 4. Shelf-life of *Ambachi* dry tubers in East Darfur.

TABLE 3. Chi-square test on the edible part of *Ambachi* plant and the social characteristics of the respondents from Eat Darfur, Sudan

Social characteristics		Edible part of <i>Ambachi</i> plant		Total	
		Stem	Root		
Respondents age	(15-30)	Count	18	0	18
		% of Total	18.2%	0.00%	18.2%
	(31-45)	Count	35	8	43
		% of Total	35.4%	8.10%	43.4%
	(46-65)	Count	33	0	33
		% of Total	33.3%	0.00%	33.3%
	(66-85)	Count	5	0	5
		% of Total	5.1%	0.00%	5.1%
Total	Count	91	8	99	
	% of Total	91.9%	8.1%	100.00%	
Respondents gender	Male	Count	65	7	72
		% of Total	64.4%	6.9%	71.3%
	Female	Count	28	1	29
		% of Total	27.7%	1.00%	28.7%
Total	Count	93	8	101	
	% of Total	92.1%	7.9%	100.00%	

TABLE 3. Contd.

Social characteristics			Edible part of Ambachi plant		Total
			Stem	Root	
Respondents main job	Pasture	Count	3	0	3
		% of Total	3.00%	0.00%	3.00%
	Agriculture	Count	66	6	72
		% of Total	65.3%	5.9%	71.3%
	Trade	Count	7	1	8
		% of Total	6.9%	1.00%	7.9%
	Government employee	Count	10	1	11
		% of Total	9.9%	1.00%	10.9%
	Others	Count	7	0	7
		% of Total	6.9%	0.00%	6.9%
Total	Count	93	8	101	
	% of Total	92.1%	7.9%	100.00%	
Respondents second job	Pasture	Count	14	2	16
		% of Total	15.6%	2.2%	17.8%
	Agriculture	Count	38	1	39
		% of Total	42.2%	1.1%	43.3%
	Trade	Count	12	0	12
		% of Total	13.3%	0.0%	13.3%
	Government employee	Count	2	0	2
		% of Total	2.2%	0.0%	2.2%
	Others	Count	21	0	21
		% of Total	23.3%	0.00%	23.3%
Total	Count	87	3	90	
	% of Total	96.7%	3.3%	100.0%	

Ambachi tuberous plant as a future famine food crop

TABLE 3. Contd.

Social characteristics			Edible part of Ambachi plant		Total
			Stem	Root	
Social status	Married	Count	82	5	87
		% of Total	81.2%	5.0%	86.1%
	Unmarried	Count	10	2	12
		% of Total	9.9%	2.0%	11.9%
	Vidual	Count	1	1	2
		% of Total	1.0%	1.0%	2.0%
Total	Count	93	8	101	
	% of Total	92.1%	7.9%	100.0%	
Family size	3-5Persons	Count	23	1	24
		% of Total	24.2%	1.1%	25.3%
	< 5 Persons	Count	65	6	71
		% of Total	68.4%	6.3%	74.7%
Total	Count	88	7	95	
	% of Total	92.6%	7.4%	100.0%	
Education level	Uneducated	Count	49	4	53
		% of Total	50.0%	4.1%	54.1%
	Primary	Count	24	2	26
		% of Total	24.5%	2.0%	26.5%
	Secondary	Count	8	1	9
		% of Total	8.2%	1.0%	9.2%
	University	Count	2	1	3
		% of Total	2.0%	1.0%	3.0%

TABLE 3. Contd.

Social characteristics			Edible part of Ambachi plant		Total
			Stem	Root	
	Above the university	% of Total	2.0%	1.0%	3.1%
		Count	1	0	1
	Khalwa	% of Total	1.0%	0.0%	1.0%
		Count	6	0	6
Total		% of Total	6.1%	0.0%	6.1%
		Count	90	98	
		% of Total	8.2%	100.0%	
		Count	90	98	
Monthly income	500-1000SDG	Count	40	7	47
		% of Total	40.0%	7.0%	47.0%
	1500-2000SDG	Count	24	0	24
		% of Total	24.0%	0.0%	24.0%
	2500-3000SDG	Count	12	0	12
		% of Total	12.0%	0.0%	12.0%
	3500-5000SDG	Count	7	0	7
		% of Total	7.0%	0.0%	7.0%
	<5000SDG	Count	10	0	10
		% of Total	10.0%	0.0%	10.0%
Total		Count	93	100	
		% of Total	93%	100.0%	

Ambachi tuberous plant as a future famine food crop

TABLE 4. Logistic Regression on the dependent variable: *Ambachi* use, experience and storage based on gender as independent variables

Gender	R ²	Sig.	Odds Ratio	95.0% C.I.for EXP(B)	
				Lower	Upper
Storage problem	0.022	0.39	2.585	0.297	22.476
Use of <i>Ambachi</i> plant during famine	0.064	0.998	0.0	0	0
Experience with <i>Ambachi</i> plant	0.23	0.997	5.98	0	0
Is <i>Ambachi</i> food storable?	0.065	0.998	0.0	0	0

With regard to the social characteristics of the respondents; that is Social status ($\chi^2 = 6.678$, $df = 2$, $P = 0.016$) and monthly income ($\chi^2 = 8.488$, $df = 4$, $P = 0.025$), Chi-square test showed significant association with the edible part of *Ambachi* plant (Table 3). About 81% of the respondents who were married confirmed that the stem was edible and only 5% believed that the root was the edible part of the crop.

The result of the regression test showed no significant association between the respondent gender and use of *Ambachi* plant during famine [$R^2 = .064$, $P = 0.998$, $CI = (0-0)$], experience with *Ambachi* plant [$R^2 = .230$, $P = 0.997$, $CI = (0-0)$], the *Ambachi* food storage [$R^2 = .065$, $P = 0.998$, $CI = (0-0)$], and storage problem encountered [$R^2 = .022$, $P = 0.39$, $CI = (0.297-22.476)$] (Table 4). This result is inconsistency with results presented above, where almost all of the respondents (99%), regardless of the gender (male or female), confirmed being aware and knowledgeable about the consumption of the *Ambachi* plant during famine periods and yet being storable for period of time. It is indeed, the availability, nutritive value and affordability of the *Ambachi* tubers in the surveyed area (Abu matareg, Darfur) that enable the *Ambachi*-based food to meet the criteria of being a potential famine food. *Dioscorea* tubers have an edge of nutritional features over other root crops (Shajeela *et al.*, 2011).

CONCLUSION

The results showed that *Ambachi* (*Dioscorea hispida*) is a wild tuber crop, widely used in East Darfur as a food security crop during famine periods. All the respondents in the surveyed area (Abu Matareg, Bahar Alarab locality, East Darfur) were knowledgeable about *Ambachi* plant physical appearance, growth cycle, and had sufficient experiences with its usage, food preparation and storage. The *Ambachi* plant tubers were marketable in different local markets across different localities; with Abu Matareg market, being the main and biggest local market for *Ambachi* tubers. Almost, all of the respondents (99%) are aware and knowledgeable about the use of the *Ambachi* plant during famine-stricken. *Ambachi* is locally available, nutritive and affordable in the surveyed area (Abu matareg, Darfur); where famine-stricken is a common historical phenomenon

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