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RESEARCH ARTICLE

Phenotypic diversity of enset (*Ensete ventricosum* (Welw.) Cheesman) landraces used in traditional medicine

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Abstract Enset (*Ensete ventricosum* (Welw.) Cheesman) is a multipurpose food security crop extensively cultivated in southern and southwestern parts of Ethiopia. In addition to its wide consumption as a source of food and feed, some enset landraces are also used as a traditional medicine in some parts of the country. However, the latter are becoming vulnerable to various human-related activities and environmental constraints. The main objective of this study was, therefore, to investigate the diversity that exist in enset landraces used for traditional medicine. A field study was conducted in four Administrative Zones and one special District in the Southern Nations, Nationalities and Peoples Region in Ethiopia. A total of 14 qualitative traits were employed to investigate the diversity in 40 landraces through field observation, color charts and focus group discussion. The data were analyzed using SAS and MINITAB softwares. Principal component analysis showed that the first four principal components accounted for 77% of the total variations and classified the landraces into four distinct groups. Similarly, cluster analysis grouped the landraces into four major clusters each containing 4–15 landraces. In general, the 14 phenotypic traits

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used in this study are important in discriminating the landraces indicating the existence of high genetic diversity among the landraces which needs to be conserved for the future.

Keywords Cluster analysis · *Ensete ventricosum* · Phenotypic diversity · Phenotypic traits · Principal component analysis · Traditional medicine

Introduction

Enset (*Ensete ventricosum*) is a herbaceous, monocarpic and monocotyledonous plant that grows from 4 to 8 m in height. Due to the plant's resemblance to the banana plant, the name 'false banana' has been given to enset. However, the edible parts in enset are the corm and pseudostem, unlike the fruit in banana. Enset is consumed as a staple food by about 20 milion people in the south and south western Ethiopia. The plant is resilient to extreme environmental conditions, especially to drought and flooding. Due to this, it is regarded as a priority crop in some parts of Ethiopia where the crop is grown as a staple food (Brandt et al. 1997).

In addition to the extensive use of enset as human food, some enset landraces play vital role in traditional medicine due to their use in repairing broken bones and fractures, assist the removal of placental remains following birth or an abortion and treatment of liver disease (Terefe and Tabogie 1989; Tsehay and Kebebew 2006; Olango et al. 2014). Since most of the corms of these landraces are a sweet type, they are highly preferred by wild animals mainly by porcupine and wild pig (Negash 2007). These enset landraces are also more susceptible to diseases and anthropogenic factors than the others. The loss of some valuable enset genotypes due to various human and environmental factors was reported (Gebremaryam 1996; Negash et al. 2002). Since these environmental effects and human practices might lead to the complete loss of some of these important landraces, attention needs to be given to the conservation and proper utilization of the landraces, considering their key role in traditional medicine.

For plant species that do not produce seeds, or predominantly propagated vegetatively, conservation in seed form has limited application. The most common method of preserving the genetic resources of these groups of plants is in situ in the field and ex situ in the gene bank, which is very costly. In this case, a clear understanding of the extent of genetic diversity in a species is very important for the effective conservation program, like reducing unnecessary duplication of the germplasm (Rao and Hodgkin 2002). The investigation of diversity among genotypes using phenotypic or morphological traits is direct, simple and inexpensive (Cholastova and Knotova 2012) and can be useful for the preliminary evaluation of genetic diversity among phenotypically distinguishable cultivars.

Several enset genetic diversity studies were using molecular techniques including Amplified Fragment Length Polymorphism (AFLP) (Negash et al. 2002), Random Amplification of Polymorphic DNA (RAPD) (Birmeta et al. 2004), Inter Simple Sequence Repeat (ISSR) (Tobiaw and Bekele 2011) and Simple Sequence Repeat (SSR) (Selamawit et al. 2014 and Olango et al. 2015), while few other studies implemented phenotypic traits (Bekele et al. 2013; Mikias 2014; Tsehay and Kebebew 2006; Yemataw et al. 2014a, 2018). As far as we know, there is no exhaustive identification and diversity study on enset landraces used for traditional medicine. Therefore, the current study was conducted to investigate the extent of genetic diversity among enset landraces used for traditional medicine growing in the Southern Nations, Nationalities and Peoples Region (SNNPR) of Ethiopia, using phenotypic traits.

Materials and methods

Description of the study area

The field study was conducted in four administrative zones and one special district in the Southern Nations, Nationalities and Peoples Region (SNNPR), the major enset growing region of Ethiopia. The geographical coordinates of the study areas ranged from 7°3′36″N to 8°4′48″N and from 37°9′36″E to 38°1′48″E, as well as altitudes ranging from 1976 to 2834 m above sea level. The map of the study area is shown in Fig. 1.

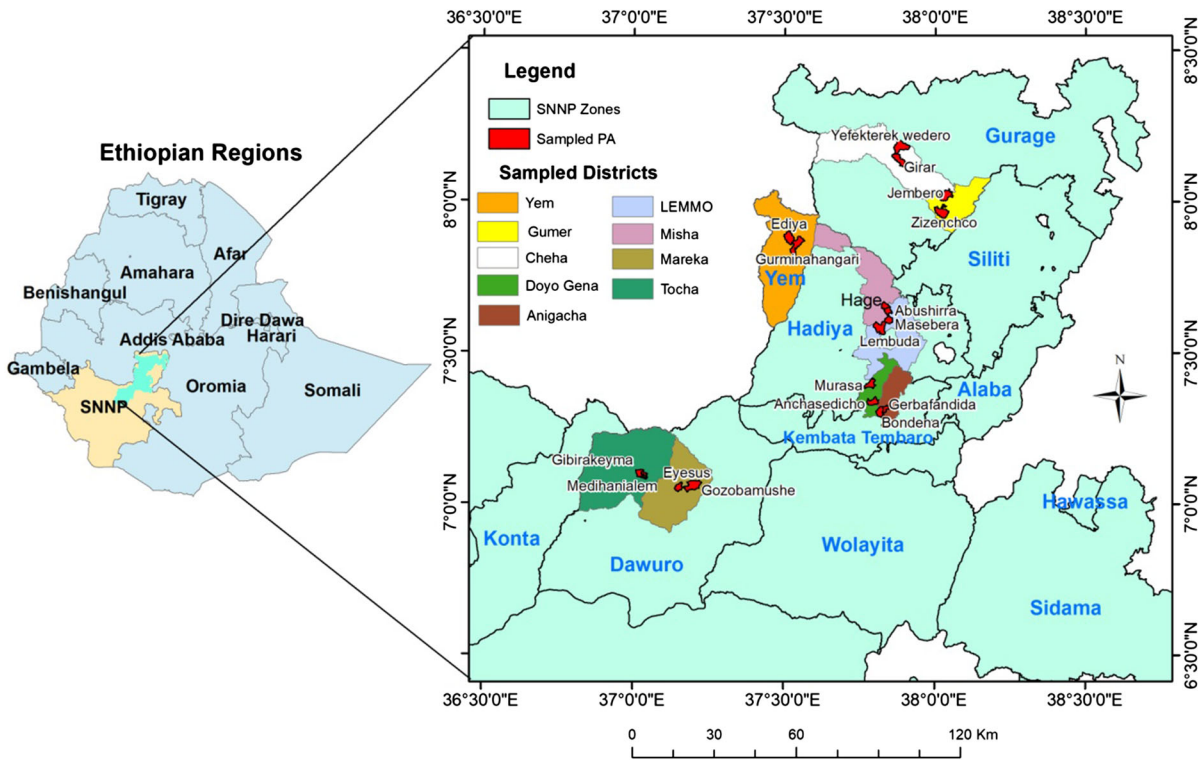

Fig. 1 A map showing location or districts from where enset landraces used in the present study were obtained

Sampling and data collection

A field survey was conducted from November 2016 to March 2017 to study diversity among enset landraces used for traditional medicine in diverse enset growing areas. Based on the previous study on enset diversity (Yemataw et al. 2014b, 2016), four Administrative Zones (namely, Dawro, Guraghe, Hadya and Kembata-Tembaro) and one special District (Yem) in SNNPR were selected to carry out the present study. From each zone, two districts and from each district two peasant associations (PAs: the lowest tier of civil administration unit) were selected based on enset diversity and distribution, secondary data obtained from the Bureau of Agriculture zonal and district level. Hence, one special district, eight districts and 18 PAs were included in the study.

For identification and characterization of enset landraces used for traditional medicine, key informants (3–5 in number) were selected at each PA, based on their experience and knowledge in production and use of enset landraces, with the help of agricultural development agents and PA administrations. During the identification of landraces, slight dialect variations within the same ethnic group were not considered. Whereas, landraces having identical names, but originated from different administrative zones, were considered as different, and included as a new landrace, since there may exist homonyms, giving the same name for different genotypes at different localities (Olango et al. 2015 and Tabogie 1997). A total of 40 enset landraces used for traditional medicine were identified from the 18 PAs (Table 1).

The phenotypic data were collected from 5 to 6-years-old mature plants, with no disease symptom, which are close to maturity or full maturity. As the landraces grew in different environmental conditions, only qualitative traits, which are less affected by the environment were considered. Since no standardized descriptor was developed for enset, fourteen qualitative traits, as shown in Table 2, were used based on farmers' indigenous knowledge and previous reports (Mikias 2014; Yemataw et al. 2014a) with some modifications. Color traits are among the first descriptors that farmers use in the identification of enset

Table 1 List of 40 enset landraces used as traditional medicine, and sites of their collections

No.	Local name	Site of collection			
		Zone	Districts	Peasant Associations	Altitude
1	Astara	Guraghe	Cheha & Gumer	Girar, Jemboro & Zizencho	2252–2834
2	Atshakit	Guraghe	Gumer	Jemboro & Zizencho	2756–2834
3	BishaEset	Guraghe	Cheha & Gumer	Girar, Jemboro & Zizencho	2252–2834
4	Chehuyet	Guraghe	Gumer	Jemboro & Zizencho	2756–2834
5	Denkinet	Guraghe	Cheha & Gumer	Girar, Jemboro & Zizencho	2252–2834
6	Dere	Guraghe	Cheha &Gumer	Yefekterek, Girar & Zizencho	1976–2835
7	Guarye	Guraghe	Cheha & Gumer	Yefekterek, Girar & Jemboro	1976–2756
8	Kibnar	Guraghe	Cheha& Gumer	Yefekterek, Girar & Jemboro	1976–2756
9	Sinwot	Guraghe	Cheha	Yefekterek & Girar	1976–2252
10	Terye	Guraghe	Gumer	Jemboro & Zizencho	2756–2834
11	Agede	Hadya	Misha & Lemo	Masbera, Lembuda, Hage & Ab*	2324–2520
12	Astar	Hadya	Misha &Lemo	Masbera, Lembuda, & Ab	2324–2520
13	Haywona	Hadya	Misha & Lemo	Masbera, Lembuda, Hage & Ab	2324–2520
14	Bedededa	Hadya	Misha	Hage & Ab	2376–2520
15	Gishra	Hadya	Misha & Lemo	Masbera, Lembuda, Hage & Ab	2324–2520
16	Kiniwara	Hadya	Misha and Lemo	Hage & Lembuda	2376–2395
17	Kombotra	Hadya	Lemo	Masbera & Lembuda	2324–2395
18	Mekelwes	Hadya	Lemo	Masbera & Lembuda	2324–2395
19	Oniya	Hadya	Lemo	Masbera & Lembuda	2324–2395
20	Tesa	KT**	Angacha & Doyogena	Bondena, Gerbafendida & Murasa	2356–2558
21	Kiklekey	KT	Angacha & Doyogena	Bondena, Gerbafendida & An***	2416–2558
22	Kiklenech	KT	Angacha	Bondena & Gerbafendida	2416–2519
23	Agene	KT	Angacha	Bondena & Gerbafendida	2416–2519
24	Sebera	KT	Angacha & Doyogena	Bondena, Gerbafendida & An	2416–2558
25	Mentiwea	KT	Angacha	Bondena & Gerbafendida	2416–2519
26	Cherkiwa	KT	Angacha	Bondena & Gerbafendida	2416–2519
27	Oniya2	KT	Angacha & Doyogena	Bondena & Murasa	2356–2416
28	Astar2	KT	Angacha & Doyogena	Bondena, Gerbafendida & Murasa	2356–2519
29	Beleka	KT	Doyogena	An & Murasa	2356–2558
30	Gishra2	KT	Angacha & Doyogena	Bondena & Gerbafendida	2356–2519
31	Asu	Yem****	Yem	Gurminahangary	2586
32	Kinkisir	Yem	Yem	Gurminahangary	2586
33	Gariye	Yem	Yem	Gurminahangary	2586
34	Deya	Yem	Yem	Ediya & Gurminahangary	2541–2586
35	Anchiro	Yem	Yem	Ediya	2541
36	Karona	Yem	Yem	Ediya	2541
37	Lochingia	Dawro	Mareka & Tocha	Eyesus, Medhanialem & Gibrakeyma	2361–2702
38	Arke	Dawro	Tocha	Medhanialem & Gibrakeyma	2683–2702
39	Tsela	Dawro	Tocha	Medhanialem & Gibrakeyma	2683–2702
40	Botsamez	Dawro	Mareka & Tocha	Gozabamushe, Eyesus &Medhanialem	2327–2683

*Abushira, **Kenbata Tembaro, ***Anchasedicho, ****Special district

Table 2 Description of categories of different traits investigated in enset landraces used in the current study

Trait name	Acronym	No of categories	Description of categories
Pseudo stem color	PSSC	14	Light to medium green with black spot/strip/patches; light to medium green with black and red purple strips/patches; Light to medium green mixed with light pink; light to medium green mixed with black and with black patches and strip; Green yellow with black spots/strips/patches; Green yellow with red purple base; Green yellow and black with red purple patches and black spot; Yellow red with black and red purple patches and spot; red purple with green strips/patches; Red purple with yellow patches and spots; Red purple with black or brown strip/patches; Red purple; Dark red purple; and Red pink
Color of petiole ventral surface	CPVS	5	Light to medium green; Light to medium green with black spot/strip/patches; Red purple with light to medium green at both sides; Red purple; and dark red purple
Color of petiole dorsal surface	CPDS	8	Light to medium green with black spots/strip/patch; Light red purple with green side parts and with black patches; Red purple with light green at both sides and black spots/patches; Red purple with light yellow at both sides and black patches; Red purple with black and green strips at both sides; Red purple with green strips; Dark red purple with green strip; and Black with green strip and patches
Color of midrib ventral surface	CMVS	5	Light to medium green; Light to medium green with spot; Red purple with light to medium green at both sides; Red purple; and Dark red purple
Color of midrib dorsal surface	CMDS	8	Light to medium green; Light to medium green with black spots/strip/patches; Light to medium green with red purple strip; Light yellow; Red purple with light to medium green at both sides; Red purple; Dark red purple; and Red pink
Color of leaf upper surface	CLUS	5	Light to medium green; Green to deep green; Light green with red purple strip; Red purple with green strips; and Red pink with green strip
Color of leaf edge and tip	CLET	4	Brown; Black brown; Red purple; and Red pink
Leaf growth habit	LGRH	3	erect; intermediate; and drooping
Corm quality	COQU	4	Low; intermediate; high; and other
Kocho quality	KOQU	4	Low; intermediate; high; and other
Bulla quality	BUQU	4	Low; intermediate; high; and other
Fiber quality	FOQU	4	Low; intermediate; high; and other
Bacterial wilt tolerance	BWDT	3	Low; intermediate; and high
Drought tolerance	DROT	3	Low; intermediate; and high

landraces (Shigeta 1991). The data on color descriptors of pseudostem color (PSSC), color of petiole ventral surface (CPVS), color of petiole dorsal surface (CPDS), color of midrib ventral surface (CMVS), color of leaf upper surface (CLUS), color of leaf dorsal surface (CLDS) and color of leaf edge and tip (CLET) were collected directly through field observation and by comparing with color chart (Munsell 1970). To reduce environmental effects, the data were collected from three to four plants,, which grew at different environmental conditions. Moreover, during sampling, informants with wide experience in the enset culture and indigenous knowledge assisted the sampling, so that representative samples of each landrace was included in the study. The picture of each landrace was also taken for further verification and documentation.

The data on leaf growth habit (LGRH), corm quality (COQU), taste, quality of *kocho* (KOQU), taste, quality of *bulla* (BUQU), taste, quality of fiber (FIQU), strength, bacterial wilt disease tolerance (BWDT) and drought tolerance (DROT) were collected through focus group discussions. Focus group discussions were held at each peasant association by involving elder farmers and agricultural development

agents, which have rich knowledge and experience in enset production, processing and consumption.

Data analysis

Frequency distribution

The frequency distribution of each of the descriptors for the fourteen qualitative traits were analyzed using SAS statistical software version 9.2 (SAS 2002).

Principal component analysis (PCA)

To investigate the overall pattern of diversity in enset landraces and the contributions of individual traits to the observed diversity, PCA was performed using the SAS software version 9.2 (SAS 2002) and MINITAB software version 14 (MINITAB 2003). For the PCA, Eigen values, the percentage of the variation accumulated by the PCA and the load coefficient values between the original traits and respective principal components were quantified. The first two principal components which accounted for the highest variation were used to plot a two-dimensional dispersion or scatter diagram of the landraces.

Cluster analysis

For cluster analysis (CA), data matrix was used to generate pair-wise genetic similarity values among enset landraces and to generate hierarchical dendrogram through an unweighted pair-group method with arithmetic average (UPGMA) (Sokal and Michener 1958) using SAS statistical software version 9.2 (SAS 2002). This analysis was used to study patterns of variance and relationships among the landraces, where landraces with close genetic distances were placed to close proximity in the dendrogram.

Results

Frequency distribution

Forty enset landraces used in traditional medicine were first identified followed by characterization using phenotypic qualitative traits. The variability in color of pseudostem, petiole and midrib are shown for selected enset genotypes (Fig. 2). Although14 types of pseudostem colors were observed, the dominant were green-yellow with black patches/strip/spot (20%) and light to medium green with black patch and spots (15%). Regarding the color of petiole, the predominant colors of the ventral and dorsal surface were light to medium green with black spots/strip/patches (40%) and red–purple with light to medium green at both sides (37.5%). Rarely observed colors at the ventral and dorsal surface of the petiole were red–purple and red-pink (2.5% each) and red purple with black and green strips at both sides (2.5%). On the other hand, the highest proportion of midrib ventral and dorsal surface colors were light to medium green (52.5%) and red–purple with light to medium green at both sides (37.5%).

Diversity in leaf color was also observed although 52.5% of the landraces were characterized by light to medium green leaf color on the upper surface while only 2.5% of the landraces possess the red-pink with green strip leaf color. On the other hand, the variability in color of the edge and tip of the leaf was low, since 87.5% of the genotypes had brown color while the remaining 12.5% were either brown, black-brown, red–purple or red-pink. Regarding the growth habit, half of the landraces had erect leaf growth, while the remaining had either intermediate or intermediate drooping growth habit. The proportions of landraces with superior quality in terms of taste were 47.5% for corm, 57.5% for *kocho*, and 45% for *bulla* quality. This shows that although the landraces used in this study were mainly selected for medicinal purpose, they are also high food quality standard. Surprisingly, about half of the landraces were characterized by low fiber quality., interms of strength. Unfortunately, the majority of enset genotypes under investigation were susceptible to bacterial wilt where only 2.5% of the landraces had high level of tolerance to this devastating disease. The investigation to the abiotic stress tolerance showed that the genotypes in present study had either intermediate level (45% of landraces) or low level (37% of landraces) of tolerance to moisture scarcity.

Principal component analysis

The principal component analysis (PCA) was carried out to investigate the traits that playa major role in phenotypic diversity among the enset landraces. The first four principal components (PCs) with coefficient

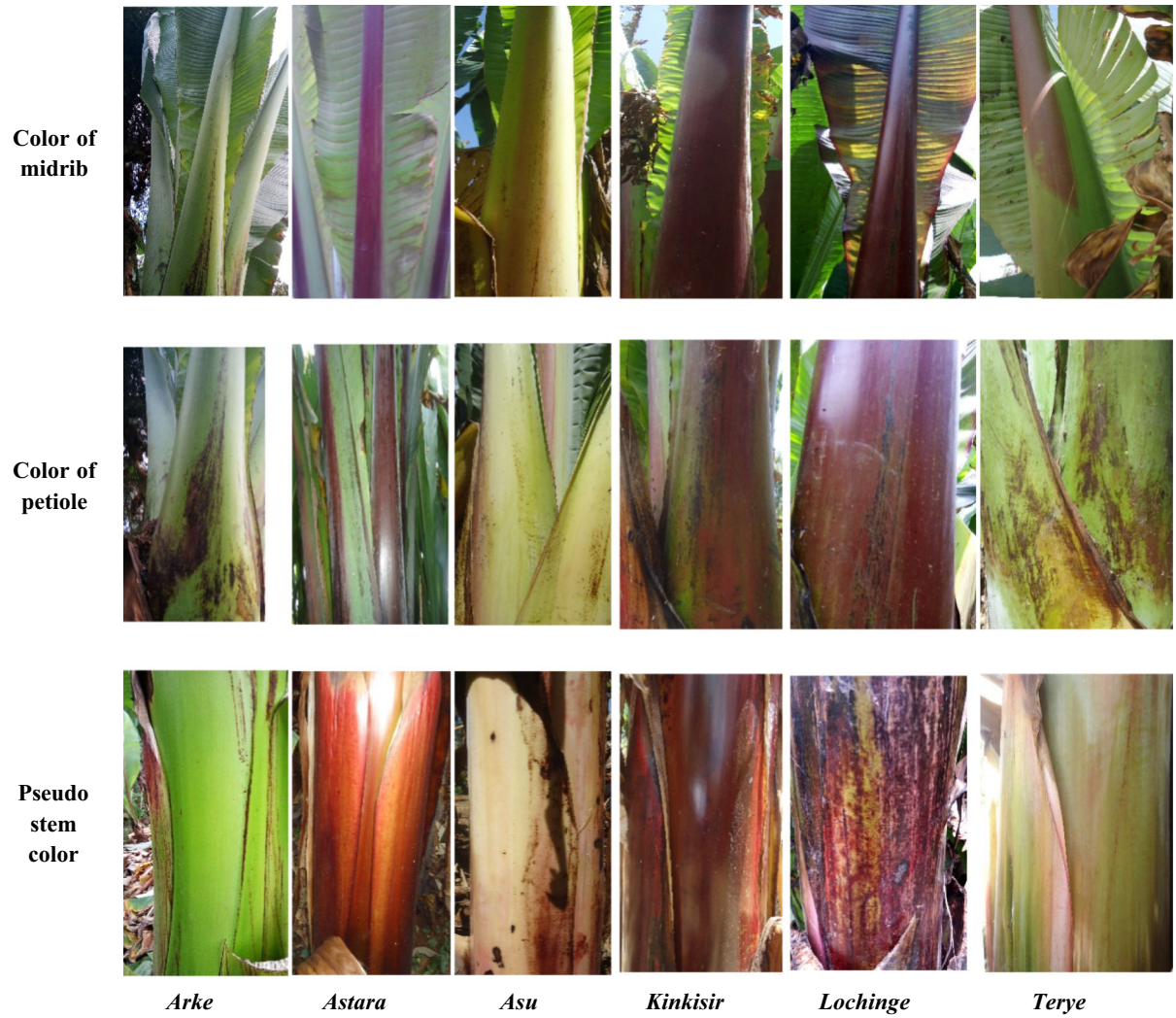

Fig. 2 Variability in the color of midrib, petiole and pseudostem of six enset landraces used for traditional medicine

values greater than 1.0 together explained 74.1% of the total variance among all the studied landraces. Correlation among the variables associated with these four principal components is shown in Table 3. Scores on the first principal component (PC-1) which accounted for 34.4% of the total variations were highly correlated (correlation coefficient > 0.7) to characters related to pseudostem color, color of petiole ventral surface, color of petiole dorsal surface, color of midrib ventral surface, color of midrib dorsal surface, color of leaf upper surface andcolor of leaf edge and tip (Table 3). The second principal component (PC-2) explained 18.1% of the total variations and was highly associated (correlation coefficient > 0.7) with corm quality, *bulla* quality and *kocho* quality. The predominant traits in the third component (PC-3) which explained for 13.5% of the variations were fiber quality, drought tolerance and bacterial wilt tolerance, while leaf growth habit was the dominant trait in the fourth component (PC-4), which accounted for 8% of the total variations. In the two dimensional scatter plot generated from the first two most important principal components (PC1 and PC2), the fourteen phenotypic traits classified the 40 enset landraces into four groups, except one outlier landrace (*bisha-eset*).

Table 3 The first four principal components (PC) generated from 14 phenotypic traits using 40 enset landraces used for traditional medicine

Characters	Eigen vectors			
	PC1	PC2	PC3	PC4
Pseudostem color	**0.726**	0.186	0.201	0.199
Color of petiole ventral surface	**0.857**	− 0.051	0.006	− 0.048
Color of petiole dorsal surface	**0.680**	− 0.037	− 0.231	− 0.03
Color of midrib ventral surface	**0.862**	0.075	0.012	0.172
Color of midrib dorsal surface	**0.825**	0.120	0.010	− 0.128
Color of leaf upper surface	**0.875**	− 0.079	0.071	0.067
Color of leaf-edge and tip	**0.795**	− 0.144	− 0.128	0.153
Leaf growth habit	− 0.333	− 0.169	0.037	**0.817**
Corm quality	− 0.111	**0.884**	0.070	0.020
Kocho quality	− 0.131	**0.864**	0.278	0.127
Bula quality	0.276	**0.715**	0.465	0.128
Fiber quality	0.164	− 0.200	**0.685**	0.449
Bacterial wilt tolerance	0.127	− 0.217	**0.84**	0.071
Drought tolerance	0.05	− 0.542	**0.547**	0.308
Eigen values	4.81	2.54	1.89	1.12
Variance (%)	34.39	18.13	13.52	8.01
Cumulative (%)	34.39	52.52	66.05	74.06

Values in bold indicate the most important traits (> 0.5) that has large contributions to the total variance of a particular principal component

Cluster analysis

The dendrogram of the hierarchical cluster analysis (HCA) grouped the 40 *enset* landraces into four major clusters (namely, A, B, C and D) with a dissimilarity coefficient of 0.8 (Fig. 3). The cluster size varied from 4 to 15 landraces. Cluster C with 15 landraces (37.5% of all landraces), was the largest and constitutes genotypes with pseudostem color of green–yellow or yellow–red and petiole underside color of red–purple. On the other hand, cluster B contained the smallest number of landraces (four in number) with above ground plant color of dark red–purple or red–purple.

In cluster A, nine landraces were included, and they were characterized by red–purple pseudostem and petiole dorsal surface color with different pigmentations. Cluster D was the second largest group, which included eleven landraces and they were basically characterized by light to medium green pseudostem and petiole dorsal surface color with various pigmentations. It was observed that each cluster was further divided into a sub and sub–sub clusters at different dissimilarity coefficients based on their relation, while at 0.1 level of dissimilarity, almost all the 40 accessions were distinct from one another.

Discussions

This study on 40 enset landraces showed wide diversity due to qualitative phenotypic traits. It confirmed earlier findings that revealed the variability on morphological traits, such as the upper and underside color of the midrib the upper & under side color of the petiole, color of leaf as well as the color of the leaf tip and edge (Mikias 2014). Yemataw et al. (2018) also reported considerable variations among enset genotypes for most agronomical and morphological traits. Traits related to color of different plant parts are the major descriptors that farmers use in the identification of enset landraces. The familiarity of farmers to enset plants they grow in their field is astonishing. According to Shigeta (1991) some farmers identify individual enset plant as they also remember people by their names. It is interesting to observe that 80% of the landraces used in the current study are highly susceptible to bacterial wilt, the major disease of enset. This indicates that enset landraces used in traditional medicine are vulnerable to environmental stresses mainly to biotic constraints, disease and drought. The susceptibility of *astara*, one of the landraces included in the current study was also

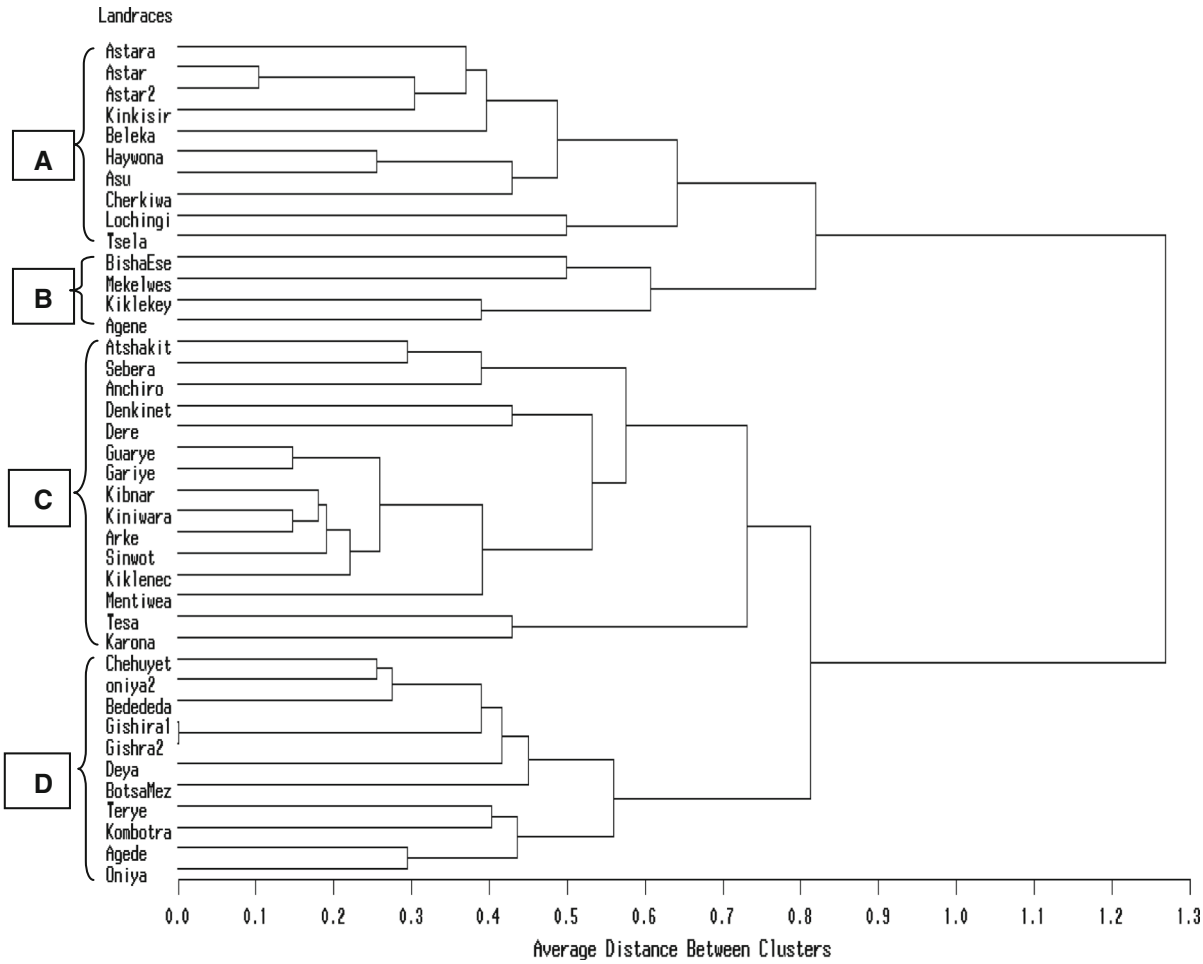

Fig. 3 Dendrogram resulting from average linkage clustering using the unweighted pair-group method with arithmetic average (UPGMA) for 40 enset landraces based on 14 phenotypic traits

reported (Weldemichael et al. 2008; Wolde et al. 2016).

The PC analysis showed that, three-quarters of the total variance among landraces was explained by the first four PCs. All the fourteen phenotypic traits showed variability and contributed for discrimination of the landraces. Similarly, the existence of considerable variabilities, due to color of midrib, color of petiole and color leaf tip and edge, as well as quality of fiber were earlier reported for enset genotype (Yemataw et al. 2014a). The two dimensional scatter plot generated from the first two principal components classified the landraces into four groups except for a landrace called *bisha-eset*. This particular landrace is characterized by red–purple color of the whole above ground part and is visually very similar with landraces such as *kiklekey*, *mekelwesa* and *lochingia*. Its distinction from this group of landraces could be related to the inability to collect the data on some of the phenotypic traits of that specific landrace, including; corm, *kocho*, *bulla* and fiber qualities. This is mainly due to the non use of this landrace for these traits. Except for one landrace, *gishra*, no overlapping or duplication of the landraces was observed, which implies the presence of high genetic diversity.

The dendrogram of the hierarchical cluster analysis showed four major clusters, which exhibited highly consistent results with that of the PCA from the scatter plot. It was observed that clustering was not based on the geographic origins of the landraces, instead landraces from the same origin categorized into different groups and those from different origins were

grouped under the same cluster. For example, cluster A contained landraces from Guraghe (1), Hadya (2), Kembata-Tenbaro (3), Yem (2) and Dawro(2). Similar clustering pattern, was earlier reported which was not related to geographical origin of the genotypes (Olango et al. 2015). Our finding is also in agreement with that of Bekele et al. (2013) which indicated that genetic diversity is not apparently related to geographic diversity in enset.

The landraces from the five different localities were distributed to all the four or at least to three of the clusters, showing the presence of high genetic diversity among the landraces of each locality. Tsehaye and Kebebew (2006) also reported high diversity within and between enset landraces. The diversity from within location could be due to the vegetative propagation mode of the crop. According to earlier report clonality tends to increase genetic variation within populations, while it has the opposite effect on genetic differentiation among populations (Balloux et al. 2003; Halkett et al. 2005). This means, in strictly clonal organisms, the alleles at one locus evolve independently and accumulate diverse mutations over time (Halkett et al. 2005) This accumulation of mutations in the absence of sex promotes the divergence between alleles at a single locus within individuals (Balloux et al. 2003; Meloni et al. 2013). Hence clonality appears to positively affect the genetic diversity by increasing allelic diversity, polymorphism, and heterozygosity. Similarly, in strict clonally propagated crops, a frequent somatic mutations provides genetic variation and contributes to adaptive evolution (McKey et al. 2010). Since enset is a clonally propagated crop, high variation occurred among the landraces in the current study could be related to the aforementioned reasons. Moreover, the sampling method that involves the selection of landraces with distinct vernacular names, which could be corresponding to the genotype (Tostain et al. 2006), could be a source of diversity, and the tendency of the farmers to maintain enset landraces having different use values could also be another reason for the higher genetic diversity.

From the landraces having identical or similar names but originated from different administrative zones, some were placed together, while others were distantly placed in the dendrogram. For instance; *gishra* landraces (*gishra* and *gishra*2) from Hadya and Kembata-Tenbaro Zones were found to be exactly the same, indicating the exchange of planting materials between the neighboring ethnic groups and zones. Landraces, *astara* from Guraghe, *astar* from Hadya and Kembata-Tenbaro, *kibnar* from Guraghe and *kinwara* from Hadya zones were placed in close proximity in the dendrogram. On the other hand, *oniya* landraces (*oniya* and *oniya*2) from Hadya and from Kembata-Tenbaro were placed far apart in the cluster. This might be due to giving the same name for different enset landraces at different localities (Olango et al. 2015; Tabogie 1997). In the current study, In the current study, no landraces with different vernacular name was identical, showing that vernacular name is a good indicator of distinctiveness. However, Tabogie (1997) and Yemataw et al. (2014b) reported duplication of enset vernacular names. The difference could be related to collection method followed in the current study which involved collection of small group of targeted landraces used as traditional medicine.

Conclusions

The characterization of enset landraces used for traditional medicine based on phenotypic qualitative traits indicated that there is a wide range of variability for most traits. According to principal component analysis, the first four principal components together explained 74.1% of the total variance and all the fourteen phenotypic traits were found to be important in discriminating and classifying the 40 landraces into four groups. Similarly, cluster analysis grouped the landraces of each population into all four or three clusters indicating the existence of variability. In both cases of multivariate analysis, only little overlapping or duplication of the landraces was observed, implying the presence of high genetic diversity within the landraces. The study provides vital information that would help to conserve the landraces and overcome losses of genotypes related to human and environmental factors. Information from this study indicates a need for systematic collection, characterization and conservation (ex situ or in situ) of enset landraces used for traditional medicine by diverse communities in the south and southwest, Ethiopia.

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Compliance with ethical standards

Conflict of interest The authors declare no conflict of interest.

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