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RESEARCH ARTICLE

QUALITATIVE TRAITS DIVERSITY IN ANCHOTE [COCCINIA ABYSSINICA (LAM.) COGN.] ACCESSIONS FROM ETHIOPIA

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ABSTRACT

Anchote (*Coccinia abyssinica* (Lam.) Cogn.) is among few indigenous crops in Ethiopia with a great potential for food and nutritional security, medicinal and socio-economically importance. Despite its importance, limited research was made in exploring the genetic diversity of anchote. Understanding the nature and magnitude of diversity and interrelationship among anchote genotypes for qualitative traits is vital to hasten the effective improvement of the crop. The present study investigated the extent and pattern of diversity within and among 400 accessions of anchote using agro-morphological qualitative traits. The accessions were collected from ten administrative zones ofWestern, South western and North western Ethiopia including East Wollega, West Wollega, Kelem Wollega, Horro Guduru Wollega, Buno Bedelle, Iluababor, Jimma, Bench Maji, West Shewa and Hulet Eju-Enese) from the altitude range of 1412 to 3025 m above sea level. The trial was planted during the off-seasons of 2017 and 2018 using irrigation on vertisols at the research site of Debre Zeit Agricultural Research Center, Bishoftu. Data on 42 qualitative traits were taken and subjected to analysis using the SAS version 9.1.3 software, R for Alpha- Lattice design. There was a highly significant difference among the genotypes for leaf, vine and flower traits including leaf blade degree of lobbing, leaf general outline, mature foliage color, mature leaf size, mature leaf lobe types, number of leaf lobes, shape of central leaf lobe, internode length and diameter, vine tip pubescence, predominant and secondary vine color, tendril twining direction, limb shape, sepal shape, sepal apex, sepal pubescence, sepal color, and style color suggesting the existence of genetic variability among the accessions. Wider ranges among traits have been exhibited for all root traits; root size and variability, predominant and secondary root flesh color, predominant and secondary root skin colors, root shape, root surface constriction and defects, root cortex thickness and color, root formation, root stalk, root skin texture, root latex production and oxidation. There was no root cracking and root surface and flesh defects across the accessions. The variability of root size ranged from uniform to slightly variable, predominant and secondary flesh colors classified under white and creamy, predominant and secondary skin colors were similar to the internal flesh colors, root shapes classified in to round and round elliptic, root cortex thickness was very thin(<1 mm) to thin(1-2 mm), closed to open clustered root formation, short (2-5 cm) to intermediate (6-8 cm) root stalk length, and no root cracking has been observed. Root latex production among the accessions ranged from little to some, and the amount of browning observed 5-10 seconds after root cut was very little. The root size showed slight (19.5%) to moderate (79.5%) variations. Predominant root flesh color of most genotypes was creamy (63%), white (23.75%) and dark cream (10.75%). The root formation structure of most accessions was closed (95%), and few were open (5%). The number of leaf lobes was diverse, and the majority (93%) had between two to four leaf lobes. A wide range of genetic variations occurred for all traits except for root cracking and flesh defects. Root skin color had a positive phenotypic correlation with secondary root flesh color. Cluster analysis divided genotypes into six main groups indicating wider genetic diversity among accessions. The principal component analysis (PCA) also indicated that the accessions were grouped into seventeen components with eigenvalue > 1 and explained 64.99 % of the variability. The variation exhibited in this experiment could be attributed to environmental and genetic factors. The morphological variability and traits relationship exhibited in this study could provide a new selection mechanism in future improvement programs of anchote.

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INTRODUCTION

Root and tuber crops are among the major crops feeding the under-nourished people of the world as food and nutritional security safeguards. Root and tuber crops are preferred since they have stable yields under conditions in which other crops do not adapt and perform well. and play an important role in the overall employment and income generation. In Ethiopia, the nutritional and economic importance of root and tuber crops has not yet been fully exploited and utilized despite their significant contributions towards food security, income generation, and provision of food energy (Gebremedhin *et al*, 2008). Some root and tuber serve as important sources of vitamins, minerals, essential amino acids such as lysine, starch supplier, food security crop, source of cash income, raw material for feed and processed products, and key components in small-scale agro-enterprise development (Yared, 2007; Scott *et al*., 2000; Gebremedhin *et al*., 2008). Anchote, *Coccinia abyssinica*, is an endemic root crop that has been widely grown throughout the south and southwestern parts of Ethiopia for centuries and belongs to the family Cucurbitaceae (Abera, 1995)). The name 'anchote' spelt as '*ancootee*' is derived from Afan Oromo, a native language spoken by the Oromo nationalities of Ethiopia; it refers to the edible tuber of the cultivated races of Coccinia. The genus Coccinia is made up of 30 species of which ten are reported to occur in Ethiopia. Of these, only eight of them were named and recorded species in Flora of Ethiopia since 1995; include *Coccinia abysinica* (Lam.) Cogn*. C. adoensis* (Hochst. Ex. A. Rich.) Cogn.), *C. grandis* (L.) Voigh (Syn*. C. indica* Wight and Arn.), *C. megarrhiza*, C. Jeffrey, and *C. schliebenni* Harms (Endashaw, 2007). The remaining species have not so far been described and named. Anchote is a unique root crop in its uses and the parts consumed as its three main parts that include immature fruits, shoot tips and tubers are consumable and its seeds, roots and shoot tips are marketable even though the root is the most economic concern among the growers. The consumable parts (i.e. root, leaf, and fruit) are rich in protein, calcium, iron, and potassium.In the major growing regions of south, western and southwestern Ethiopia, it is planted on very fertile soils in homestead areas, though almost no research information exists on the ecological adaptation of the crop. It is adapted well to south and south western parts of the country between 1300 to 2800 m above sea level, prefers soil pH of 4.5 to 7.5, mean minimum and maximum temperatures of 12 °C and 28 °C and rainfall ranging from 800 to 2000 mm/year (Amare, 1973; Abera, 1995; BARC, 2004; Desta *et al*., 2011,). It is an annual trailing herbaceous vine as it is hardy creeper with prominent vine colors ranging from green to dark purple; climb up where there are supports, and the young shoots and tuberous roots are processed and used as vegetables and root crops, respectively (Abera Hora, 1995;Endashaw, 2007;; Desta *et al*., 2011; Fekadu, 2013). Anchote is found in different parts of Ethiopia; western, southeastern, southwestern, and northern parts; though it is cultivated as a root crop only in the west, southwest and southern regions of the country, mainly Wollegga, llluababor, Jimma, Kaffa and Sidama (Amare, 1973, Edwards, 1991; Desta *et al*., 2011).

Anchote is also known by different vernacular names in different places and by different tribes in Ethiopia; such as 'Ushushe' in Walaita, 'Shushe/Ushushe' in Dawuro, 'Ajo' in Kaffa and Bench Maji, 'Yeamora Misa' in Gojam, Gonder and North Shewa, and 'Wochicho' in Tigray (Amsalu *et al*., 2008; Desta *et al.,* 2022). Anchote is a preferable and good source of minerals, fiber, protein, potassium, calcium, and iron. Its protein content is also far greater than other root crops, which are known for their low protein content. It is a rich source of calcium, which is an important constituent of our bones and teeth, and the anchote growers use it as a food and medicinal crop to treat displaced joints and fractured bones (Amare, 1973; Habtamu and Kelbessa, 1997; Endashaw, 2007; *Habtamu,* 2011; Desta *et al*., 2021). Juice prepared from the roots of anchote has been used in Ethiopian traditional medicine to treat cancer, tuberculosis, skin eruptions and gonorrhea (Abera, 1995). On average every farmer in Western Wollega allocates 400 to 600 square meters of land for anchote production primarily for home consumption, income generation, rural employment, securing easy food and nutritional access (Abera,1995; Mengesha *et al.*, 2012; Desta *et al*., 2021). Tubers may vary in shape depending on environmental and genetic conditions, but are generally spherical or elongated and round at maturity. Activities associated with anchote culture including germplasm selection, planting, other agronomic practices, utilization and conservation are all done by women (Abera, 1995; Endashaw, 2007). Wild animals such as porcupines, wild pigs, and wart hogs hunt anchote tubers and could cause a serious yield reduction. In addition, domestic animals and wild animals such as cattle and goats damage the aerial parts and all attacks could cause a serious yield reduction. Powdery mildew is the only fungal disease that attacks the aerial parts of the plant including the older leaves and vines (Desta *et al*., 2021). Anchote is commonly propagated by seed collected from matured red and/or yellow fruits, and also vegetatively using its root as a seed source for the next growing season and as a conservation strategy (Abera, 1995; Habtamu and Kelbessa, 1997; Endashaw, 2007). Its productivity may vary based on genotypes, soil fertility level, location and cultural practices and ranges from 20 to 30 t ha^{-1} (Abera, 1995; BARC, 2004). However, under research condition, it has a potential to yield upto 73 t ha^{-1} (Desta *et al*., 2011) and 76.45 tha^{-1} (Mengesha *et al*., 2012). The national average total yield of anchote is 150-180 quintals/hectare, which is in the range of the total yield of sweet potato and potato in the country (IAR, 1986). In spite of its importance as a food and nutritional security crop, there is very limited information available on the genetic diversity of this crop and this type of studies are crucial in bringing the crop to the scientific arena to utilize the full potential of anchote in attaining food and nutritional security of Ethiopia. Therefore, this study aims to investigate the extent and pattern of diversity within and among 400 accessions of anchote collected from different parts of Ethiopia using agro-morphological qualitative traits.

MATERIALS AND METHODS

Plant material: Seeds of four-hundred anchote accessions collected from ten districts of Western, South Western and North Western regions of Ethiopia were used for planting. Descriptions of the collection sites are given in Figure 1.

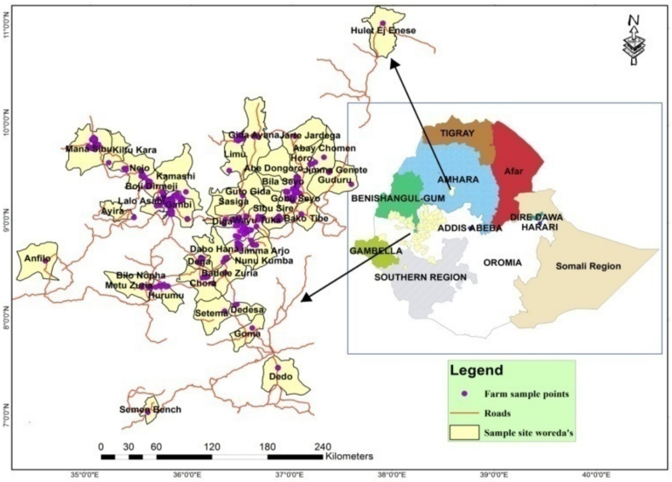

Figure 1. Anchote accessions collection areas from different producing areas of Ethiopia

Study site : The trial was planted at the research site of Debre Zeit Agriculture Research Centre in 2017 and 2018 dry season using irrigation. It is located at 08°44' N and longitude of 38°58' E, 1860 meters above sea level receiving an annual average rainfall of 851 mm and the mean minimum and maximum temperature of 8.9°C and 24.3°C, respectively onvertisols, heavy black soil (DZARC, 2008).

Experimental Materials: Four hundred accessions (Appendex Table 1) were grown in alpha-lattice design with three replications. Each experimental unit consisted of four ridges per plot with a spacing of 0.6 m between rows and 0.2 m between plants, and ten plants per ridge. Anchote accessions were randomly distributed in twenty blocks in each replication. Planting was carried out in March using seeds in a single row on the ridge and harvested in August. All the recommended cultivation practices for anchote such as weeding, watering and fertilizer application rates were followed.

Data collection and analysis: Morphological qualitative traits of all the 400 accessions were scored using the morphological descriptors available from International Board for Plant Genetic Resources (IBPGR) and; International Potato Center(CIP) standard descriptors of sweet potato (Huaccho and Hijmans, 2000). Working Group report on Cucurbits (ECPPGR, 2010), minimum descriptors for Cucurbita spp., cucumber, melon and watermelon (ECPGR, 2008), descriptors for melon (IPGRI. 2003), and characterization of selected morphological and agronomic descriptors for cassava were also followed (Fukuda *et al*., 1998). A total of 42 qualitative; 24 aerials; 9 leaf traits, 9 vine traits, and 6 flower traits and 18 storage root characters were evaluated for each accession and were transformed into numbers using the CIP scale to process statistically (Table 2). Data recorded for aerial parts were the average of 10 sample plants for each trait. Storage root descriptors were recorded considering the most representative expression of the character shown in medium to large sized storage roots of ten plants. The analysis of variance (ANOVA), clustering, principal component, mean separation and chi-square test were performed using the SAS version 9.1.3 software, META-R version 6.0, and Minitab 19 for Alpha-Lattice Design. Analyses of variances were done using the mean of ten sample plants for each trait. The Least Significant Difference (LSD) was used to compare two means at the 5% level of significance. The formula given by Haynes et al (1995) and Falconer (1989) was used to calculate broad sense heritability (h^2). Genetic advance (GA) and genetic advance expressed as percent of mean (GAM) were employed for each qualitative trait to assess the extent of genetic or environmental variations were estimated according to Allard (1999). The Shannon-Weaver diversity index was also used to calculate amount of genetic variation as described by Hutchenson (1970).

RESULT AND DISCUSSION

The mean and range of 42 qualitative traits are exhibited in Table 3. There was a highly significant difference among the genotypes for leaf (Figure 2), vine and flower traits including leaf blade degree of lobbing, leaf general outline, mature foliage color, mature leaf size, mature leaf lobe types, number of leaf lobe, shape of central leaf lobe, internode length and diameter, vine tip pubescence, predominant and secondary vine color(Figure 6), tendril twining direction, limb shape, sepal shape, sepal apex, sepal pubescence, sepal color, and style color were confirming the genetic variability among the accessions.The results of the present study agree with Rahajeng *et al*., 2018 on 183 accessions of sweet potato germplasm, Tilahun*et al*., (2014) on 49 anchote accessions, and Bekele *et al*., (2017) on 182 anchote accessions. Wider ranges among traits have been exhibited for all root traits treated in this experiment; root size and variability, predominant and secondary root flesh color, predominant and secondary root skin

Figure 2. Variability of general outline of the leaf, leaf lobe types, leaf lobe number, shape of central leaf lobe and leaf color respectively (a- cordate, no lateral leaf lobes, one, toothed, deep green; b- rounded, no lateral lobes, one, toothed, light green; c-cordate, very slight teeth, three, toothed, deep green; d-triangular, slight, three, semi-circular, light green; e-reniform, slight, five, semi-elliptic, deep green; f-lobed, moderate, five, elliptic, deep green; g-lobed, deep, five, oblanceolate, deep green; h and j- almost divided, very deep, seven, linear/narrow, bright light green; i- almost divided, very deep, seven, oblanceolate, deep green)

Figure 3. Primary and secondary anchote root flesh color variability(primary: *a*-dark creamy, *b*- white/oyster, *c-g*- creamy where *d* and *e* are creamy with light ivory, and *h*- pale yellow/melon yellow) secondary: *a*-creamy, *b*- absent, *c*- light ivory white, *d*- sand or pale yellow, *e*- intermediate orange, *f*- signal yellow/pale yellow *g*-dark yellow/pastel yellow, and *h*-strongly pigmented/Dahila yellow)).
Source(additonal)*: *Ralph S. Alberts Company Incorporated(RS Alberts Color Chart)

colors, root shape, root surface constriction and defects, root cortex thickness and color, root formation, root stalk, root skin texture, root latex production and oxidation (Table 3, Figure 3 and 4). In agreement with this finding, Dandena, 2010; Tilahun *et al*., 2014; Bekele *et al.,* 2017 have reported that anchote exhibits great diversity in foliage, fruit, vine, and root morphological traits. There were no root cracking and root flesh defects observed and recorded across the accessions exhibiting the endurance of anchote roots to soil environmental conditions such as compacted and cracking soils at maturity periods that affect other root and tuber crops. The variability in root size was diverse and mostly moderately variable (79.5%), slightly variable (19.75%) and uniform that exhibits the presence of genetic variability among accessions and indicates the possibility of selection for improvement of productivity of anchote through research and development (Figure 4). Most genotypes have closed root formation (94.75%) and the remaining were open clustered (Figure 4). The predominant root flesh colors were classified as creamy (63%), white (23.75%), dark cream (10.75%), and pale yellow (2.5%) (Figure 3) which is in contrary to Bekele *et al*., (2017) where 182 anchote accessions were classified only *into* white and reddish flesh colors. Predominant and secondary skin colors were similar to the internal flesh colors and root shapes were classified into round (86%) and round elliptic. Root cortex thickness was very thin (<1 mm) to thin (1-2 mm), root formation was closed to open clustered, root stalk length was short (2-5 cm) to intermediate (6-8 cm), and no root cracking has been observed. Root latex production among the accessions ranged from little to some and the amount of browning observed 5-10 seconds after root cut was very little which is one of the quality parameters in root and tuber crops for prolonged storage and transportation to the distant markets.

Figure 4. Root shape, variability in root size, number of roots per plant and root formation(round L:B 1:1-a, f,g,h,and i, and round elliptic L:B not >2:1-b,c, d and e; moderately variable-a,b,c,d,e,; slightly variable-f and g; uniform-h and i; number of root/plant- a and b-7, c-5, d and e-6, f- 5, g-4, h and i-1; root formation: closed-a, e, f and g; open clustered- b,c,d)

Figure 5. Male flower(a), female flower with fruit bud(b), immature green fruits(c), and month and half old anchote plant in the field

Figure 6. Predominant and secondary vine colors respectively(a- green and green base, b and c- green and green base, d- green with few purple spots and purple base, eand f- totally purple and purple base)

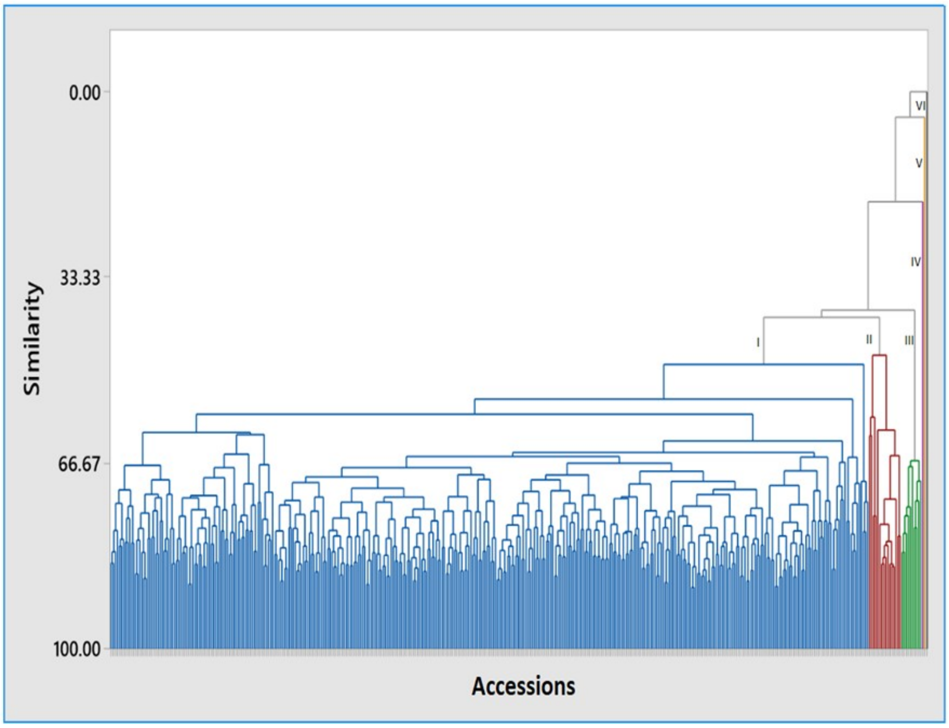

Figure 7. Dendrogram of 400 anchote accessions into 6 clusters based on 42 qualitative traits

Table 5. Cluster centroids among the traits

Variable	C-I	C-II	C-III	C-IV	C-V	C-VI	Grand centroid	Variable	C-I	C-II	C-III	C-IV	C-V	C-VI	Grand centroid
rsv	-0.030	0.378	0.600	0.200	1.810	-0.610	-0.001	**ll**	0.010	-0.002	-0.418	0.830	0.830	-1.660	-0.001
rfcp	0.008	-0.237	-0.482	4.030	-0.770	1.150	0.001	**lb**	-0.050	-0.050	-0.050	19.950	-0.050	-0.050	0.000
pr	-0.014	-0.037	0.475	1.020	1.020	-1.690	-0.001	**outl**	-0.007	-0.103	0.358	-0.680	1.050	-0.680	-0.001
rfcs	-0.007	0.290	-0.178	1.010	1.010	-0.070	0.001	**lno**	0.009	-0.426	0.012	0.010	1.330	-1.300	-0.001
rscp	-0.030	0.246	1.133	-0.660	-0.660	-0.660	0.000	**sll**	0.022	-0.418	-0.253	-0.250	0.480	-1.720	0.002
rscs	0.004	0.190	-0.145	0.390	-0.500	-1.390	0.001	**il**	0.014	-0.282	0.122	-2.640	0.560	-0.900	0.002
rsh	0.008	-0.058	0.000	-0.780	-0.780	-0.780	0.001	**id**	-0.036	1.480	0.102	-0.510	-0.900	0.780	0.000
fd	-0.092	4.003	-0.200	-0.200	-0.200	-0.200	-0.004	**vtp**	-0.006	-0.392	0.357	1.480	0.360	0.360	0.000
rc	-0.099	4.086	-0.170	-0.170	-0.170	3.660	0.002	**pvc**	-0.019	-0.044	0.272	-0.440	4.900	-0.440	-0.002
rsd	-0.050	-0.050	-0.050	-0.050	19.950	-0.050	0.000	**svc**	-0.013	-0.001	-0.042	-0.420	5.230	-0.420	-0.003
rct	0.007	-0.148	-0.054	-0.920	-0.920	0.810	-0.001	**ttd**	0.010	-0.074	-0.295	-0.750	-0.750	0.770	-0.002
rpr	-0.032	0.439	0.685	0.290	0.290	0.290	-0.001	**fsh**	0.050	0.050	0.050	0.050	0.050	-19.950	0.000
rf	-0.014	0.121	0.477	-0.900	-0.130	0.630	0.000	**ssh**	-0.028	0.146	1.022	0.910	-1.380	-0.240	0.001
rstk	0.009	-0.401	0.038	1.120	-0.590	-1.160	-0.001	**sa**	0.012	0.269	-0.584	0.600	-0.880	-0.880	-0.001
ccor	-0.020	-0.317	0.591	0.790	3.780	-0.210	0.000	**sp**	-0.022	0.563	0.316	0.210	-1.380	1.270	0.000
lp	-0.010	-0.219	0.589	0.690	-1.360	0.690	0.000	**sco**	0.011	-0.320	-0.320	-0.320	-0.320	3.150	0.001
rst	-0.001	0.192	-0.054	-0.690	0.900	-0.690	0.001	**stco**	0.006	-0.100	-0.100	-0.100	-0.100	-0.100	0.000
ox	-0.146	-0.130	5.678	-0.130	-0.130	-0.130	0.000	**styco**	0.008	-0.113	-0.154	-0.520	-0.520	1.310	0.002
								fsex	0.017	-0.254	-0.280	-0.520	-0.520	-0.520	-0.002

Table 6. Average inter cluster divergence (D^2) value in 400 anchote accessions

	I	II	III	IV	V	VI
I		6.24	6.35	20.92**	22.09**	21.21**
II			8.82**	21.91**	23.10**	21.33**
III				21.88**	22.83**	22.19**
IV					30.54**	29.75**
V						31.18**
VI						

There was no root cracking and flesh defects for all the accessions tested and it helped to increase productivity by increasing the marketable yield. Root cortex thickness varies from thin to thick and 55.5% of the accessions exhibited intermediate which enables anchote withstand bruising upon handling. Degree of leaf lobbing among the genotypes was mostly weak (53.25%) and intermediate (44.5%) (Table 4). The genetic advance was higher for variability in root size, root cortex thickness, root skin texture and root latex production. The results of the present study agree with the findings of Desta *et al*., (2011) and Daba *et al*., (2012) on 36 and 10 anchote accessions respectively, Amsalu, (2013) on cassava, Yared, (2007) on taro, Muluneh, (2006) on yam and Asfaw, (2006) on Ethiopian taro. Based on pooled mean of 42 qualitative traits of 400 anchote accessions were clustered in to 6 groups at 88.09% similarity (Figure 7). The first, second, third, fourth, fifth and sixth clusters consisted of 378(94.5%), 9(2.25%), 10(2.5%), and the remaining three (IV-VI) consisted 1(0.25%) accessions each, respectively with the first cluster was the largest group. The inclusion of majority of accessions in cluster one and few of them in the remaining five clusters indicates.

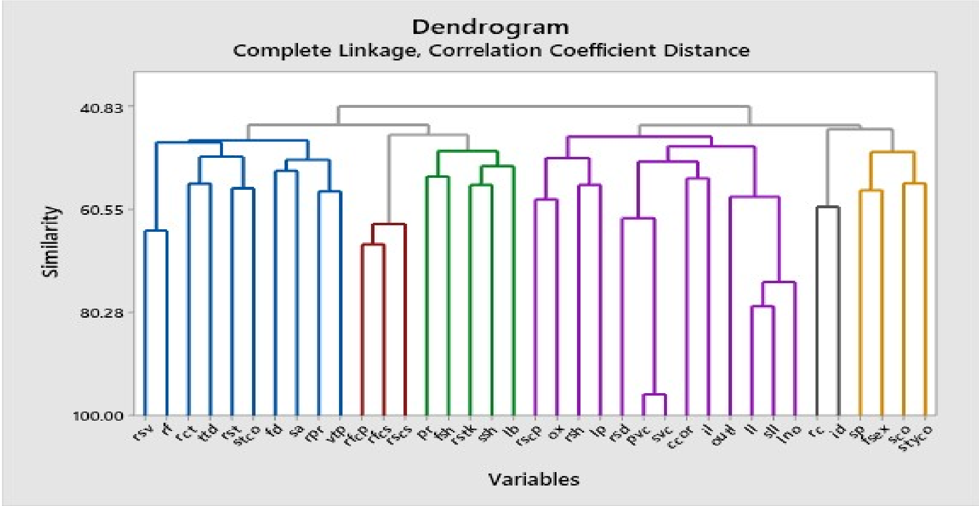

Figure 8. Dendrogram of 400 anchote accessions based on 42 qualitative traits for 6 clusters

Table 8. Shannon-Weaver indices (H') among and between accessions with respect to geographic areas of collections

Accession numbers	Zone	No. of accessions	H'	Accession numbers	Zone	No. of accessions	H'
236/09	B.B	1	0.55	072/09, 088/09	E.W	2	1.13
339-352/09	B.B	14	7.70	076/09,081/09,082/09,086/09	E.W	4	2.22
353/09,354/09	B.B	2	1.09	091/09	E.W	1	0.55
372-377/09,380-383/09	B.B	10	5.48	391-397/09,399-406/09, 408-410/09, 317-320/09, 411-413/09, 315/09, 264-274/09, 092-097/09	E.W	43	23.86
244/09	Benchmaji	1	0.55	234/09	E.W	1	0.56
239/09	E.G	1	0.58	251/09,253/09,257/09	E.W	3	1.69
001/09,002/09,089/09,241/09,090/09	E.W	5	2.74	254/09,262/09	E.W	2	1.13
003-008/09	E.W	7	3.91	301-310/09	E.W	10	5.64
009-016/09	E.W	7	3.85	311-314/09,316/09	E.W	5	2.76
017/09, 018/09	E.W	2	1.12	330/09, 332-338/09, 248/09,261/09	E.W	10	5.53
046/09, 051/09,021/09,022/09, 258/09,260/09	E.W	6	3.35	222-226/09,229/09,275-277/09,415/09,416/09	H.G.W	11	6.05
071/09,073/09,074/09,077-080/09,083-087/09,019/09,020/09,024-033/09,321-329/09,034-041/09	E.W	40	22.03	245/09	H.G.W	1	0.54
075/09,069/09,070/09,098-104/09	E.W	10	5.48	230/09,231/09	H.G. W	2	1.06
384-390/09,407/09	H.G. W	7	3.85	285/09,287/09,290/09,291/09,064/09,218-221/09,227/09	W. W	10	5.57
233/09,235/09,247/09,252/09	ILU	4	2.18	293-295/09,298-300/09,065-068/09,185/09,187-217/09,278/09	W. W	43	23.77
355/09,356/09, 358-360/09	ILU	5	2.78	288/09,292/09,296/09,297/09	W. W	4	2.20
363-371/09	ILU	9	4.95	105-137/09,139-184/09, 042-045/09, 047-050/09, 052-054/09,056-059/09, 237/09,240/09,255/09	W. W	97	53.64
238/09	Jimma	1	0.56	249/09	W. W	1	0.57
242/09,256/09	Jimma	2	1.08	279-284/09,289/09	W. W	7	3.90
378/,379/09	Jimma	2	1.09	246/09,250/09	Q. W	2	1.12
061-063/09	W. W	3	1.65	259/09, 263/09	W. Sh	2	1.12
				TOTAL	10	400	

Key: E.W-East Wollega, W.W-West Wollega, W.Sh-West Shewa, Q.W-Qellem wollega, B.B-Buno Bedelle, ILU-Iluababor, E.G-East Gojjam, H.G.W-Horro Guduru Wollega, H'- Shannon Weaver Diversity Index.

Moderate divergence among the accessions tested in this experiment. The moderate divergence could be due to the lack of morphological descriptor for anchote and rather descriptors of cucurbits, cassava, sweet potato and yam were used with some modifications. Mahalanobis distance (D^2) of the 6 clusters of 400 anchote accessions based on 42 qualitative traits is presented in Table 5. The cluster centroids also indicated maximum cluster distances between clusters V and IV (30.54) and 31.18 between V and VI (Table 6). The maximum distance from the centroid for clusters I, II, and III was 11.9, 10.67, and 7.5 respectively. In cluster I, flowerlimb shape,shape of central leaf lobe, and flower sex were contributed positively and other traits such as sepal shape, root size and variability, predominant root skin color, ease of periderm removal, vine internode diameter, root surface and flesh defects, degree of leaf lobbing, root constriction, and root flesh oxidation contributed negatively.Vine internode length, sepal pubescence, ease of periderm removal, root size and variability, secondary root flesh color, sepal apex, predominant root skin color, were the positive contributors and color of root cortex, sepal color, vine tip pubescence, root stalk, shape of central leaf lobe and leaf lobe number were negative contributors in cluster II. In cluster III, root flesh oxidation, predominant root skin color, sepal shape, ease of periderm removal, variability of root size, color of root cortex, root latex, root formation structure, root positioning, general outline of leaf, vine tip pubescence, sepal pubescence, and predominant vine color contributed positively though predominant root flesh color, and some flower traits were negative contributors. 11 traits contributed positively in cluster IV; degree of leaf lobbing, predominant and secondary root flesh colors, vine tip pubescence, root stalk, root positioning, sepal shape, leaf lobe types, root cortex color, and sepal apex. Predominant and secondary vine colors, color of root cortex, variability of root size, leaf lobe number, general outline of the leaf, positioning of root, and secondary root flesh color were determinant traits in cluster V. Root surface constriction, sepal and stigma colors, sepal pubescence, and predominant root flesh color were positive determinants in cluster VI (Figure 8). The relative importance of each trait and patterns of variation in explaining the observed variability and finding the characters that contribute to the diversity is assessed through principal component analysis. The results of principal component analysis (PCA) indicated that the accessions were grouped into 17 components based on the evaluated traits, significant (eigenvalue > 1) and explained 65 % of the total variation (Table 7). Predominant root flesh color had the highest loading in 3,6,12, and 13 principal components. Variability in root size was largely explained in principal components 4, 5, and 16. Flower traits were more explained in 6,10,14, and 15 principal components. Among the traits examined, higher genotypic significance was scored by predominant root flesh color (99%) and root shape (83%).Leaf traits; degree of leaf lobbing, general outline of the leaf, mature foliage color, leaf size, leaf lobe types, leaf lobe number, and shape of central leaf lobe; all vine traits and most flower traits were highly heritable and significant ($p < 0.001$) (Appendix Table 7). Characterizing germplasm accessions into morphologically similar, more particularly genetically similar groups is useful for selecting parents for crossing and further improvement of the crop (Souza and Sorrels, 1991). High Shannon-Weaver indices (H') was among and between the geographic locations of collections and Gimbi (53.64), Gudeya Bila (23.86), Manasibu Mandi (23.77), and Leka Dullacha (22.03) were the higher indices (Table 8).

Conclusion and Recommendations: The database and maps presented here are the first detailed description of anchote distribution in Ethiopia, mainly the major producing areas. The maps provide considerably more detailed information than the map presented by Bekele *et al*., (2007) (Figure 1 and Appendix Table 1). Significant variations among the accessions for leaf, vine, flower traits and all the root traits with significant weight in contributing the most to the total diversity; six divergent groups of clusters and 17 principal components explaining 65% of the total variability. The confirmed existence of diversity among the accessions is indicating huge potentials for selection, and crossing of superior anchote genotypes for yield and yield related traits and for medicinal purposes mainly based on root flesh colors. Morphological descriptor development for anchote is basic and necessary for further traits association research. The use of large number of collections from different districts forgenetic diversityand employing selection based on these traits is efficient to maximize root yield, conservation as well as future improvement programs of Anchote.

Significance Statement: As the Nordic Journal ofBotany is interested in publishing papers focusing on research results focusing on interactions between plants and society and anchote is one of the indigenous crops with strong bond with women and culture of Oromo people of Ethiopia. This manuscript paves a way for future research on genetic diversity studies of anchote. New outlooks on crops like anchote could boost the interest of readers with new ideas and experience of new crop to the science and food arena.

Author Contributions.

Desta Fekadu Mijena; Conceptualization, methodology, software, validation, data analysis, investigation, writing—original draft preparation.Sentayehu Alamerew, Kebebew Assefa, and Mandefro Nigussie; reviewing, editing, and supervision.

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Conflicts of Interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. The data shown in this publication are used for academic and research purposes, and we declare no conflict of interest.

Data Availability Statement: The authors declare that all data discussed in the study are available in the manuscript and be availed on demand.

Ethics statement: We, the authors will not any facts just for personal benefit, and the results in this study will always be dependable, trustworthy and reliable.

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Appendex A

Table 1. List of 400 anchote accessions with their areas of collection.

	Zone	Woreda	Kebele	Longitude	Latitude	Altitude
001/09	E.W	Sibu Sire	Sire 01	9°02'29.46"N	36°52'15.02"E	1834
002/09	E.W	Sibu Sire	Burka Talo	9°01'49.00"N	36°50'52.04"E	1791
003/09	E.W	Wayu Tuka	Wara Babbo Migna	9°03'52.98"N	36°52'05.77"E	1889
004/09	E.W	Wayu Tuka	Wara Babbo Migna	9°03'37.54"N	36°52'34.88"E	1840
005/09	E.W	Wayu Tuka	Wara Babbo Migna	9°03'47.65"N	36°52'56.35"E	1877
006/09	E.W	Wayu Tuka	Kura Migna	9°02'29.71"N	36°51'00.51"E	1825
007/09	E.W	Wayu Tuka	Kura Migna	9°01'52.93"N	36°51'01.64"E	1799
008/09	E.W	Wayu Tuka	Kura Migna	9°02'15.02"N	36°51'10.74"E	1830
009/09	E.W	Chingi	MajaAle	9°02'43.31"N	36°43'10.25"E	1823
010/09	E.W	Wayu Tuka	Gute	9°02'04.84"N	36°40'22.64"E	1884
011/09	E.W	Chingi	Gobu	9°02'55.33"N	36°43'18.10"E	1843
012/09	E.W	Chingi	Gordommo/Gaba Sanbata	9°02'33.16"N	36°43'13.09"E	1797
013/09	E.W	Chingi	Ale Gordomo	9°02'27.23"N	36°42'23.13"E	1735
014/09	E.W	Chingi	Gordommo	9°03'06.28"N	36°42'10.24"E	1935
015/09	E.W	Chingi	Ebicha	9°01'54.27"N	36°40'49.14"E	1863
016/09	E.W	Chingi	Jarte/Birbo Gibbi	9°01'55.46"N	36°40'40.97"E	1857
017/09	E.W	Ukke	Adu Bukke	9°30'39.23"N	36°33'28.60"E	1439
018/09	E.W	Ukke	Chari	9°30'18.64"N	36°33'27.18"E	1412
019/09	E.W	Leka Dullecha	Ale Qawusa	9°16'36.62"N	36°31'31.19"E	1435
020/09	E.W	Leka Dullecha	Ale Qawusa	9°02'25.94"N	36°29'12.92"E	2222
021/09	E.W	Digga	Demeksa	9°01'20.43"N	36°27'10.81"E	2178
022/09	E.W	Digga	Demeksa	9°01'19.32"N	36°26'59.71"E	2192
023/09	E.W	Digga	Geracho	9°02'03.81"N	36°26'53.86"E	2203
024/09	E.W	Leka Dullecha	Horda Qawusa	9°01'47.65"N	36°25'39.68"E	2110
025/09	E.W	Leka Dullecha	Horda Qawusa	9°01'58.86"N	36°25'38.05"E	2090
026/09	E.W	Leka Dullecha	Horda Qawusa	9°01'59.79"N	36°25'21.80"E	2064
027/09	E.W	Leka Dullecha	Gatama 01	8°53'54.90"N	36°29'07.96"E	2170
028/09	E.W	Leka Dullecha	Horda Qawusa	9°01'28.09"N	36°25'29.94"E	2114
029/09	E.W	Leka Dullecha	Horda Qawusa	9°01'46.27"N	36°25'06.82"E	2103
030/09	E.W	Leka Dullecha	Horda Qawusa	9°01'59.35"N	36°25'20.75"E	2065
031/09	E.W	Leka Dullecha	Horda Qawusa	9°01'56.76"N	36°25'10.01"E	2078
032/09	E.W	Leka Dullecha	Horda Qawusa	9°02'01.91"N	36°25'20.10"E	2056
033/09	E.W	Leka Dullecha	Horda Qawusa	9°01'57.79"N	36°25'05.08"E	2079
034/09	E.W	Leka Dullecha	Geracho	9°01'40.61"N	36°26'04.45"E	2153
035/09	E.W	Leka Dullecha	Horda Qawusa	9°00'05.95"N	36°29'13.56"E	2244
036/09	E.W	Leka Dullecha	Horda Qawusa	9°00'19.37"N	36°29'13.28"E	2225
037/09	E.W	Leka Dullecha	Horda Qawusa	9°00'30.41"N	36°29'13.32"E	2225
038/09	E.W	Leka Dullecha	Horda Qawusa	8°59'59.66"N	36°28'49.76"E	2240
039/09	E.W	Leka Dullecha	Horda Qawusa	8°59'22.32"N	36°29'40.70"E	2264
040/09	E.W	Leka Dullecha	Horda Qawusa	8°59'55.44"N	36°30'31.60"E	2209
041/09	E.W	Leka Dullecha	Horda Qawusa	8°59'21.87"N	36°30'25.81"E	2227
042/09	W.W	Gimbi	Jogir	9°10'12.00"N	35°46'58.28"E	1776
043/09	W.W	Gimbi	Jogir	9°10'10.87"N	35°46'31.44"E	1727
044/09	W.W	Gimbi	Aba Sena	9°01'39.43"N	35°58'50.01"E	1650
045/09	W.W	Gimbi	chuta Goch	9°12'18.85"N	35°44'27.29"E	1857
046/09	E.W	Digga	Demeksa	9°01'26.43"N	36°26'11.65"E	2129
047/09	W.W	Gimbi	Inango Dambali	9°10'05.05"N	35°42'31.00"E	1843
048/09	W.W	Gimbi	Chuta Goch	9°12'15.88"N	35°44'16.34"E	1867
049/09	W.W	Gimbi	Chuta Goch	9°12'06.03"N	35°44'03.15"E	1870
050/09	W.W	Gimbi	Inango Dambali	9°10'08.88"N	35°41'45.15"E	1888
051/09	E.W	Digga	Demeksa	9°02'26.20"N	36°27'17.84"E	2199
052/09	W.W	Gimbi	Inango Dambali	9°09'49.25"N	35°40'39.86"E	1820
053/09	W.W	Gimbi	Aba Sena	9°02'00.08"N	35°58'42.00"E	1637
054/09	W.W	Gimbi	Bikiltu Tokkumma	9°11'30.45"N	35°47'16.52"E	1837
055/09	W.W	Gimbi	Gimbo 03/Gimbi Town	9°10'38.30"N	35°50'10.18"E	1930
056/09	W.W	Gimbi	Choli	9°12'55.57"N	35°49'27.30"E	1864
057/09	W.W	Gimbi	Walo Anchabi	9°14'00.50"N	35°41'56.80"E	1888
058/09	W.W	Gimbi	Lalisa Yesus	9°24'43.28"N	35°35'50.16"E	1892
059/09	W.W	Gimbi	Lalisa Yesus	9°24'47.14"N	35°36'09.86"E	1943
060/09	W.W	Gimbi	Lalisa Yesus	9°25'10.49"N	35°35'43.05"E	1917
061/09	W.W	Lalo Asabi	Garjo Siban	9°27'29.22"N	35°32'47.00"E	1732
062/09	W.W	Lalo Asabi	Harojji Harowwa	9°27'57.57"N	35°32'26.10"E	1798
063/09	W.W	Lalo Asabi	Harojji Harowwa	9°28'04.40"N	35°31'26.28"E	1851
064/09	W.W	Boji Dirmaji	Lata Bobine	9°21'41.84"N	35°36'22.79"E	1959
065/09	W.W	Mana Sibu Mandi	Gombo Kiltu Jale	9°50'50.05"N	35°04'29.09"E	1753
066/09	W.W	Mana Sibu Mandi	Gombo Kiltu Jale	9°50'45.38"N	35°03'35.58"E	1651
067/09	W.W	Mana Sibu Mandi	Gombo Kiltu Jale	9°50'16.38"N	35°02'38.49"E	1616
068/09	W.W	Mana Sibu Mandi	Gombo Kiltu Jale	9°51'33.05"N	35°03'03.65"E	1583
069/09	E.W	Gobbu Sayyo	Tibbe Hara	8°59'18.78"N	36°20'56.98"E	1619
070/09	E.W	Gobbu Sayyo	Tibbe Hara	9°01'47.42"N	36°21'58.99"E	1897
071/09	E.W	Leka Dullecha	Fododdo/Gatama	8°53'35.16"N	36°33'09.89"E	2013
072/09	E.W	Arjo	Kumba	8°45'25.03"N	36°29'25.67"E	2427
073/09	E.W	Leka Dullecha	Fododdo/Gatama	8°53'32.25"N	36°33'52.30"E	2028

074/09	E.W	Leka Dullecha	Fododdo/Gatama	8°52'32.89"N	36°32'50.56"E	1973
075/09	E.W	Gobbu Sayyo	Tibbe Hara	9°05'11.09"N	36°21'50.67"E	1441
076/09	E.W	Arjo	Kumba	8°46'06.66"N	36°29'07.73"E	2430
077/09	E.W	Leka Dullecha	Shakko	8°51'35.58"N	36°27'24.85"E	2474
078/09	E.W	Leka Dullecha	Bollo	8°51'05.11"N	36°29'44.01"E	2190
079/09	E.W	Leka Dullecha	Fododdo/Gatama	8°54'21.85"N	36°34'02.04"E	1902
080/09	E.W	Leka Dullecha	Shakko	8°57'26.16"N	36°32'30.67"E	1986
081/09	E.W	Nunnu Kumba	Nunnu	8°46'10.08"N	36°37'51.14"E	2313
082/09	E.W	Nunnu Kumba	Nunnu	8°46'04.84"N	36°38'26.40"E	2338
083/09	E.W	Leka Dullecha	Kawusa	8°56'09.70"N	36°31'12.17"E	2182
084/09	E.W	Leka Dullecha	Kawusa	8°54'40.67"N	36°30'02.87"E	2133
085/09	E.W	Leka Dullecha	Haro Shakko	8°58'06.93"N	36°28'29.72"E	2249
086/09	E.W	Nunu Kumba	Amuru Botoro	8°46'01.74"N	36°39'15.28"E	2253
087/09	E.W	Leka Dullecha	Badh'o	8°57'53.82"N	36°27'57.20"E	2248
088/09	E.W	Arjo	Qumba	8°48'54.34"N	36°36'26.70"E	2248
089/09	E.W	Sibu Sire	Home Baro	9°02'12.41"N	36°53'05.23"E	1842
090/09	E.W	Sibu Sire	Burka Talo	9°01'52.57"N	36°51'01.05"E	1800
091/09	E.W	Bonaya Boshe	Ejersa Gute	8°57'33.64"N	36°39'52.77"E	1759
092/09	E.W	GudeyaBila	Gonka Ija	9°14'53.50"N	36°57'56.26"E	1943
093/09	E.W	GudeyaBila	Gonka Ija	9°14'55.42"N	36°57'40.82"E	1934
094/09	E.W	GudeyaBila	Gonka Ija	9°14'48.15"N	36°57'27.68"E	1949
095/09	E.W	GudeyaBila	Kalala	9°15'49.79"N	36°59'41.92"E	1989
096/09	E.W	GudeyaBila	Gonka Ija	9°14'41.02"N	37°00'26.13"E	1910
097/09	E.W	GudeyaBila	Gonka Ija	9°15'01.93"N	37°00'31.92"E	1943
098/09	E.W	Gobbu Sayyo	Adare Tiksa	9°19'03.77"N	36°57'04.14"E	1924
099/09	E.W	Gobbu Sayyo	Adare Tiksa	9°19'02.66"N	36°57'03.43"E	1921
100/09	E.W	Gobbu Sayyo	Adare Tiksa	9°18'54.99"N	36°56'50.76"E	1941
101/09	E.W	Gobbu Sayyo	Adare Tiksa	9°18'49.47"N	36°57'03.27"E	1965
102/09	E.W	Gobbu Sayyo	Adare Tiksa	9°19'09.47"N	36°57'15.54"E	1953
103/09	E.W	Gobbu Sayyo	Adare Tiksa	9°19'20.05"N	36°56'54.49"E	1957
104/09	E.W	Gobbu Sayyo	Adare Tiksa	9°18'32.61"N	36°57'38.33"E	1965
105/09	W.W	Gimbi	Kombo Mikael	9°05'40.07"N	35°49'37.35"E	1885
106/09	W.W	Gimbi	Kombo Mikael	9°05'54.10"N	35°49'55.34"E	2006
107/09	W.W	Gimbi	Kombo Mikael	9°05'53.27"N	35°49'19.04"E	1860
108/09	W.W	Gimbi	Kombo Mikael	9°06'25.19"N	35°49'56.17"E	2008
109/09	W.W	Gimbi	Kombo Mikael	9°06'22.67"N	35°49'07.07"E	2009
110/09	W.W	Gimbi	Kombo Mikael	9°06'27.21"N	35°48'42.00"E	1919
111/09	W.W	Gimbi	Kombo Mikael	9°05'49.93"N	35°48'44.90"E	1916
112/09	W.W	Gimbi	Kombo Mikael	9°05'36.96"N	35°48'32.01"E	1938
113/09	W.W	Gimbi	Kombo Mikael	9°05'20.43"N	35°48'38.52"E	1911
114/09	W.W	Gimbi	Kombo Mikael	9°06'10.49"N	35°48'21.41"E	1995
115/09	W.W	Gimbi	Kombo Mikael	9°06'25.75"N	35°48'21.28"E	1986
116/09	W.W	Gimbi	Kombo Mikael	9°04'57.80"N	35°48'43.66"E	1860
117/09	W.W	Gimbi	Kombo Mikael	9°04'48.21"N	35°48'31.84"E	1875
118/09	W.W	Gimbi	Kombo Mikael	9°05'05.80"N	35°48'53.27"E	1868
119/09	W.W	Gimbi	Kombo Mikael	9°04'41.37"N	35°49'06.57"E	1917
120/09	W.W	Gimbi	Kombo Mikael	9°07'52.61"N	35°48'27.40"E	2028
121/09	W.W	Gimbi	Kombo Mikael	9°08'13.31"N	35°48'29.14"E	2015
122/09	W.W	Gimbi	Kombo Mikael	9°09'27.31"N	35°48'35.53"E	1888
123/09	W.W	Gimbi	Kombo Mikael	9°09'26.10"N	35°49'01.32"E	1892
124/09	W.W	Gimbi	Kombo Mikael	9°05'05.24"N	35°49'11.10"E	1848
125/09	W.W	Gimbi	Garjo Bikilal	9°13'46.15"N	35°54'47.05"E	1753
126/09	W.W	Gimbi	Garjo Bikilal	9°14'02.64"N	35°55'19.48"E	1729
127/09	W.W	Gimbi	Garjo Bikilal	9°14'12.69"N	35°55'22.72"E	1726
128/09	W.W	Gimbi	Garjo Bikilal	9°14'17.42"N	35°55'07.21"E	1734
129/09	W.W	Gimbi	Garjo Bikilal	9°14'17.49"N	35°54'33.69"E	1739
130/09	W.W	Gimbi	Garjo Bikilal	9°14'20.22"N	35°54'13.16"E	1750
131/09	W.W	Gimbi	Garjo Bikilal	9°14'34.03"N	35°54'11.09"E	1704
132/09	W.W	Gimbi	Garjo Bikilal	9°14'57.66"N	35°54'30.61"E	1661
133/09	W.W	Gimbi	Garjo Bikilal	9°14'54.55"N	35°53'54.15"E	1650
134/09	W.W	Gimbi	Garjo Bikilal	9°12'46.20"N	35°54'39.48"E	1842
135/09	W.W	Gimbi	Garjo Bikilal	9°13'31.18"N	35°55'02.51"E	1762
136/09	W.W	Gimbi	Garjo Bikilal	9°13'39.76"N	35°55'39.86"E	1771
137/09	W.W	Gimbi	Garjo Bikilal	9°13'43.95"N	35°55'39.17"E	1770
138/09	W.W	Gimbi	Garjo Bikilal	9°15'01.84"N	35°53'17.62"E	1780
139/09	W.W	Gimbi	Garjo Bikilal	9°17'24.34"N	35°52'47.19"E	2140
140/09	W.W	Gimbi	Garjo Bikilal	9°16'40.84"N	35°51'39.96"E	2052
141/09	W.W	Gimbi	Garjo Bikilal	9°16'00.38"N	35°50'54.60"E	1973
142/09	W.W	Gimbi	Garjo Bikilal	9°16'02.38"N	35°50'35.87"E	1942
143/09	W.W	Gimbi	Garjo Bikilal	9°15'59.99"N	35°50'20.79"E	1889
144/09	W.W	Gimbi	Garjo Bikilal	9°15'28.22"N	35°50'26.16"E	1891
145/09	W.W	Gimbi	Lalo Choli	9°13'26.57"N	35°49'14.83"E	1831
146/09	W.W	Gimbi	Lalo Choli	9°13'51.03"N	35°49'11.40"E	1806
147/09	W.W	Gimbi	Lalo Choli	9°14'20.70"N	35°49'45.08"E	1730
148/09	W.W	Gimbi	Lalo Choli	9°14'13.95"N	35°48'38.07"E	1793
149/09	W.W	Gimbi	Lalo Choli	9°14'03.40"N	35°48'26.41"E	1790
150/09	W.W	Gimbi	Lalo Choli	9°13'56.66"N	35°47'55.64"E	1824
151/09	W.W	Gimbi	Lalo Choli	9°13'41.94"N	35°48'02.11"E	1838

152/09	W.W	Gimbi	Lalo Choli	9°13'07.44"N	35°48'03.32"E	1847
153/09	W.W	Gimbi	Lalo Choli	9°13'02.91"N	35°48'13.15"E	1827
154/09	W.W	Gimbi	Lalo Choli	9°12'49.36"N	35°47'56.95"E	1824
155/09	W.W	Gimbi	Lalo Choli	9°13'02.03"N	35°47'55.28"E	1814
156/09	W.W	Gimbi	Lalo Choli	9°13'29.23"N	35°47'57.03"E	1845
157/09	W.W	Gimbi	Lalo Choli	9°13'16.14"N	35°48'16.95"E	1846
158/09	W.W	Gimbi	Lalo Choli	9°13'40.52"N	35°48'15.06"E	1826
159/09	W.W	Gimbi	Lalo Choli	9°13'35.80"N	35°48'25.60"E	1793
160/09	W.W	Gimbi	Lalo Choli	9°13'40.75"N	35°46'07.29"E	1839
161/09	W.W	Gimbi	Lalo Choli	9°12'59.74"N	35°47'27.49"E	1811
162/09	W.W	Gimbi	Lalo Choli	9°12'50.07"N	35°45'07.71"E	1814
163/09	W.W	Gimbi	Lalo Choli	9°12'42.65"N	35°47'28.12"E	1819
164/09	W.W	Gimbi	Lalo Choli	9°12'33.55"N	35°47'32.15"E	1809
165/09	W.W	Gimbi	Didisa Bikilal	9°16'04.73"N	35°44'32.94"E	1835
166/09	W.W	Gimbi	Didisa Bikilal	9°16'00.39"N	35°44'16.65"E	1854
167/09	W.W	Gimbi	Didisa Bikilal	9°15'55.18"N	35°44'07.13"E	1846
168/09	W.W	Gimbi	Didisa Bikilal	9°16'00.01"N	35°44'16.75"E	1853
169/09	W.W	Gimbi	Didisa Bikilal	9°16'07.72"N	35°44'03.88"E	1839
170/09	W.W	Gimbi	Didisa Bikilal	9°16'19.41"N	35°44'34.50"E	1864
171/09	W.W	Gimbi	Didisa Bikilal	9°16'30.82"N	35°44'20.96"E	1832
172/09	W.W	Gimbi	Didisa Bikilal	9°16'30.91"N	35°44'38.31"E	1875
173/09	W.W	Gimbi	Didisa Bikilal	9°16'33.28"N	35°44'54.60"E	1886
174/09	W.W	Gimbi	Didisa Bikilal	9°16'42.27"N	35°44'58.50"E	1885
175/09	W.W	Gimbi	Didisa Bikilal	9°16'56.56"N	35°44'33.78"E	1849
176/09	W.W	Gimbi	Didisa Bikilal	9°17'03.59"N	35°44'52.60"E	1870
177/09	W.W	Gimbi	Didisa Bikilal	9°17'08.52"N	35°44'34.16"E	1845
178/09	W.W	Gimbi	Didisa Bikilal	9°17'08.70"N	35°44'12.03"E	1841
179/09	W.W	Gimbi	Didisa Bikilal	9°17'17.24"N	35°44'45.32"E	1831
180/09	W.W	Gimbi	Didisa Bikilal	9°17'35.46"N	35°44'40.77"E	1802
181/09	W.W	Gimbi	Didisa Bikilal	9°17'24.18"N	35°44'13.73"E	1830
182/09	W.W	Gimbi	Didisa Bikilal	9°17'37.21"N	35°44'23.71"E	1780
183/09	W.W	Gimbi	Didisa Bikilal	9°17'48.43"N	35°44'29.76"E	1766
184/09	W.W	Gimbi	Didisa Bikilal	9°18'26.52"N	35°43'56.80"E	1846
185/09	W.W	Mana Sibu Mandi	Guyo Sachi	9°45'13.68"N	35°01'35.14"E	1574
186/09	W.W	Mana Sibu Mandi	Guyo Sachi	9°45'13.64"N	35°01'35.19"E	1619
187/09	W.W	Mana Sibu Mandi	Guyo Sachi	9°45'29.26"N	35°01'17.20"E	1575
188/09	W.W	Mana Sibu Mandi	Wajitu Mandi	9°47'10.51"N	35°05'37.63"E	1689
189/09	W.W	Mana Sibu Mandi	Wajitu Mandi	9°47'10.42"N	35°05'22.03"E	1677
190/09	W.W	Mana Sibu Mandi	Wajitu Mandi	9°46'58.16"N	35°04'58.74"E	1637
191/09	W.W	Mana Sibu Mandi	Wajitu Mandi 01	9°47'14.30"N	35°06'00.61"E	1688
192/09	W.W	Mana Sibu Mandi	Wajitu Mandi	9°46'58.65"N	35°04'46.44"E	1629
193/09	W.W	Mana Sibu Mandi	Wajitu Kiltu Lubo	9°44'43.66"N	35°02'22.39"E	1597
194/09	W.W	Mana Sibu Mandi	Wajitu Kiltu Lubo	9°44'56.57"N	35°02'50.72"E	1555
195/09	W.W	Mana Sibu Mandi	Wajitu Mandi	9°46'18.84"N	35°04'37.03"E	1608
196/09	W.W	Mana Sibu Mandi	Wajitu Mandi	9°46'28.09"N	35°04'29.06"E	1611
197/09	W.W	Mana Sibu Mandi	Wajitu Mandi 01	9°46'24.42"N	35°04'13.55"E	1607
198/09	W.W	Mana Sibu Mandi	Wajitu Kiltu Lubo	9°45'01.32"N	35°03'14.45"E	1572
199/09	W.W	Mana Sibu Mandi	Wajitu Mandi	9°46'32.96"N	35°04'01.11"E	1603
200/09	W.W	Mana Sibu Mandi	Wajitu Kiltu Lubo	9°45'13.20"N	35°03'34.14"E	1585
201/09	W.W	Mana Sibu Mandi	Wajitu Mandi 01	9°46'58.27"N	35°04'18.97"E	1622
202/09	W.W	Mana Sibu Mandi	Wajitu Mandi	9°47'44.78"N	35°04'44.43"E	1590
203/09	W.W	Mana Sibu Mandi	Wajitu Mandi 01	9°47'48.34"N	35°04'29.22"E	1589
204/09	W.W	Mana Sibu Mandi	Wajitu Kiltu Lubo	9°44'56.88"N	35°03'46.19"E	1574
205/09	W.W	Mana Sibu Mandi	Wajitu Kiltu Lubo	9°45'29.51"N	35°03'53.50"E	1587
206/09	W.W	Mana Sibu Mandi	Wajitu Mandi	9°48'07.68"N	35°04'40.67"E	1610
207/09	W.W	Mana Sibu Mandi	Wajitu Kiltu Lubo	9°45'30.49"N	35°04'13.43"E	1567
208/09	W.W	Mana Sibu Mandi	Wajitu Kiltu Lubo	9°45'14.14"N	35°04'36.22"E	1595
209/09	W.W	Mana Sibu Mandi	Wajitu Mandi 01	9°48'22.76"N	35°04'32.51"E	1610
210/09	W.W	Mana Sibu Mandi	Wajitu Kiltu Lubo	9°45'14.21"N	35°04'51.49"E	1596
211/09	W.W	Mana Sibu Mandi	Wajitu Kiltu Lubo	9°45'36.34"N	35°05'34.92"E	1622
212/09	W.W	Mana Sibu Mandi	Wajitu Mandi	9°46'54.39"N	35°05'55.53"E	1627
213/09	W.W	Mana Sibu Mandi	Wajitu Kiltu Lubo	9°46'13.01"N	35°05'53.05"E	1652
214/09	W.W	Mana Sibu Mandi	Wajitu Kiltu Lubo	9°45'56.74"N	35°00'29.85"E	1543
215/09	W.W	Mana Sibu Mandi	Wajitu Kiltu Lubo	9°45'46.48"N	35°00'37.54"E	1536
216/09	W.W	Mana Sibu Mandi	Wajitu Kiltu Lubo	9°45'46.71"N	35°00'47.09"E	1558
217/09	W.W	Mana Sibu Mandi	Wajitu Mandi 01	9°47'06.51"N	35°06'15.89"E	1688
218/09	W.W	Boji Dirmaji	Gumbo Boji	9°23'14.75"N	35°36'03.09"E	2004
219/09	W.W	Boji Dirmaji	Lata Bobine	9°23'23.60"N	35°35'57.02"E	2000
220/09	W.W	Boji Dirmaji	Lata Bobine	9°23'28.25"N	35°36'12.30"E	1965
221/09	W.W	Boji Dirmaji	Gumbo Boji	9°21'34.11"N	35°34'51.96"E	1944
222/09	H.G.W	Horro	Doyyo Bariso	9°36'09.82"N	37°11'33.91"E	2399
223/09	H.G.W	Horro	Doyyo Bariso	9°36'12.85"N	37°11'33.27"E	2392
224/09	H.G.W	Horro	Doyyo Bariso	9°36'19.70"N	37°11'42.36"E	2381
225/09	H.G.W	Horro	Doyyo Bariso	9°36'15.30"N	37°11'54.53"E	2390
226/09	H.G.W	Horro	Doyyo Bariso	9°36'05.22"N	37°12'00.61"E	2385
227/09	W.W	Boji Dirmaji	Lata Bobine	9°23'47.77"N	35°35'42.86"E	1964
228/09	H.G.W	Horro	Doyyo Bariso	9°36'22.08"N	37°12'14.99"E	2371
229/09	H.G.W	Horro	Didibbe Kistana	9°37'20.12"N	37°14'26.98"E	2369

230/09	H.G.W	Guduru	Walkitumma	9°40'30.30"N	37°19'43.49"E	2426
231/09	H.G.W	Guduru	Walkitumma	9°40'28.33"N	37°19'11.57"E	2432
232/09	H.G.W	Abay Chomen	Fincha/forest	9°31'57.98"N	37°23'22.20"E	2245
233/09	Iluababor	Ale	Ale	8°26'16.33"N	36°11'31.46"E	1974
234/09	E.W	Gute	Kichi	9°01'34.40"N	36°40'00.42"E	1840
235/09	Iluababor	Ale	Ale	8°25'50.73"N	36°10'59.04"E	1965
236/09	Buno Bedelle	Bedelle	Ale	8°29'01.27"N	36°21'35.78"E	2030
237/09	W.W	Gimbi	Gimbi 03	9°11'13.38"N	35°49'42.19"E	1890
238/09	Jimma	manna	Koche	7°54'50.64"N	36°37'33.99"E	1615
239/09	E.Gojjam	hulet eju	Mota zuria	11°03'27.14"N	37°53'11.56"E	2441
240/09	W.W	Gimbi	Choli	9°12'14.19"N	35°49'22.29"E	1885
241/09	E.W	Sibu Sire	Tuqa	9°01'46.96"N	36°53'17.77"E	1815
242/09	jimma	Dedo	Dedo zuria	7°30'27.26"N	36°52'03.20"E	2212
243/09	H.G.W	Abay Chomen	Nashe	9°32'00.54"N	37°22'18.84"E	2281
244/09	Bench Madji	Andracha	Kufe	7°02'19.25"N	35°36'46.57"E	1457
245/09	H.G.W	Abay Chomen	Mazoria	9°31'09.43"N	37°22'37.92"E	2269
246/09	Q.W	Dembi Dolo	Gida Gebo	8°35'11.84"N	34°35'02.99"E	1498
247/09	Iluababor	Ale	Sotelo	8°26'37.00"N	36°10'50.29"E	1970
248/09	E.W	Jimma Arjo	Guddanne	8°45'41.04"N	36°28'44.67"E	2297
249/09	W.W	Gimbi	Aba Sena	9°01'50.27"N	35°58'33.26"E	1630
250/09	Q.W	Dembi Dolo	Gida Gebo	8°35'09.69"N	34°35'40.21"E	1541
251/09	E.W	Guto wayu	Gute	9°03'21.83"N	36°41'16.00"E	1971
252/09	Iluababor	Ale	Sotelo	8°26'32.00"N	36°11'01.82"E	1952
253/09	E.W	Guto wayu	Gute	9°03'42.50"N	36°40'20.09"E	2133
254/09	E.W	Digga	Digga Leqa	9°03'07.28"N	36°29'09.13"E	2187
255/09	W.W	Gimbi	Gimbi Adventist	9°10'14.94"N	35°50'23.85"E	1945
256/09	jimma	Dedo	Dedo Zuria	7°30'11.60"N	36°52'12.49"E	2294
257/09	E.W	Guto wayu	Gute	9°03'26.70"N	36°40'36.65"E	2066
258/09	E.W	Digga	Digga Leqa	9°01'54.52"N	36°27'26.24"E	2207
259/09	W.Sh	Bako Tibbe	Tibbe	9°05'06.06"N	37°06'20.86"E	1658
260/09	E.W	Digga	Digga Zuria	9°01'47.10"N	36°26'03.21"E	2174
261/09	E.W	Jimma Arjo	Guddanne	8°44'54.98"N	36°29'27.24"E	2450
262/09	E.W	Digga	Digga zuria	9°02'25.58"N	36°29'03.58"E	2214
263/09	w.sh	Bako Tibbe	Bacha Oda Gibe	9°05'27.02"N	37°06'02.52"E	1695
264/09	E.W	Gudeya Bila	Haro Gudisa	9°13'51.21"N	37°01'23.90"E	1877
265/09	E.W	Gudeya Bila	Haro Gudisa	9°13'25.52"N	37°01'54.19"E	1888
266/09	E.W	Gudeya Bila	Haro Gudisa	9°13'33.28"N	37°01'56.71"E	1886
267/09	E.W	Gudeya Bila	Haro Gudisa	9°13'51.97"N	37°01'28.74"E	1877
268/09	E.W	Gudeya Bila	Haro Gudisa	9°14'04.49"N	37°01'47.56"E	1877
269/09	E.W	Gudeya Bila	Haro Gudisa	9°14'15.32"N	37°01'49.49"E	1879
270/09	E.W	Gudeya Bila	Haro Gudisa	9°14'18.65"N	37°01'35.30"E	1890
271/09	E.W	Gudeya Bila	Hena Jawaja	9°14'09.72"N	37°01'31.09"E	1883
272/09	E.W	Gudeya Bila	Hena Jawaja	9°13'50.59"N	37°01'19.67"E	1877
273/09	E.W	Gudeya Bila	Hena Jawaja	9°14'17.30"N	37°01'13.26"E	1923
274/09	E.W	Gudeya Bila	Hena Jawaja	9°14'27.02"N	37°01'01.46"E	1964
275/09	H.G.W	Horro	Burkitu Oborra	9°27'53.61"N	37°04'06.99"E	3014
276/09	H.G.W	Horro	Burkitu Oborra	9°27'49.76"N	37°04'06.83"E	2806
277/09	H.G.W	Horro	Burkitu Oborra	9°27'24.62"N	37°04'00.75"E	2903
278/09	W.W	Mana Sibu Mandi	Guyo Sachi	9°44'44.99"N	35°03'33.58"E	1590
279/09	W.W	Kiltu Kara	Dandi Gudi	9°31'52.40"N	35°22'19.50"E	1799
280/09	W.W	Kiltu Kara	Dandi Gudi	9°32'04.39"N	35°22'30.93"E	1817
281/09	W.W	Kiltu Kara	Dandi Gudi	9°32'09.40"N	35°22'09.30"E	1793
282/09	W.W	Kiltu Kara	Dandi Gudi	9°32'32.55"N	35°22'27.27"E	1747
283/09	W.W	Kiltu Kara	Dandi Gudi	9°32'33.33"N	35°21'50.32"E	1694
284/09	W.W	Kiltu Kara	Dandi Gudi	9°32'40.79"N	35°22'13.50"E	1717
285/09	W.W	Boji Dirmaji	Lata Bobine	9°24'12.07"N	35°35'26.52"E	1896
286/09	W.W	Boji Dirmaji	Lata Bobine	9°24'20.62"N	35°36'18.70"E	1918
287/09	W.W	Boji Dirmaji	Lata Bobine	9°23'50.10"N	35°35'44.46"E	1976
288/09	W.W	Nejo	Humna Wakayyo	9°30'32.40"N	35°31'10.33"E	1901
289/09	W.W	Kiltu Kara	Chara Gudi	9°31'45.47"N	35°22'30.00"E	1839
290/09	W.W	Boji Dirmaji	Lata Bobine	9°27'13.65"N	35°33'15.48"E	1853
291/09	W.W	Boji Dirmaji	Gumbo Boji	9°28'42.70"N	35°32'21.80"E	1805
292/09	W.W	Nejo	Humna Wakayyo	9°31'20.80"N	35°31'32.35"E	1914
293/09	W.W	Mana Sibu Mandi	Guyo Sachi	9°49'56.69"N	35°03'56.82"E	1694
294/09	W.W	Mana Sibu Mandi	Lafto Salga	9°49'46.33"N	35°04'36.46"E	1759
295/09	W.W	Mana Sibu Mandi	Lafto Salga	9°50'05.95"N	35°04'48.14"E	1718
296/09	W.W	Nejo	Humna Wakayyo	9°31'09.60"N	35°31'28.18"E	1913
297/09	W.W	Nejo	Humna Wakayyo	9°31'36.07"N	35°31'31.17"E	1890
298/09	W.W	Mana Sibu Mandi	Guyo Sachi	9°50'09.75"N	35°03'36.54"E	1650
299/09	W.W	Mana Sibu Mandi	Guyo Sachi	9°50'17.03"N	35°03'53.42"E	1661
300/09	W.W	Mana Sibu Mandi	Guyo Sachi	9°50'29.80"N	35°03'50.10"E	1655
301/09	E.W	Limmu	Bolale	9°50'21.70"N	36°28'48.42"E	2149
302/09	E.W	Limmu	Sakata Kiltu Babbo	9°51'04.95"N	36°29'27.52"E	2181
303/09	E.W	Limmu	Muka Arba Dima	9°51'13.49"N	36°28'22.20"E	2134
304/09	E.W	Limmu	Sapera	9°51'49.78"N	36°31'30.58"E	2192
305/09	E.W	Limmu	Degem Silassie	9°51'46.82"N	36°30'46.08"E	2133
306/09	E.W	Limmu	Bolale	9°51'03.51"N	36°29'03.25"E	2170
307/09	E.W	Limmu	Degem Silassie	9°51'25.62"N	36°30'09.88"E	2151

308/09	E.W	Limmu	Sapera	9°51'34.09"N	36°29'36.91"E	2115
309/09	E.W	Limmu	Muka Arba Dima	9°51'29.62"N	36°29'03.18"E	2149
310/09	E.W	Limmu	Sakata Kiltu Babbo	9°51'05.03"N	36°27'02.75"E	2122
311/09	E.W	Gida Ayana	Gute Gudina	9°53'33.86"N	36°37'03.19"E	1970
312/09	E.W	Gida Ayana	Gaba Jimata	9°53'15.79"N	36°39'41.04"E	2085
313/09	E.W	Gida Ayana	Gute Gudina	9°53'13.79"N	36°37'13.93"E	2060
314/09	E.W	Gida Ayana	Gaba Jimata	9°53'33.86"N	36°37'03.19"E	2049
315/09	E.W	Gudeya Bila	Chali Jima	9°53'00.99"N	36°39'39.42"E	2629
316/09	E.W	Gida Ayana	Gaba Jimata	9°53'07.17"N	36°39'51.96"E	2098
317/09	E.W	Gudeya Bila	Alito	9°19'22.55"N	37°02'22.78"E	2194
318/09	E.W	Gudeya Bila	Chali Jima	9°19'37.40"N	37°02'24.96"E	2192
319/09	E.W	Gudeya Bila	Chali Jima	9°19'26.06"N	37°02'06.92"E	2315
320/09	E.W	Gudeya Bila	Alito	9°19'34.34"N	37°02'02.38"E	2339
321/09	E.W	Leka Dullecha	Badh'o	8°55'13.31"N	36°34'48.24"E	1892
322/09	E.W	Leka Dullecha	Badh'o	8°55'15.97"N	36°34'57.55"E	1887
323/09	E.W	Leka Dullecha	Badh'o	8°55'10.07"N	36°35'12.47"E	1863
324/09	E.W	Leka Dullecha	Badh'o	8°55'04.73"N	36°35'24.52"E	1847
325/09	E.W	Leka Dullecha	Ale Qawusa	8°55'02.77"N	36°34'25.45"E	1899
326/09	E.W	Leka Dullecha	Badh'o	8°55'18.16"N	36°35'32.22"E	1871
327/09	E.W	Leka Dullecha	Badh'o	8°55'17.25"N	36°36'11.20"E	1825
328/09	E.W	Leka Dullecha	Badh'o	8°55'28.47"N	36°35'39.29"E	1855
329/09	E.W	Leka Dullecha	Badh'o	8°55'29.25"N	36°35'38.82"E	1854
330/09	E.W	Jimma Arjo	Hara Kekko	8°47'34.62"N	36°28'33.67"E	2478
331/09	E.W	Jimma Arjo	Wayu Warke	8°46'52.62"N	36°29'22.35"E	2355
332/09	E.W	Jimma Arjo	Wayu Qiltu	8°45'46.77"N	36°29'19.93"E	2455
333/09	E.W	Jimma Arjo	Abayyi	8°45'52.41"N	36°30'49.37"E	2313
334/09	E.W	Jimma Arjo	Hara Gabato	8°45'37.63"N	36°29'16.52"E	2424
335/09	E.W	Jimma Arjo	Hara Gabato	8°44'18.16"N	36°29'45.85"E	2349
336/09	E.W	Jimma Arjo	Hara Gabato	8°44'03.37"N	36°29'25.09"E	2294
337/09	E.W	Jimma Arjo	Hara Gabato	8°44'18.73"N	36°29'05.08"E	2308
338/09	E.W	Jimma Arjo	Tibbe Chafe	8°43'37.06"N	36°30'48.99"E	2456
339/09	Buno Bedelle	Makko	Dambali Sophe	8°37'46.55"N	36°07'42.97"E	2081
340/09	Buno Bedelle	Makko	Dambali Sophe	8°37'42.79"N	36°08'02.82"E	2061
341/09	Buno Bedelle	Makko	Dambali Sophe	8°37'34.06"N	36°07'57.73"E	2037
342/09	Buno Bedelle	Makko	Dambali Sophe	8°37'37.15"N	36°07'47.12"E	2088
343/09	Buno Bedelle	Makko	Dambali Sophe	8°37'29.41"N	36°07'48.25"E	2072
344/09	Buno Bedelle	Makko	Dambali Sophe	8°37'57.74"N	36°07'45.24"E	2044
345/09	Buno Bedelle	Makko	Dambali Sophe	8°38'05.50"N	36°07'20.15"E	2082
346/09	Buno Bedelle	Makko	Dambali Sophe	8°37'51.48"N	36°07'12.78"E	2078
347/09	Buno Bedelle	Makko	Dambali Sophe	8°37'46.43"N	36°07'17.95"E	2055
348/09	Buno Bedelle	Makko	Dambali Sophe	8°37'33.12"N	36°07'22.82"E	2087
349/09	Buno Bedelle	Makko	Dambali Sophe	8°37'24.84"N	36°07'27.57"E	2079
350/09	Buno Bedelle	Makko	Dambali Sophe	8°37'20.96"N	36°07'44.91"E	2072
351/09	Buno Bedelle	Makko	Dambali Sophe	8°37'02.04"N	36°08'10.31"E	2101
352/09	Buno Bedelle	Makko	Makko 01	8°34'43.13"N	36°06'54.51"E	2266
353/09	Buno Bedelle	Chora	Umbe	8°35'37.51"N	36°06'50.21"E	2218
354/09	Buno Bedelle	Chora	Bero Sariti	8°25'38.96"N	36°08'28.38"E	1944
355/09	Iluababor	Hurumu	Mettu Mechi	8°20'40.18"N	35°42'54.96"E	1803
356/09	Iluababor	Hurumu	Mettu Mechi	8°20'07.06"N	35°43'29.91"E	1822
357/09	Iluababor	Hurumu	Mettu Mechi	8°21'00.88"N	35°44'14.66"E	1636
358/09	Iluababor	Hurumu	Yobidola	8°21'00.18"N	35°44'24.56"E	1695
359/09	Iluababor	Hurumu	Mettu Mechi	8°19'54.58"N	35°43'55.64"E	1789
360/09	Iluababor	Hurumu	Mettu Mechi	8°20'19.89"N	35°47'56.08"E	1535
361/09	Buno Bedelle	Chora	Abdella	8°22'14.47"N	36°14'58.79"E	1947
362/09	Iluababor	Mettu	Tulubbe	8°19'28.43"N	35°32'25.43"E	1694
363/09	Iluababor	Mettu	Tulubbe	8°19'49.75"N	35°32'17.86"E	1699
364/09	Iluababor	Mettu	Adale Bishe	8°19'28.26"N	35°36'39.14"E	1670
365/09	Iluababor	Mettu	Adale Gumar	8°19'51.57"N	35°36'37.08"E	1710
366/09	Iluababor	Mettu	Adale Bishe	8°19'10.18"N	35°36'21.29"E	1668
367/09	Iluababor	Mettu	Mettu Mechi	8°19'15.42"N	35°37'52.79"E	1760
368/09	Iluababor	Mettu	Adale Gumar	8°19'03.01"N	35°37'06.00"E	1686
369/09	Iluababor	Mettu	Tulubbe	8°20'42.11"N	35°32'36.68"E	1702
370/09	Iluababor	Mettu	Mettu Mechi	8°19'39.85"N	35°40'06.85"E	1770
371/09	Iluababor	Mettu	Adale Gumar	8°19'56.80"N	35°46'07.38"E	1429
372/09	Buno Bedelle	Didessa	Sasso	8°35'39.43"N	36°20'25.99"E	1659
373/09	Buno Bedelle	Didessa	Masara	8°38'15.24"N	36°22'43.41"E	1671
374/09	Buno Bedelle	Didessa	Yembero	8°38'00.28"N	36°22'26.22"E	1427
375/09	Buno Bedelle	Didessa	Yembero	8°37'54.75"N	36°22'20.67"E	1432
376/09	Buno Bedelle	Didessa	Sasso	8°37'45.79"N	36°22'04.73"E	1459
377/09	Buno Bedelle	Didessa	Sasso	8°37'46.82"N	36°22'02.86"E	1463
378/09	Jimma	Gumay	Naga Agayo	8°09'17.74"N	36°28'21.92"E	2096
379/09	Jimma	Gumay	Naga Agayo	8°08'50.42"N	36°27'56.25"E	2244
380/09	Buno Bedelle	Didessa	Sasso	8°37'48.74"N	36°21'58.97"E	1470
381/09	Buno Bedelle	Didessa	Yembero	8°37'51.56"N	36°21'28.53"E	1427
382/09	Buno Bedelle	Didessa	Sasso	8°37'58.10"N	36°22'24.76"E	1427
383/09	Buno Bedelle	Didessa	Yembero	8°38'07.58"N	36°22'16.42"E	1450
384/09	H.G.W	Jimma Geneti	Bikila Nagaro	9°25'53.75"N	37°04'00.90"E	3016
384/10	H.G.W	Jimma Geneti	Bikila Nagaro	9°25'53.98"N	37°04'20.75"E	2945

386/09	H.G.W	Jimma Geneti	Gidami Dabsho	9°24'30.06"N	37°03'54.72"E	2929
387/09	H.G.W	Jimma Geneti	Gidami Dabsho	9°24'16.42"N	37°03'53.10"E	2911
388/09	H.G.W	Jimma Geneti	Gidami Dabsho	9°24'25.81"N	37°04'13.78"E	2703
389/09	H.G.W	Jimma Geneti	Gidami Dabsho	9°24'10.84"N	37°04'13.18"E	2706
390/09	H.G.W	Jimma Geneti	Gidami Dabsho	9°23'45.36"N	37°04'03.17"E	2843
391/09	E.W	Gudeya Bila	Lanfaji	9°17'55.86"N	37°02'26.65"E	2042
392/09	E.W	Gudeya Bila	Lanfaji	9°18'03.82"N	37°02'24.11"E	2051
393/09	E.W	Gudeya Bila	Lanfaji	9°18'10.48"N	37°02'19.92"E	2063
394/09	E.W	Gudeya Bila	Lanfaji	9°18'02.31"N	37°02'51.32"E	2060
395/09	E.W	Gudeya Bila	Lanfaji	9°17'55.39"N	37°02'50.81"E	2049
396/09	E.W	Gudeya Bila	Walane Lemu	9°21'03.48"N	37°02'08.19"E	2251
397/09	E.W	Gudeya Bila	Walane Lemu	9°20'53.47"N	37°02'16.31"E	2289
398/09	E.W	Gudeya Bila	Walane Lemu	9°20'40.41"N	37°02'35.54"E	2277
399/09	E.W	Gudeya Bila	Walane Lemu	9°20'33.35"N	37°02'46.15"E	2329
400/09	E.W	Gudeya Bila	Walane Lemu	9°20'14.80"N	37°02'55.30"E	2238
401/09	E.W	Gudeya Bila	Walane Lemu	9°20'09.92"N	37°02'47.05"E	2192
402/09	E.W	Gudeya Bila	Walane Lemu	9°20'10.43"N	37°02'11.83"E	2252
403/09	E.W	Gudeya Bila	Walane Lemu	9°20'25.56"N	37°02'18.44"E	2230
404/09	E.W	Gudeya Bila	Walane Lemu	9°20'44.94"N	37°01'50.14"E	2332
405/09	E.W	Gudeya Bila	Walane Lemu	9°21'00.44"N	37°01'54.05"E	2338
406/09	E.W	Gudeya Bila	Walane Lemu	9°19'55.93"N	37°02'15.88"E	2216
407/09	H.G.W	Jimma Geneti	Gamo Nagaro	9°22'45.81"N	37°04'18.96"E	2509
408/09	E.W	Gudeya bila	Bilo	9°18'26.50"N	37°03'11.15"E	2117
409/09	E.W	Gudeya bila	Ejere	9°15'21.32"N	37°02'41.72"E	1974
410/09	E.W	Gudeya bila	Chali	9°18'09.28"N	37°05'55.89"E	2803
411/09	E.W	Gudeya bila	Chali	9°18'17.31"N	37°05'41.32"E	2873
412/09	E.W	Gudeya bila	Gute Chacho	9°19'26.04"N	37°03'17.75"E	2257
413/09	E.W	Gudeya bila	Gute Chacho	9°19'11.72"N	37°03'24.73"E	2237
414/09	H.G.W	Horro	Burkitu Oborra	9°28'13.59"N	37°03'45.56"E	2699
415/09	H.G.W	Horro	Burkitu Oborra	9°28'05.24"N	37°03'17.31"E	2676
416/09	H.G.W	Horro	Burkitu Oborra	9°27'08.97"N	37°03'43.07"E	3025
	10	40	127			1412-3025

Key: E.W-East Wollega, W.W-West Wollega, W.Sh-West Shewa, Q.W-Qellem wollega, B.B-Buno Bedelle, ILU-Iluababor, E.G-East Gojjam, H.G.W-Horro Gurudu Wollega, H'- Shannon Weaver Diversity Index.

Table 2. Qualitative traits with their respective codes and description

Trait	Code	Scale	Description
Leaf traits			
Foliage color	Fci	1-9	1=yellow, 2=green, 3=green with purple edge, 4=grayish green due to heavy pubescence, 5=green with purple veins on upper surface, 6=slightly purple, 7=mostly purple, 8=green upper purple lower, 9=purple both surface
Mature leaf size	Ls	3, 5, 7, 9	3=small-<8 cm, 5=medium-8-15 cm,7=large-16-25 cm, 9=very large->25 cm
Mature leaf lobe types	Ll	0,1,3,5,7,9	0=no lateral lobes, 1=very slight teeth, 3=slight, 5=moderate,7=deep, 9=very deep
Leaf blade/degree of secondary lobing	Lb	0, 3, 5, 7	0= no blade,3=weak, 5=intermediate, 7=strong
General outline of the leaf (shape)	Outl	1-7	1-rounded, 2=reniform/kidney shaped, 3=cordate/heart shaped, 4=triangular, 5=hastate/trilobular & spear shaped, 6= lobed, 7= almost divided
Leaf lobe number	Lno	1,3,5,7,9	Each number indicate the number of lobes
Shape of central leaf lobe	Ssl	0-9	0=absent, 1=toothed, 2= circular, 3=semi-circular, 4= semi-elliptic, 5=elliptic, 6=lanceolate, 7=oblanceolate, 8=linear/broad, 9=linear/narrow
Petiole length	Pl	1,3,5,7,9	1=very short-<10 cm, 3=short-10-20 cm, 5=intermediate-21-30 cm, 7=long-31-40 cm, 9= very long->40 cm
Petiole pigmentation	Pp	1-9	1=green, 2=green with purple with purple near stem, 3=green with purple near leaf, 4=green with purple at both ends, 5= green with purple spots throughout petiole, 6=green with purple strips, 7=purple with green near leaf, 8=some petioles purple others green, 9=totally or mostly purple
Vine traits			
Plant growth type	gt	1-2	1=determinate (main stem distinct with shortened internodes), 2=indeterminate (long main stem)
Vine spreading nature/growth habit	gh	1-2	1=bushy, 2=runner
Ground cover	gc	3,5,7,9	3=<50%low, 5=50-74%medium, 7=75-90%high, 9=>90%total
Vine internode length(cm)-il	il	1,3,5,7,9	1=<3 cm very short, 3=3-5 cm short, 5=6-9 cm intermediate, 7=10-12cm long, 9= >12cm very long
Vine internode diameter (mm)-id	id	1,3,5,7,9	1=<3 mm very thin, 3=4-6mm thin, 5=7-9mm intermediate, 7=10-12mm thick, 9=>12mm very thick
Vine tip pubescence (degree of hairiness)	vtp	0,3,5,7	0=absent, 3=sparse, 5=moderate, 7=heavy
Tendril twining direction	ttd	1, 3	1=to right, 3=to left
Predominant vine color	pvc	1, 3-9	1=green, 3=green with few purple spots, 4=green with many purple spots, 5=green with many dark purple spots, 6=mostly purple, 7=mostly dark purple, 8=totally purple, 9=totally dark purple
Secondary vine color	svc	0-7	0=absent, 1=green base, 2=green tip, 3=green nodes, 4=purple base, 5=purple tip, 6=purple nodes, 7=others

Flower traits			
Flowering habit	flh	0,3,5,7	0=none, 3=sparse, 5=moderate, 7=profuse
Flower color	fc	1-6	1=white, 2=white limb with purple throat, 3= white limb with pale purple ring and purple throat,4=plae purple limb with purple throat, 5=purple, 6=yellow
Limb shape	lsh	3,5,7	3=semi-stellate, 5=pentagonal, 7=rounded
Sepal shape	ssh	1,3,5,7,9	1=ovate, 3=elliptic, 5=obovate, 7=oblong, 9=lanceolate
Sepal apex	sa	1,3,5,7	1=acute, 3=obtuse, 5=acuminate, 7=caudate
Sepal pubescence	sp	0,3,5,7	0=absent, 3=sparse, 5=moderate, 7=heavy
Sepal color	sco	1,2,3,5,6,7,9	1=green, 2=green with purple edge, 3=green with purple spots, 5=green with purple areas, 6=some green others purple, 7=totally pigmented pale purple, 9=totally pigmented dark purple
Stigma color	stco	1,,5,9	1=white, 5=pale purple, 9=purple
Style color	styco	1,3,5,7,9	1=white, 3=white with purple at the base, 5=white with purple at the top, 7=white with purple spots throughout, 9=purple
Sex type	fsex	1-5	1=Monoecious (male and female flowers on the same plant), 2= Andromonoecious (male/female and male flowers on the same plant), 3= Gynoecious (female flowers on the same plant) 4= Male sterile 5= Female steril
Root traits			
Root shape	rsh	1-9	1=round L/B ratio 1:1, 2=round elliptic L/B ratio not >2:1, 3=elliptic L/B ratio not >3:1,
Root surface and flesh defects	Rsd,fd	0-8	0=absent, 1=alligator like skin, 2=veins, 3=shallow horizontal constrictions, 4=deep horizontal constrictions, 5=shallow longitudinal grooves, 6=deep longitudinal grooves, 7=deep constrictions and deep grooves, 8=others
Root cortex thickness	rct	1,3,5,7,9	1=very thin <1mm, 3=thin 1-2mm, 5=intermediate 2-3mm, 7=thick 3-4mm
Root cortex color	ccor	1,2,3	1=dark brown, 2=light brown,3= white/cream
Root constriction	rc	1,2	1=present, 2= absent
Root skin texture	rst	3,5,7	1=medium, 2=soft, 3=rough
Root stalk	rstk	0,1,3,5,7,9	0=absent, 1=very short <2 cm, 3=short 2-5 cm, 5=intermediate 6-8 cm, 7=long 9-12 cm, 9=very long >12 cm
Root cracking	rcr	0,3,5,7	0=absent, 3=few cracks, 5=medium no. of cracks, 7=many cracks
Latex production of root	lp	3,5,7	3=little, 5=some, 7=abundant
Oxidation of root	ox	3,5,7	Amount of browning observed 5-10 seconds after roots cut cross sectionally; 3=little, 5=some, 7=abundant
Root size and variability	rsv	3,5,7	3=uniform, 5=slightly variable, 7= moderately variable
Predominant root flesh color	rfcp	1-9	1=white, 2=cream, 3=dark cream, 4=pale yellow, 5=dark yellow, 6=orange, 7=intermediate orange, 8=dark orange, 9=strongly pigmented
Secondary root flesh color	rfcs	0-9	0=absent, 1=white, 2=cream, 3=dark cream, 4=pale yellow, 5=dark yellow, 6=pale yellow, 7=intermediate orange, 8=dark orange, 9=strongly pigmented
Predominant root skin color	rscp	1-9	1=white, 2=cream, 3=yellow, 4=orange, 5=pink, 6=red, 7=purple red, 8=purple, 9=dark purple
Secondary root skin color	rscs	0-9	0=absent, 1=white, 2=cream, 3=yellow, 4=orange, 5=pink, 6=red, 7=purple red, 8=purple, 9=dark purple
Position of root	pr	1-3	1 = Tending toward horizontal, 2= Irregular, 3= Tending toward vertical
Ease of root periderm (outer skin) removal	rpr	1-3	1=average, 2=ease, 3=difficult

Table 3. Range, mean, and heritability (H^2) of qualitative traits of 400 anchote accessions

Trait	R	Range	CV (%)	Mean (SD)	LSD	P value	H^2	GA	GAM	Trait	R	Range	CV (%)	Mean (SD)	LSD	P value	H^2
rsv	0.52	3.00(5.00)	10.46	3.92(0.41)	1.12	0.29	0.26	0.06	10.34	outl	1.00	1.67(3.00)	8.92	2.13(0.19)	0.00	<.0001	1.00
rfcp	0.52	1.00(1.83)	15.04	1.13(0.17)	0.48	0.46	0.25	0.01	4.29	fcl	0.00	1.00(1.00)	0.00	1.00(0.00)	0.00	<.0001	-
pr	0.72	1.00(1.83)	8.76	1.37(0.12)	0.36	0.82	0.23	0.00	2.63	ls	0.00	3.00(3.00)	0.00	3.00(0.00)	0.00	<.0001	-
rfcs	0.57	1.00(1.83)	12.71	1.18(0.15)	0.40	0.11	0.27	0.01	2.65	ll	1.00	2.00(3.00)	11.07	2.44(0.27)	0.01	<.0001	1.00
rscp	0.51	1.00(1.50)	9.35	1.07(0.10)	0.29	0.71	0.24	0.00	3.30	lno	1.00	1.00(5.00)	43.53	2.32(1.01)	0.02	<.0001	1.00
rscs	0.54	1.00(2.00)	15.08	1.26(0.19)	0.51	0.39	0.27	0.01	4.28	sll	1.00	1.00(5.00)	28.17	3.23(0.91)	0.08	<.0001	1.00
rsh	0.55	1.00(1.67)	11.82	1.10(0.13)	0.35	0.42	0.25	0.01	2.86	il	1.00	1.72(2.00)	3.05	1.97(0.06)	0.00	<.0001	1.00
fd	0.50	0.00(0.50)	6.00	0.01(0.06)	0.16	0.60	0.25	0.00	0.00	id	1.00	0.44(1.74)	15.28	0.72(0.11)	0.00	<.0001	1.00
rc	0.53	1.00(1.67)	8.82	1.02(0.09)	0.23	0.09	0.28	0.00	0.00	vtp	1.00	3.00(5.00)	14.32	4.12(0.59)	0.00	<.0001	1.00
rsd	0.50	0.00(0.50)	0.00	0.00(0.03)	0.07	0.50	0.25	0.00	0.00	pvc	1.00	1.00(2.00)	17.59	1.08(0.19)	0.02	<.0001	1.00
rct	0.52	1.33(3.00)	16.60	2.35(0.39)	1.03	0.24	0.26	0.05	9.10	svc	1.00	2.00(3.00)	8.70	2.07(0.18)	0.02	<.0001	1.00
rpr	0.51	1.00(1.67)	11.50	1.13(0.13)	0.35	0.42	0.37	0.01	4.23	ttd	1.00	1.00(3.00)	16.54	2.66(0.44)	0.00	<.0001	1.00
rf	0.53	1.00(3.00)	25.43	1.73(0.44)	1.14	0.11	0.27	0.06	10.55	fsh	1.00	2.33(3.00)	1.00	3.00(0.03)	0.00	<.0001	1.00
rstk	0.52	2.50(4.00)	8.68	3.34(0.29)	0.84	0.70	0.24	0.03	6.90	ssh	1.00	1.00(3.00)	32.04	1.81(0.58)	0.04	<.0001	1.00
rcrk	0.00	0.00(0.00)	0.00	0.00(0.00)	0.00	0.00	-	-	-	sa	1.00	1.00(3.00)	32.14	1.40(0.45)	0.07	<.0001	1.00
ccor	0.52	1.00(1.83)	14.17	1.20(0.17)	0.45	0.22	0.26	0.01	4.66	sp	1.00	0.00(3.00)	41.18	1.53(0.63)	0.00	<.0001	1.00
lp	0.53	3.00(4.33)	9.59	3.44(0.33)	0.87	0.21	0.27	0.03	7.58	sco	1.00	1.00(1.67)	17.92	1.06(0.19)	0.09	<.0001	1.00
rst	0.55	3.00(4.00)	6.69	3.14(0.21)	0.56	0.16	0.27	0.02	5.96	stco	0.50	1.00(1.33)	3.00	1.00(0.03)	0.06	0.50	0.25
ox	0.97	1.00(2.50)	5.96	1.51(0.09)	0.26	0.55	0.25	0.01	3.96	styco	1.00	1.00(3.00)	30.25	1.19(0.36)	0.00	<.0001	0.99
lb	1.00	3.00(3.67)	1.00	3.00(0.03)	0.00	<.0001	1.00	0.00	0.00	fsex	1.00	1.00(1.67)	13.08	1.07(0.14)		<.0001	1.00

Table 4. Frequency distribution of the 400 anchote accessions among 42 qualitative traits

Traits	Characters of traits	Freq.	%	Traits	Characters of traits	Freq.	%
Root size and variability	Uniform	3	0.75	Predominant root skin color	Creamy	390	97.5
	Slightly variable	79	19.75		Orange	1	0.25
	Moderately variable	318	79.5		White	4	1
Predominant root flesh color	White	95	23.75		Yellow	5	1.25
	Creamy	252	63	Secondary root skin color	Creamy	290	72.5
	Dark cream	43	10.75		Orange	2	0.5
	Pale yellow	10	2.5		White	56	14
Secondary root flesh color	Creamy	273	68.25		Yellow	52	13
	Dark cream	19	4.75	Root shape	Round	54	13.5
	Dark yellow	1	0.25		Round elliptic	344	86
	Pale yellow	1	0.25		Elliptic	2	0.5
	White	106	26.5	Root surface and flesh defect	Absent	395	98.75
Root position	Horizontal	15	3.75		Alligator like skin	3	0.75
	Vertical	5	1.25		Veins	2	0.5
	Irregular	380	95	Root surface constriction	Present	394	98.5
Ease of root periderm (outer skin) removal	Ease	387	96.75		Absent	6	1.5
	Average	5	1.25	Root cortex thickness	Thin	131	32.75
	Difficult	8	2		Intermediate	222	55.5
					Thick	47	11.75
Root cortex color	dark brown	343	85.75	Root formation	Closed	379	94.75
	light brown	56	14		Open	21	5.25
	white/cream	1	0.25	Root stalk	Short	395	98.75
					Intermediate	5	1.25
Flesh latex production	Little	185	46.25	Oxidation	Little	400	100
	Some	196	49	Leaf blade/degree of secondary lobbing	Weak	213	53.25
	Abundant	19	4.75		Intermediate	178	44.5
Root skin texture	Soft	107	26.75		Strong	9	2.25
	Medium	290	72.5	General outline of the leaf (shape)	Hastate	295	73.75
	Rough	3	0.75		Cordate	1	0.25
Mature leaf lobe types	Very slight	45	11.25		Triangular	26	6.5
	Slight	294	73.5		Lobed	78	19.5
	Moderate	57	14.25	Foliage color	Green	400	100
	Deep	4	1	Shape of central leaf lobe	Circular	64	16
Mature leaf size	Small	37	9.25		Semi-circular	171	42.75
	Medium	363	90.75		Elliptic	17	4.25
Number of leaf lobes	One	6	1.5		Semi-elliptic	137	34.25
	Two	45	11.25		Toothed	11	2.75
	Three	167	41.75	Internode length	Short	18	4.5
	Four	158	39.5		Intermediate	382	95.5
	Five	23	5.75	Vine tip pubescence	Sparse	345	86.25
	Six	1	0.25		Moderate	55	13.75
Internode diameter	Very thin	398	99.5	Predominant vine color	Green	400	100
	Thin	2	0.5	Tendril twining direction	Left	388	97
Secondary vine color	Purple base	383	95.75		Right	12	3
	Purple tip	17	4.25	Sepal shape	Elliptic	37	9.25
Limb shape	Semi-stellate	61	15.25		Ovate	363	90.75
	Pentagonal	339	84.75	Sepal apex	Acute	261	65.25
Sepal pubescence	Absent	36	9		Obtuse	139	34.75
	Moderate	36	9	Stigma color	White	400	100
	Sparse	328	82	Flower sex	Monoecious	400	100
Style color	White	384	96	Sepal color	Green	343	85.75
	White with purple at the base	16	4		Green with purple edge	45	11.25
					Green with purple spots throughout	12	3

Table 7. Eigen vectors and eigen values of the first 17 Principal Components of 42 qualitative traits of 400 anchote accessions

Variable	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12	PC13	PC14	PC15	PC16	PC17
rsv	-0.06	0.17	0.14	-0.30	0.25	-0.09	0.19	-0.14	-0.02	-0.03	0.13	-0.05	0.18	0.05	0.04	0.23	-0.11
rfcp	0.12	0.09	0.38	0.33	-0.08	-0.04	0.14	0.04	-0.12	0.10	-0.01	0.31	-0.11	-0.03	-0.08	0.07	0.03
pr	-0.06	0.12	0.24	-0.14	0.01	0.05	-0.06	0.23	-0.02	-0.07	0.04	-0.38	-0.05	-0.27	0.22	0.03	0.05
rfcs	0.07	0.09	0.47	0.20	0.10	0.05	0.02	-0.03	-0.04	0.10	-0.07	0.02	0.07	0.24	-0.05	-0.07	-0.11
rscp	0.08	0.00	0.15	-0.09	-0.06	0.41	-0.12	0.02	-0.11	-0.05	0.15	0.37	0.26	-0.13	0.01	0.02	0.10
rscs	0.07	0.06	0.49	0.06	0.02	0.02	-0.08	-0.19	-0.02	0.04	0.11	-0.12	0.07	0.07	-0.08	-0.06	0.03
rsh	0.00	0.05	0.20	-0.25	-0.03	-0.21	-0.14	-0.06	0.08	-0.24	0.14	0.02	-0.01	0.32	-0.22	-0.24	0.20
fd	-0.04	-0.10	0.02	0.17	0.27	-0.08	0.09	-0.05	0.00	-0.11	-0.02	-0.04	0.32	-0.25	0.13	-0.23	-0.27
rc	-0.11	-0.05	-0.08	0.14	0.27	0.10	0.25	-0.41	0.11	-0.19	-0.09	0.05	0.04	0.06	-0.10	-0.03	0.26
rsd	0.08	0.28	-0.08	0.02	0.18	-0.02	-0.11	-0.10	-0.22	0.12	-0.19	-0.19	-0.04	-0.05	0.24	0.13	0.17

rct	0.12	0.00	-0.02	-0.08	0.02	-0.13	0.25	0.00	0.09	0.20	0.36	0.04	-0.14	-0.22	-0.27	0.20	-0.24
rpr	-0.04	-0.02	-0.17	0.04	0.16	-0.06	0.33	0.15	-0.28	0.20	0.14	-0.06	0.07	0.12	0.08	-0.30	0.10
rf	-0.06	0.11	0.07	-0.38	0.20	-0.22	0.09	-0.09	-0.05	-0.06	0.14	0.09	-0.14	0.13	0.20	0.14	-0.19
rstk	-0.09	0.01	0.15	-0.20	-0.15	-0.17	0.19	0.07	0.15	0.12	-0.21	-0.25	-0.16	-0.06	-0.23	-0.03	0.08
ccor	0.17	0.18	0.12	-0.16	0.08	0.23	0.08	-0.07	-0.13	0.20	-0.14	-0.24	-0.06	0.19	-0.03	0.01	0.06
lp	0.02	0.03	0.10	-0.03	-0.06	0.09	-0.08	0.29	0.24	-0.44	0.23	0.05	-0.30	0.10	0.16	-0.03	0.05
rst	0.02	0.03	0.02	-0.02	0.13	-0.16	-0.05	-0.11	0.40	0.28	-0.07	0.08	0.07	-0.09	0.23	0.07	0.48
ox	-0.04	0.04	0.03	-0.27	0.14	0.28	0.15	0.28	-0.11	0.05	0.21	0.12	0.16	-0.07	0.16	-0.15	0.33
lb	0.01	0.02	0.17	0.10	-0.09	-0.06	0.29	0.19	-0.13	-0.12	-0.36	0.09	-0.17	-0.18	0.04	-0.01	0.17
outl	0.29	-0.01	-0.19	-0.02	0.14	0.04	0.09	0.12	-0.20	-0.06	-0.03	0.05	0.00	0.36	-0.21	0.16	0.09
ll	0.51	-0.03	0.02	0.01	-0.03	-0.07	0.07	-0.08	0.10	-0.12	-0.04	-0.07	0.05	-0.08	0.13	-0.05	0.01
lno	0.51	0.00	-0.09	-0.08	-0.07	-0.06	0.12	-0.01	-0.06	-0.06	0.00	0.06	0.06	-0.02	-0.01	0.01	0.04
sll	0.50	-0.04	-0.07	-0.08	-0.05	-0.01	0.04	-0.01	0.18	-0.05	-0.02	-0.07	0.00	-0.03	0.13	-0.15	-0.07
il	0.06	0.05	-0.12	0.08	0.07	0.25	-0.34	0.05	0.05	0.32	0.17	-0.12	-0.08	0.12	-0.24	-0.08	0.04
id	0.02	-0.04	-0.03	0.20	0.28	0.32	0.12	0.02	0.41	-0.14	0.01	-0.33	-0.02	0.12	-0.06	0.02	-0.06
vtp	-0.06	0.17	-0.04	0.25	-0.01	0.01	0.28	0.43	0.04	0.05	0.06	-0.13	0.00	0.24	0.09	0.00	-0.11
pvc	0.02	0.59	-0.15	0.13	-0.03	-0.04	-0.06	-0.05	0.03	-0.11	0.09	0.06	0.00	-0.12	-0.06	-0.10	-0.01
svc	0.01	0.60	-0.13	0.13	-0.01	-0.07	-0.05	-0.07	0.03	-0.08	0.08	0.06	-0.02	-0.13	-0.09	-0.08	-0.03
ttd	0.09	-0.16	0.12	0.14	0.17	-0.12	-0.03	-0.04	-0.01	0.23	0.40	-0.08	-0.07	-0.18	0.04	-0.15	-0.05
fsh	0.10	0.04	0.05	-0.14	0.05	-0.15	-0.27	0.31	0.06	0.08	-0.24	-0.11	0.38	-0.12	-0.20	-0.16	-0.10
ssh	-0.05	0.08	-0.06	-0.27	-0.12	0.20	0.29	0.00	0.20	0.15	-0.09	0.09	-0.01	-0.18	-0.37	-0.17	0.00
sa	-0.03	-0.08	-0.05	0.15	-0.04	-0.40	0.00	0.05	-0.17	-0.19	0.21	-0.19	0.19	0.03	-0.23	-0.13	0.34
sp	-0.08	0.11	0.04	0.03	-0.29	0.10	0.28	-0.10	0.18	-0.12	0.09	-0.05	0.37	0.03	0.03	-0.10	-0.01
sco	0.03	-0.05	-0.02	0.10	-0.38	0.10	0.08	-0.19	-0.11	0.08	0.28	-0.29	-0.11	-0.14	0.07	0.11	0.25
stco	-0.02	0.06	-0.03	0.04	-0.11	-0.20	0.02	0.05	0.31	0.35	0.01	0.26	-0.07	0.26	0.28	-0.28	0.00
styco	-0.05	0.01	-0.04	-0.13	-0.33	0.11	0.02	-0.30	-0.20	0.01	-0.05	-0.14	-0.02	0.18	0.21	-0.37	-0.22
fsex	-0.03	0.04	-0.03	0.05	-0.30	-0.07	0.02	0.08	0.12	0.10	0.07	-0.07	0.44	0.23	0.10	0.48	-0.02
Eigenvalue	2.37	2.25	1.86	1.66	1.48	1.43	1.39	1.37	1.27	1.23	1.22	1.15	1.14	1.09	1.07	1.05	1.01
Proportion	6.4	6.1	5	4.5	4	3.9	3.8	3.7	3.4	3.3	3.3	3.1	3.1	2.9	2.9	2.8	2.7
Cumulative	6.4	12.5	17.5	22	26	29.9	33.7	37.4	40.8	44.1	47.4	50.5	53.6	56.5	59.4	62.3	65

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