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Research Article

Assessment of Indigenous Knowledge for Selection and Classification of Aerial Yam *(Dioscorea Bulbifera* (L.)*)* Accessions in South and Southwestern Ethiopia

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ABSTRACT

Participatory evaluation on forty seven accessions of the aerial yam (Dioscorea bulbifera) was carried out in woldiya peasant association, which is a major D. bulbifera growing area of Jimma zone and near to Jimma Agricultural Research Center. The objectives of the study were to select aerial yam accessions based on key morphological traits and classification of D. bulbifera accessions based on maturity and farmers' utilization options. Twenty households from the PA were selected based on consultation with key informants knowledgeable about the crop to determine yam selection, classification systems, and on different management practices through the entire growing period of aerial yam during the 2007/2008 growing season. The results of the evaluation indicated that from all accessions of D. bulbifera, 14 (29.78%), 22(46.8%) and 11(23.4%) of accessions are early, medium and late maturing respectively. Besides this, 62.5%, 25.0% and 12.5% of the farmers selected the late, medium and early maturing D. bulbifera accessions based on total yield (bulbils and tuber). Even if 62.5% of participated farmers preferred late maturing aerial yam accessions by total yield, most of the farmers selected the early and medium types due to the ease of harvesting and market value. Based on organoleptic test of tuber and bulbils, 60 and 85% of the farmers preferred late maturing accessions. On the bases of overall criteria, the late maturing accessions had the first ranks by farmers' evaluation.

Keywords: Aerial yam, Participatory, Selection, classification, evaluation and maturity.

1. INTRODUCTION

Yam is a multi species crop that belongs to the genus *Dioscorea* and family *Dioscoreaceae*. It is found in Africa, India, Southeast Asia, Australia and tropical America with about 600 described species (Coursey, 1967; Jayasurya, 1984; Wilkin, 1998). It is the fourth most important tuber crop in economic terms (Mignouna and Dansi, 2003), after potatoes (*Solanum tuberosum* L.), cassava (*Manihot esculenta* Crantz), and sweet potatoes (*Ipomoea batatas* (L.) Poir). Yam is being cultivated in most Sub-Saharan Africa, especially in West Africa, which produces over 95 % of the output (FAO, 2010) and they are the staple carbohydrate source of millions of peoples.

Yams in Ethiopia are hardly known to the scientific community. The country is only referred to as an isolated center of yam cultivation (Norman et al., 1995*;* Tamiru, 2006), where a number of *Dioscorea* species are grown in complex cropping systems together with cereals, and other root and tuber crops. Aerial yam (*Dioscorea bulbifera* L.) is one of the important food yam species for millions of people in humid and sub humid tropics. It's distinguished from all other species by having specialized aerial bulbils on the basis of petioles (Marthin, 1974; Mulualem, 2008). To such an extent that tuberization is solely aerial, the tuber and bulbils provide an important food sources in these region.

In Ethiopia, especially in the south and southwestern parts, aerial yam has been a basic and traditional food crop for small-and medium-scale farmers. Despite in its importance, the production aerial yam has been going down; this is because of the fact that yams have been widely neglected by research and development programs (Norman *et al.,* 1995; Tamiru, 2006), drought and trampling by hoof of mammals and deforestation have been identified to be among the major constraints. Besides this, there is no systematic study on selection, classification, diversity, production and use of *D. bulbifera* in the country. Evaluation and conservation of germplasm are viewed to be the most feasible solution to the problems, efficient utilization and breeding so as to reduce further genetic erosion

(Edwards, 1991). In order to get promising germplasm to end users, a system which enables farmers' selection and classification of the accessions is crucial. In this system, the main evaluator is the farmer, assisted by extensionists and researchers. Moreover, the taxonomical classification of aerial yam is considered to be problematic (Velayudhan et al., 1998), which is attributed to their extensive variability within the species, especially of aerial and subterranean parts, such as leaves, bulbils and tubers; as consequence, its taxonomy is confusing. However, the communities who depend on wild aerial yam species for their food classify each member based on characters of its edibility and other uses and applications. Such classification of taxa based on use value and application by ordinary men and women is often called folk taxonomy (Brush, 1981). Several authors have discussed folk taxonomy and their relation to the genetics of the crops and it has been shown that inter-specific folk taxonomies are often biologically accurate (Quiros *et al.,* 1990). Folk identification and classification to a certain extent also helps in estimating genotypic diversity. Folk taxonomists depend on a wide range of information including not only characteristics of the taxa in question, but also location in certain habitats and seasonal periods (Boster, 1985; Edwards, 1991). The folk system relies chiefly on the use classes of tubers such as edibility, taste, flesh color, size, and direction of growth, fiber content, cooking properties and occasionally tuber and bulbils number. For classifying aerial yam species, the Linnaean system uses character classes pertaining to that of floral, fruit and seed (reproductive) characters as well as the direction of twining of the stem. The size, shape, color and nature of tubers and bulbils are also used as important taxonomic characters (Edwards, 1991).

The ploidy levels exhibiting differences in chromosome numbers among *Dioscorea* species. The most commonly reported chromosome numbers of *D. bulbifera* are 2n= 26, 28 and 80. The disparity of chromosome number may be due to the fact that aerial yam chromosomes are liable to unpredictable behavior during cell division (Onwume and Charles, 1978; Mulualem, 2008). Therefore, to clarify the taxonomy of this crop, a comprehensive approach is needed to assess characters when delimiting species and varieties, perhaps by integrating the Linnaean, folk and modern taxonomic systems. Therefore, this study focuses on selection and classification of *D. bulbifera* accessions by farmers' evaluation criteria. Thus, detailed descriptions of aerial yam accessions based on morphological characters for farmers' selection and classification have tremendous impact on the conservation and genetic improvement of the crop.

2. MATERIALS AND METHODS

2.1 Description of the Study Area and Experimental Design

The experiment was conducted at Jimma Agricultural Research Center 2007/2008 cropping season. The center located at 7° 40. 00' N and longitude 36° 47'.00 E, having an altitude of 1764 m.a.s.l. The area receives mean annual rainfall of 1432 mm with maximum and minimum temperature of 29.2 ^{0} C and of 8.90 ^{0} C, respectively. The soil Eutric Nitosole (reddish brown) with pH of 5.3 (Labouissie, 2006). A total of 47 *Dioscorea bulbifera* accessions were considered in this study. The accessions were collected from south and southwestern parts of Ethiopia, during March- April 2000. The collections covered diverse agro-ecologies (low, mid and high lands) with an altitude range of 1130-2340 m.a.s.l, representing one of the major yam production areas in the country. Farmers were selected from woldiya peasant association (PA) which is a major *D. bulbifera* growing area of Jimma zone and located near to the center.

2.2 Sampling technique

Individual and group discussions with field visits were used for evaluation and data collection with farmers. Selection of individual farmer was made on meeting with key informants familiar about the crops to determine the selection and classification of aerial yam accessions through the entire growing period. Through recurrent discussions, we reiterated our engagement to ground the research on farmers' knowledge and preferences. Our relationship with farmers developed into a sort of contract based on mutual benefit. Such contracts with farmers appear as pre-requisites for joint learning and platform generation and form the frames on which the research trial and activities are developed. A total of twenty households from the PA were selected for semi-structured interviews and discussions. Through individual discussions with farmers in the area; a total of 10 different criteria were identified by farmers based on selection and classification of *D. bulbifera* accessions. These criteria were submitted to the group of farmers for further evaluation.

The interviews are later extended to group participatory discussions with selected farmers in two clusters in the area. Group discussions were to carefully build on and critically examine derived information from individual farmers of different households. It was also intended to clear conflicting ideas on issue like culinary attributes and classification of accessions during the discussion with individual farmers . The group discussions focused on ; i)

Selection procedure by evaluating through time, ii) Farmers' preference among accessions, iii) The utilization options of *D. bulbifera* at the farm level, iv) Longevity in storage, v) Ease of harvesting, vi) Total yield (tuber and bulbils) and vii) Susceptibility to diseases and pests. Information obtained from the interviews (individual households and group discussion) and from the key informants was used to obtain a broad understanding on selection and classification of *D. bulbifera* in the area. After harvesting of all accessions, the tested farmers were evaluated based on utilization options and other agronomic characters of *D. bulbifera*; such as organoleptic evaluation was assessed by tasting the cooked yam.

3 RESULTS AND DISCUSSIONS

3.1 Selection of *D. bulbifera* accessions based on farmers' criteria

The result of farmers' evaluation indicated that there were many important practices carried out by farmers' concerning selection and utilization options of *D. bulbifera*. Although, selection of accessions can go on through out the year by observation, intensive selection and planting of the selected material is done during the long rainy season. From the household interviews, 13 farmers (65.0%) replied that they select and collect planting materials from their own gardens or from their neighbor's gardens and the remaining seven farmers (35.0%) replied that they collect planting material from the local market.

Apart from this, all farmers were asked to evaluate the 47 aerial yam accessions based on their criteria. On an average 70.0% of the farmers' preferred the late maturing accessions, 23.75% selected medium maturing and the remaining 6.25% of the farmers selected early maturing accessions, based on organoleptic tasting of the boiled yam. Early maturing accessions had high amount of water after boiling, were not tasty, and had poor color and quality after cooking. In addition to this, based on total yield (bulbils and tuber), 62.5%, 25.0% and 12.5% of the farmers selected the late, medium and early maturing *D. bulbifera* accessions respectively. Farmers preferred early maturing accessions to get early harvesting during seasonal food shortage in the area when other crops are still in the field. Thus, early maturing accessions fill a seasonal food shortage in the area and had high market value at a time in the area. Besides this, early maturing yam had high moisture content and can easily spoil after harvesting was done, as a result, only 10% of the respondents selected early maturing accessions, the other 30% and 60% of farmers selected medium and late maturing accessions based on longevity of storage.

Almost all farmers have the same knowledge about different accession of *D. bulbifera* that are cultivated in the area, but they use the common name 'hare kote or kote hare' for *D. bulbifera* as a whole, Which is derived from Oromo language meaning 'the hoof of the donkey' because of the resemblance of *Dioscorea bulbifera* bulbils with donkey hoof. This provides a good setting for studying, selection and evaluation criteria of *Dioscorea bulbifera* in traditional agriculture using named cultivars with a minimum influence of language polymorphism within the farmers. Aerial yam (*Dioscorea bulbifera)* harvesting is a labour-intensive operation that involves standing, bending, squatting, and sometimes sitting on the ground depending on the size of the mound, size of tubers or depth of tuber penetration and the height at which bulbils are produced. Moreover, many tubers also get deformed during their entire growing periods as a result of obstacles they encounter. This is taken into consideration by the farmers; 15 (75.0%) of the farmers selected early maturing accessions for ease of harvesting. In the late maturing accessions, the tuber penetrates deep into the soil and harvesting became tedious. The remaining 5 (25.0%) of the farmers selected medium maturing accessions (Table 1). During the entire growing period of *D. bulbifera*, there is no disease and pests were observed, as a result, farmers had not evaluated the susceptibility and resistance of accessions to diseases and pests. However, during the dry season and onset of rainy seasons, some larva of yam beetle is observed in the area (Tewodros, 2008). In general, farmers selection criteria vary and highly dependent on the needs of individual farmers.

Table 1: Summary of major selection and evaluation criteria of *Dioscorea bulbifera* by Farmers' and their rankings (n= 20 farmers).

Criterion	Early maturing			Medium maturing			Late maturing		
	No of farmers	%	Rank	No of farmers	%	Rank	No of farmers	%	Rank
Bulbils yield	3	15.0	3	4	20.0	2	13	65.0	1
Tuber yield	2	10.0	3	6	30.0	2	12	60.0	1
Taste of bulbils after cooking	0	0.0	3	3	15.0	2	17	85.0	1
Taste of tuber after cooking	3	15.0	2	5	25.0	2	12	60.0	1
Powder ness of bulbils when cooked	0	0.0	3	4	20.0	2	16	80.00	1
Powderness of tuber when cooked	2	10.0	3	7	35.0	2	11	55.0	1
Easiness to harvest	15	75.0	1	5	25.0	2	0	0.0	3
Market value	8	40.0	1	7	35.0	2	5	25.0	3
Storability	2	10.0	3	6	30.0	2	12	60.0	1
Over all sum	35			47			98		
Over all rank	3			2			1		

Rank: 1= Best; 2= Fair; 3= Worst. The scoring represents farmer's evaluation criteria of aerial yam. This scoring reveals the degree of satisfaction provided by each group in considering each criteria (n=20). Only farmers who held evolutional knowledge on each given technology were requested to assess it.

3.2 Classification of *Dioscorea bulbifera* based on farmers' criteria

Farmers' selection and management of *D. bulbifera* is facilitated through a complex local classification system (Brush, 1981), which is developed as it suits their needs without reference to any code of nomenclature. Selections are often made in terms of known categories and their classification scheme (Tamiru, 2006). The local classification system by farmers based on maturity and organoleptic quality are showed a pattern of hierarchy in that it starts with more general grouping of the available accessions into those that produce aerial bulbils and underground tubers. At this level, it is akin to the conventional botanical taxonomy, where major cultivated species are classified into sections within the *D. bulbifera* mainly based on the organoleptic taste and their related morphological characters; for example, vine twining directions, vine length and bulbils shape etc.

Besides this, due to its dioecious nature, classification of *D. bulbifera* accessions as 'female and male' is an interesting aspect of the local classification system. Careful scrutiny of farmers' account of the two categories indicated that this grouping reflects more than mere differences in agro-morphological traits and ecological adaptation. It appears that the system has also a bearing on the society's perception of gender and its role. This gender related categorization of crop in the study area is not peculiar to *Dioscorea bulbifera* but it is common in other crop. The detail description of the major attributes of the two groups, pointed out that such categories reflect the fact that men and women prefer different qualities in their cultivars. The female characters are related to consumption qualities. These findings further reveal the complex nature of folk taxonomy and support the view that crops are biological as well as cultural entities, which makes the study of both evolution and society possible through diversity (Brush, 2004; Admasu, 2002; Tamiru, 2006).

Maturity assessment is an important activity to achieving good quality of *Dioscorea bulbifera*. Mature aerial yam is generally distinguishable by cessation of vegetative growth and yellowing of leaves. The period from planting or field emergence to maturity is the cause of variability in yield and it is highly dependent on the type of species. The most frequently reported measures were done from the period of planting to harvest (growing period), but it has been suggested that the time from emergence to maturity provides a better measure of growing periods of *D. bulbifera* (Onwueme and Charles, 1994).

In this study, accessions of *Dioscorea bulbifera* were classified into three maturity groups: early, medium and late maturing yam groups. Based on farmers' recognition, early maturing accessions are mature within a short period (within four up to six months after planting), farmers' used these accessions to fill their seasonal food gap (when

other crops are not mature in the area) for marketing (a source of income) and as a medicinal purposes. Accessions that mature between 6-8 months after planting are medium maturing and accessions that need more than 8 months to mature after planting, are late maturing. Selection based on maturity also varies with other yam species. For example, *Dioscorea Cayenensis* matures within 280-350 days after planting and *Dioscorea rotundata* matures within a range of 200-330 days after planting (Onwueme and Charles, 1994). Furthermore, the total yields (tuber and bulbils) of accessions varied depending on their maturity group. For example, early maturing accessions of *D. bulbifera* accessions produced relatively smaller yield than that of late maturing yam accessions.

In this study, 14 aerial yam accessions (29.78%) are early maturing, 22 accessions (46.80%) medium maturing and the remaining 11 accessions (23.40%) are late maturing. The mean total bulbils and tuber yields of early and medium *D. bulbifera* accessions grown at Jimma is higher than the yield of *Dioscorea bulbifera* grown in Nigeria (Table 2).

This indicates that, Ethiopia, especially the southern and southwestern parts have high potential for the production of *Dioscorea bulbifera*. However, its annual total production is still low (4 tones per hectare) (Miege and Demessew, 1997; FAO, 2005; Tamiru, 2006). This is due to lack of understanding about the potentials of this crop and its importance in human diet. Therefore, attention should be paid to the production, storage, utilization and other agronomical aspect of *D. bulbifera* is vital.

Table 2: Maturity and yield (t/ha) of *Dioscorea bulbifera* grown at Nigeria (West Africa) (Onwueme and Charles, 1994).

Maturity group	Days to maturity (day)	West Africa			Jimma		
		Yield(t/ha)			Yield(t/ha)		
		Bulbils	Tuber	Total	Bulbils	Tuber	Total
Early maturing aerial yam	120-180	3-5	2-3	5-8	9.02	4.38	13.5
Medium maturing aerial yam	180-240	6-10	4-6	10-16	10.08	4.63	14.71
Late maturing aerial yam	240-300	11-15	7-8	17-23	9.71	4.38	14.09

4. CONCLUSION

The result of farmers' evaluation criteria revealed that, farmers in the study area possess considerable knowledge about aerial yam and the attributes of each group. Owing to past research neglect, farmers are often the only sources of information concerning yams in Ethiopia. Some of the criteria that are commonly considered for classification and selection of accessions (yield, maturity, and organoleptic quality, ease of harvesting, storage and marketing) are vital. Consequently, a through analysis of indigenous knowledge system, farmers' perception in designing and implementing conservation and improvement programs is critical to bringing practical solutions to problems of immediate concern to them. Moreover, knowing that farmers' behavior is based on very specific needs, preferences and socio-cultural aspects, research in cooperation with farmers becomes necessary to establish new ways of dialogue between researchers and farmers in evaluating the characteristics of the varieties farmers maintained in their systems.

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