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RESEARCH ARTICLE

Studies on the genetic variability among wollega coffee (*Coffea arabica* L.) landrace in western Ethiopia

Dawit Merga[1], Hussein Mohammed[2], Ashenafi Ayano[1]

1. Ethiopian institute of Agricultural Research, Jimma Agricultural Research Center, P.O. Box 192, Jimma, Ethiopia, Fax. +251 47 111 1999,Tel.+251 47 111 0206

2. Hawassa University College of Agriculture, School of Plant and Horticultural Sciences, P.O. Box 5, Hawassa, Ethiopia, Fax. +251 46 212 3040 or +251 46 220 6711, Tel. +251 46 220 6696

Corresponding authors email Id: dawitmerga@gmail.com

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Abstract

The twenty six coffee genotypes (22 accessions with four standard checks) were tested during 2016 and 2017 cropping season using Randomized complete block design (RCBD) at Haru and Mugi Agricultural research sub-centers of Ethiopia to study the variability among Wollega Coffee. The combined analysis of variance revealed non significant difference among tested coffee genotypes in all traits although the difference among genotypes was significant for 7 and 6 of 8 traits at Mugi and at Haru, respectively. The difference between the two locations was not significantly different in all traits. Genotype x environmental interaction (GEI) was significant for all traits indicating inconsistency of performance of Coffee genotypes across the two locations. This manifested that the difficulty of developing widely adapted Coffee varieties maintaining similar in their organoleptic traits. Hence, in order to develop Coffee variety that is acceptable in organoleptic traits, it is momentous to focus on Coffee variety development for individual location. Clustering was performed using the average linkage clustering method. The 26 Coffee genotypes clustered in to four and three at Haru and at Mugi based on organoleptic traits respectively. The genetic distance analysis between all clusters at both locations showed highly significant difference indicating the existence of genetic variability among clustered genotypes. The current results revealed that the presence of genetic diversity among genotypes for most traits at individual location indicating the possibility of improvement for desired organoleptic traits.

Keywords: Variability, coffea , genotypes, organoleptic, cluster

Introduction

Globally, coffee is the second most traded commodity after oil and one of the most common beverages enjoyed throughout the world which generates up to US$ 14 billion annually for the producing countries (Davis *et al*. 2012). More than 80 countries, including Ethiopia cultivate Coffee, which is exported as raw, roasted, or soluble product to more than 165 countries worldwide providing a livelihood for 125 million people around the world (ICO, 2016). In line with this, Esayas (2005) reported as Coffee provides one of the most widely drunk beverages in the world, and is a very important source of foreign exchange for many countries.

which is the second most important coffee species The agricultural based Ethiopian economy is highly dependent on Arabica coffee. Around 30 percent of the country's foreign exchange income comes from this single commodity crop (Alazar, 2017). Ethiopia is Africa's largest Coffee producer and the world's fifth largest *Coffea arabica* L. exporter next to Brazil, Vietnam, Colombia and Indonesia (ICO, 2016). It provides momentous employment opportunities in rural areas and sustains the livelihood of around 16% of Ethiopian population (Davis *et al.*, 2012; ICO, 2016).

Although different part of World's countries are growing and producing *Coffea arabica* L., its center of origin and genetic diversity is in Ethiopia. Ethiopian *Coffea arabica* L. is well known for its excellent quality, unique aroma and flavor. Arabica coffee landraces that are known having such unique organoleptic characteristics include Sidama, Yirgachefe, Harage, Gimbi and Limu (Kebede and Belachew, 2008). These different coffee landraces recognized by their origin and quality, and used as trade names. These include Harar which has mocha flavor, Jimma/limmu has heavy bodied cup with winy taste, Wollega known for its large bean size, and fruity flavor after taste, Sidama and Yirgacheffe has spice after taste (Boot, 2011; Desse, 2008). This variability in quality traits of coffee landrace is importantly indicates the availability of genetic diversity in organoleptic traits in Ethiopia. Similarly several authors indicated that the existence of Coffee genetic diversity using Organoleptic (cup quality) and Biochemical characterizations (Yigizaw, 2005; Olika *et al*., 2011). Similarly, Abdulfeta (2018) authenticated the existence variability among *Coffea arabica L*. in South Western Ethiopia using organoleptic traits. According to this author 93 Coffee accessions collected from South Western Ethiopia were grouped in to four using multivariate analysis method.

Wollega is one of the potential coffee growing areas of Western Ethiopia and has genetically diverse coffee in morphological, *organoleptic* and in World Coffee production (Stieger *et al*., 2002). bean physical characteristics which is essential in coffee improvement program. Therefore; the first step in any plant breeding activity is to determine the presence of plants that exhibit variations for the traits that breeder interested. Currently different studies are focused on evaluating crop genetic variability to continuo the next breeding program. Organoleptic characteristics significantly determine the price of Coffee on international trade. Thus, coffee breeding to improve such traits is crucial to be competent in world market. However, until today, there was no scientific study carried out on Wollega coffee landrace to evaluate the extent genetic variability among Coffee genotypes using organoleptic characteristics which is important for Coffee production as customers interest. Hence, this study was carried out with the objective to estimate the extent of genetic variability among some Wollega Coffee landrace based on organoleptic traits for the next breeding program.

Materials and methods

Description of studying areas

The experiment was conducted at Haru and Mugi agricultural research sub centers which are sub centers of Jimma agricultural research center. Mugi found in Kellam Wollega zone at 34^0 00' to East and $8^0$40' to North. It is 610km far from Jimma city to North West direction. It is located at altitude of 1570m a.s.l and receive 1655mm annual rain fall. Also, it has Nitosol soil type (Dubale, 2001) and minimum 17°C and maximum 29°C temperature for this location. Haru is located 35^0 47' 56'' to East and 8^0 59' 21'' to North, in West Wollega zone at altitude of 1752m a.s.l. and 360 km away from Jimma city. The area receives annual rain fall of 1727mm which is unimodal, the peak being in July. Also, it has an average maximum and minimum temperature of 27°C and 16°C respectively (Alemseged and Taye, 2002) and sand clay loam soil.

Experimental materials, design and agronomic practice

The experiment was conducted during 2016 and 2017 cropping season, on 22 promising Wollega coffee accessions with four standards check (Table 1). Randomized complete block design (RCBD) in three replications was used. The study was superimposed on the already established coffee planted in July, 2015 with six plants per plot using spacing of 2m by 2m and 4m between replications. All field management applied as recommended (IAR, 1996).

Table 1: Wollega coffee accessions information

Sl. No.	Accessions	District	Peasants Association	Collection altitude (m. a.s.l)
1	W02/98	Haru	Wora Baro	1740
2	W34/98	Haru	Wora Baro	1790
3	W98/98	Haru	Chageli	1800
4	W141/98	Gimbi	H.Giorgis	1620
5	W163/98	Gimbi	Homa Arsama	1600-1670
6	W167/98	Gimbi	Homa Arsama	1600-1670
7	W175/98	Gimbi	Homa Arsama	1600-1670
8	W188/98	Gimbi	Homa Biribir	1550-1600
9	W191/98	Gimbi	Homa Biribir	1500-1570
10	W203/98	Gimbi	Siba Yesus	1560
10	W203/98	Gimbi	Siba Yesus	1560
11	W212/98	Gimbi	Sibo Charo	1560
12	W01/99	Haru	Guracha Holata	1660
13	W40/99	Haru	Dogi Adere	1720
14	W109/99	Ayira Gliso	-	1600
15	W03/00	Ayira Guliso	Waro Seyo	1500
16	W09/00	Ayira Guliso	Boke Keda	1600
17	W50/00	Ayira Guliso	Kurfessa birbir	1580
18	W52/00	Ayira Guliso	Kurfessa birbir	1520
19	W06/01	Ayira Guliso	Lalo Asella	1600
20	W08/01	Ayira Guliso	Tosiyo mole	1620
21	W15/01	Ayira Guliso	Buro Hasabar	1700
22	W38/01	Ayira Guliso	Nebo Daleti	1600
23	Mana sibu (W78/98) (C)	Haru	Haru	1550
24	Sinde (W92/98) (C)	Haru	Haru	1590
25	Chala (W76/98) (C)	Haru	Haru	1740
26	Haru-I (66/98) (C)	Haru	Haru	1800

Quality assessment performed at each location per replication for each genotype (CLU, 2007). About six kg red ripe Coffee cherries were handpicked per plot. Prior to pulping over mature, green cherries and foreign material were sorted out from healthy and red ripe cherries. The samples were carefully prepared using wet processing method and dried to the moisture level at 10.5-11.0% for all samples uniformly. Further, uniform Coffee beans were prepared from each genotype by passing through a sieve screen size of 14 inch. Each sample was sub divided into three to replicate in the laboratory. About 300 g of green coffee bean samples were prepared per replication separately for each genotype for organoleptic (cup quality) traits evaluation. Three cups per sample were prepared for cup quality testing session. Eight gram of Coffee powder was used in each cup, with 180 ml capacity (3 cups per sample unit). Fresh boiled water was poured on to the grinded coffee up to about half size of the cup, followed by stirring the content to ensure the homogeneity of the mixture. Before filling the cup to full size, the volatile aromatic quality and intensity parameters were evaluated by sniffing. Then, cups filled to the full size (180 ml) and left to settle and allowed to steep undisturbed or steeled. After three minutes, the floater was skimmed and the brew ready for cup tasting by panelists. Organoleptic traits analysis was carried out once the beverage cooled to around 60°C (drinkable temperature) by three cuppers of internationally certified Quality grader professional panelist of Jimma Agricultural Research Center (JARC) at Coffee Processing unit and Liquoring Laboratory of the center. Aroma (quality &Intensity), acidity, astringency, bitterness, body, flavor and overall standard of the brew were scored using scale ranging as described in Table 2. Each panelist had given his independent judgment for each sample unit of the treatment. The average results of all panelists were used for data analysis.

Analyses of variance

Analysis of variance (ANOVA) of Randomized complete block design *(*RCBD) was used to see variability using proc mixed procedure of SAS version 9.0 software package (SAS Institute, 2004). Random model was used following statistical model: $Y_{ijk} = \mu + G_i + L_j + B_k (L_j) + GL_{ij} + \varepsilon_{ijk}$. Where, Y_{ijk} was the observation for genotype 'i' at location 'j' in replication 'k'. In the model 'μ' was the overall mean 'G_i' the effect of the genotype 'i', 'L_j' was the effect of environment 'j', 'B_k' block effect, 'GL_{ij}' the interaction between genotype and location or environment and 'ε_{ijk}' was the random error associated with the' k^{th} observation on genotype 'i' in environment.

Clustering analysis

Clustering analysis is one of Multivariate analysis method which used to group some things according to their resemblance. In this study, organoleptic characters of individual location data were used for clustering analysis due to non stability performance of Coffee genotypes over locations. The data were used for cluster analysis to determine the variability among the grouped accessions. Clustering of the accessions was performed using the proc cluster procedure of SAS version 9.0 software package (SAS Institute, 2004. The numbers of clusters were determined by following the approach suggested by Copper and Miligan (1988) based on Pseudo F^2 and Pseudo t^2 value. Therefore, the points where local peaks of the pseudo F^2-statistic join with small values of the pseudo-t^2 statistic followed by a larger pseudo-t^2 was used to decided number of cluster. Genetic divergence between clusters was determined using the generalized Mahalanobis's D^2 statistics (Mahalanobis, 1936). The D^2 values obtained between clusters was tested for significance at the required level of probability against the tabulated values of X^2 for p degrees of freedom of the number of variables considered as indicated by Singh and Chaudhary (1985). The generalized distance between any two clusters was given by formula: $D^2ij = (Xi - Xj)\ cov^{-1}(Xi - Xj)$ where, D^2ij = the distance between cases i and j; xi and xj = vectors of the values of the variables for cases i and j; cov^{-1}= the pooled within groups' variance-covariance matrix (Mahalanobis, 1936).

Table 2: Standard parameters and their respective values used for washed coffee cup quality evaluation (CLU, 2007)

Aromatic Quality (5)		Aromatic Intensity (5)		Acidity (10)		Astringency (5)		Bitterness (5)		Body (10)		Flavor (10)		Overall cup Quality+ (10)	
Quality	Points	Quality	Points	Quality	Points	Quality	Points	Quality	Points	Quality	Points	Quality	Points	Quality	Points
Excellent	5	Very strong	5	Pointed	10	Nil	5	Nil	5	Full	110	Very good	110	Excellent	10
Very good	4	Strong	4	Medium pointed	8	Very light	4	Vlight	4	Medium full	8	Good	8	Very good	8
Good	3	Medium	3	Medium	6	Light	3	Light	3	Medium	6	Average	6	Good	6
Regular	2	Light	2	Light	4	Medium	2	Medium	2	Light	4	Fair	4	Regular	4
Bad	1	Very light	1	Lacking	2	Strong	1	Strong	1	Very light	2	Bad	2	Bad	2
Nil	0	Nil	0	Nil	0	Very strong	0	Very strong	0	Nil	0	Nil	0	Unacceptable	0

Note: - + Overall standard is evaluated based on the other attributes (Aromatic Quality, Acidity, Body, and Flavor)

Results and discussion

Analysis of variance

The ANOVA results showed that significant difference at p<0.05 and p<0.01 probability level among Coffee accessions for organoleptic traits except for odor and body at Mugi and at Haru location (Table 4). In additions to the above, aromatic quality showed non significant difference at Haru at the same probability level. From organoleptic traits aromatic quality, acidity, flavour and overall cup quality indicated highly significant difference (p<0.01) among accessions at Mugi. Traits such as aromatic intensity, astringency and bitterness showed significant difference at p<0.05 between genotypes at this location.

At Haru, organoleptic traits like aromatic intensity, acidity, bitterness, flavour and overall cup quality revealed highly significant different (p<0.01) among genotypes. Astringency from organoleptic traits indicated that significant difference at P<0.05 at this location. In agreement with this, Abeyot *et al.*, (2001) obtained that compromise result using 21Coffee genotypes' cup quality tributes traits and authenticated that the existence variability among *Coffea arabica* L. genotypes. Also, Yigzaw *et al.*, (2008) reported the significant difference among genotypes using physical and organoleptic characteristics of 42 Arabica coffee germplasm at the Finoteselam Coffee trial site.

Combined analysis of variance for organoleptic traits

The combined analysis of variance based on organoleptic characteristics of 26 coffee genotypes was given in Table 5. From the combined data results, all organoleptic characteristics showed non significant difference among coffee genotypes. This resulted from highly significant genotypes x environmental interaction in almost all traits which hide the significance different among genotypes (Table 4). This pointed that genotypes showed fluctuation ranking in organoleptic traits which caused the average performance of genotypes of the two location non significant. All organoleptic traits showed non significant difference (p>0.05) among locations. This indicated that no statistical difference among locations observed based on value recorded at both locations. In contrast to this, from the study carried out at three locations Gichimu *et al.,* (2013) obtained the significant difference result among locations on organoleptic characteristics using 34 coffee genotypes based on traits used in this study. Additionally, the present result contrast the finding of Elsa *et al.,* (2015) who reported that significant different among environments from the experiment conducted at Gera, Jimma and Metu location using seven coffee genotypes.

Table 4: Analysis of variance for organoleptic traits of coffee genotypes

	Mugi					**Haru**				
Traits	**MSB** (df=2)	**MSG** (df=25)	**MSE** (df=50)	CV%	Mean	**MSB** (df=2)	**MSG** (df=25)	**MSE** (df=50)	CV%	Mean
Aromatic intensity	2.20**	0.18*	0.09	4.05	7.47	2.70**	0.26**	0.10	8.00	4.05
Aromatic quality	2.98**	0.33**	0.13	9.16	4.04	3.02**	0.50	0.30	13.79	4.00
Acidity	0.83**	0.48**	0.10	4.38	7.22	0.11	0.41**	0.08	4.16	7.14
Astringency	8.16**	0.13*	0.07	6.47	4.17	10.58**	0.14*	0.06	6.23	4.14
Bitterness	15.23**	0.26*	0.13	8.93	4.04	15.33**	0.28**	0.12	8.65	4.00
Body	1.07**	0.27	0.16	5.54	7.28	0.15	0.19ns	0.13	5.02	7.19
Flavor	0.18	0.44**	0.07	398	7.07	1.22**	0.34**	0.10	4.58	6.94
Over all cup quality	0.35*	0.49**	0.09	4.22	7.19	0.04	0.36**	0.08	4.04	7.07

Table 5: Analysis of variance for combined organoleptic attributes traits

Traits	Mean square of block	Mean square of genotypes	Mean square of location	Mean square of genotypes x Location	Mean square of error	CV%	Mean
	(df=4)	(df=25)	(df=1)	(df=25)	(df=100)		
Aromatic intensity	2.45**	0.22	0.00	0.21**	0.09	7.70	4.05
Aromatic quality	3.00**	0.40	0.06	0.42*	0.21	11.57	4.02
Acidity	0.58**	0.34	0.23	0.55**	0.10	4.39	7.18
Astringency	9.37**	0.09	0.04	0.18**	0.07	6.39	4.16
Bitterness	15.28**	0.17	0.05	0.36**	0.12	8.71	4.02
Flavor	0.17*	0.27	0.70	0.51**	0.09	4.35	7.01
Over all cup quality	0.12	0.31	0.57	0.54**	0.09	4.22	7.13

Where, *, ** and ns - represent significant different at 0.05, 0.01 probability level and non significant difference respectively

Aromatic intensity, acidity, astringency, bitterness, flavour and overall cup quality showed highly significant difference ($p<0.01$) in GxE interaction. Whereas, from organoleptic traits aromatic quality showed significant difference ($P<0.05$) in GxE interaction. These indicated that coffee genotypes did not show stability over locations in organoleptic traits. From this result it is possible to understand the coffee genotypes cup quality attributes traits is specific to environment. Similarly, Walyaro (1983) reported that significant different of genotype by environmental interaction based on organoleptic traits. Agwanda *et al.*, (2003) reported significant different of genotype x environment interaction effects on organoleptic characteristics.

Clustering based on organoleptic characteristics at Haru and at Mugi

The 26 Coffee genotypes were clustered in to 4 and 3 different groups using 8 organoleptic traits (Table 6, Figure 1 and Figure 2) at Haru and Mugi respectively. At Haru, the highest percentage (73.08%) coffee genotypes were grouped in Cluster I and followed by clusters III (11.54%). Cluster IV and II consisted the same number of accessions. Checks (Mana sibu, Chala and Haru-I) were grouped in cluster I and Sinde in cluster III. Cluster I consisted six accessions collected from Haru, five from Ayira Guliso and eight from Gimbi collections districts. Cluster II consisted one from Haru and the other from Ayira Guliso. Cluster III contained two from Ayira Gulliso and one from Haru. At Mugi, many accessions grouped under cluster I which consisted 69.23% (18) of total accessions. Cluster II hold large accessions next to cluster I and least accession contained in cluster III. All checks (Mena sibu, Haru-I, Chala and Sinde) clustered under cluster I. This may be due to almost all similar inherent performance of all checks in cup quality attribute traits at this location. At both locations, all clusters consisted accessions collected from different collection districts. This implies that accessions did not cluster according to their geographical origin based on organoleptic traits. Therefore; it is not obligatory to go for different geographical areas to search Coffee genotypes that are genetically diverse in organoleptic traits. Earlier Getachew (2012) and Yigzaw *et al.*, (2008) grouped 49 and 42 coffee accessions into three and two main clusters base on organoleptic traits. The current results confirmed with the finding of Abiyot *et al.*, (2011) grouped Coffee genotypes in to different clusters using cup quality attribute characteristics.

Table 1: Clustering of coffee genotypes based on organoleptic traits at Haru and Mugi

Cluster at Haru	No. of Genotypes	Percentage	Genotypes
I	19	73.08	W01/99,W40/99,W188/98, W66/98(Haru-I), W191/98, W175/98, W15/01,W78/84(Menasibu),W167/98,W141/98,W203/98,W163/98, W03/00,W02/98,W06/01,W08/01,W76/98(Chala),W38/01, W212/98
II	2	7.69	W34/98,W109/99
III	3	11.54	W09//00,W92/98 (Sinde),W52/00
IV	2	7.69	W98/98,W50/00
Cluster at Mugi			
I	18	69.23	W34/98, W188/98, W98/98, W167/98, W03/00, W15/01, W92/98(Sinde), W78/84(Menasibu), W66/98(HaruI), W09/00,W06/01, W50/00, W191/98, W76/98(Chala), W109/99, W02/98,W141/98,W08/01
II	6	23.08	W40/99, W52/00, W01/99,W203/98,W163/98,W212/98
III	2	11.54	W175/98,W38/01

Variability analysis based on cluster mean at Haru and Mugi

The two locations cluster mean performance of 26 Coffee genotypes based on 8 organoleptic characteristics were given in Table 7. Coffee genotypes grouped under cluster IV showed excellent aromatic quality, very strong aromatic intensity, medium pointed acidity, good flavor and very good overall cup quality at Haru. Coffee genotypes under cluster III and II showed relatively low in cup quality attribute traits like acidity, astringency, body and flavour. Hence, they showed relatively low in overall cup quality when compared with other clusters. Accessions under cluster I showed good performance in cup quality attributed traits (aromatic intensity, acidity, astringency, body and flavour) next to cluster IV. Thus, it showed good in over all cup quality next to cluster IV.

At Mugi, accession under cluster II showed better performance in organoleptic traits relative to other clusters. This cluster characterized by very good in aromatic quality, strong aromatic intensity, mid-pointed acidity, very light astringency, very light bitterness, mid -full in body and good flavour in cup quality attribute traits. Thus, this cluster showed very good in over all cup quality attribute traits. Accessions in cluster I had good performance in organoleptic traits next to cluster II. Hence, accessions under this cluster ranked 2nd in over all cup quality next to cluster II. Accessions contained in cluster III showed less performance in most cup quality attribute traits relative to the other two clusters. Thus, accessions under this cluster ranked 3rd in over all cup quality.

The highest 7.84 and 7.72 overall cup quality were recorded in cluster IV and II at Haru and Mugi respectively; these clusters consisted genotypes that showed very good in overall cup quality. Genotypes having high value of overall cup quality are important for coffee quality improvement in the next breeding program and should be established as germplasm. Thus, priority should be given to cluster I next to cluster IV and II at Haru and Mugi correspondingly during coffee organoleptic traits improvement. Abiyot *et al. (*2011) and Yizaw *et al*., (2008) reported similar result using organoleptic traits.

Table 7: Clusters mean of coffee genotypes using organoleptic traits at Haru and Mugi

Cluster	Aromatic intensity	Aromatic quality	Acidity	Astringency	Bitterness	Body	Flavor	Over all cup quality
	Cluster mean at Haru							
I	4.03	3.99	7.20	4.22	4.06	7.19	7.00	7.11
II	4.33	4.33	6.67	3.67	3.84	7.09	6.50	6.67
III	3.61	3.44	6.61	3.83	3.44	6.94	6.39	6.55
IV	4.67	4.67	7.92	4.42	4.50	7.67	7.67	7.84
	Cluster mean at Mugi							
I	4.05	4.05	7.14	4.17	4.07	7.20	7.01	7.11
II	4.17	4.17	7.75	4.36	4.25	7.72	7.56	7.72
III	3.83	3.67	6.42	3.75	3.25	6.75	6.25	6.34

Genetic distance analysis at Haru and Mugi

Genetic distances among clusters based on organoleptic traits were given in Table 8 below and above diagonal; Figure 1 and Figure 2 at Haru and Mugi respectively. At both locations, highly significant differences ($p< 0.01$) among all clusters were clearly observed. The highest distance was recorded between cluster IV and III (149.15) and followed by cluster IV and II at Haru. However, the least genetic distance recorded between cluster III and I next to cluster IV and I.

At Mugi, the highest genetic distance recorded among cluster III and II (126.24) and followed by cluster III and I (46.91) at Mugi. The least diversity was observed between cluster II and I (26.73). Since high variability among crop is the first criteria during crop improvement for desired traits, consideration should be given to groups that showed great genetic distance. Thus, for organoleptic traits improvement, priority should be given for those clusters which showed high genetic distance (cluster IV and III, cluster IV and II at Haru respectively and Cluster III and II at Mugi) indicating high heterosis from great combination expected during hybridization program for quality improvement (Shagufta *et al.*, 2020).

Table 8: Pair-wise generalized squared distance between cluster of genotypes tested at both locations (below diagonal at Haru and above diagonal at Mugi)

Cluster	I	II	III	IV
I	-	26.73**	46.91**	
II	84.58**	-	126.24**	
III	42.6**	57.71**	-	
IV	41.52**	143.23**	149.15**	-

Figure 1: Dendrogram showing hierarchical clustering patterns of coffee genotypes based on organoleptic traits at Haru

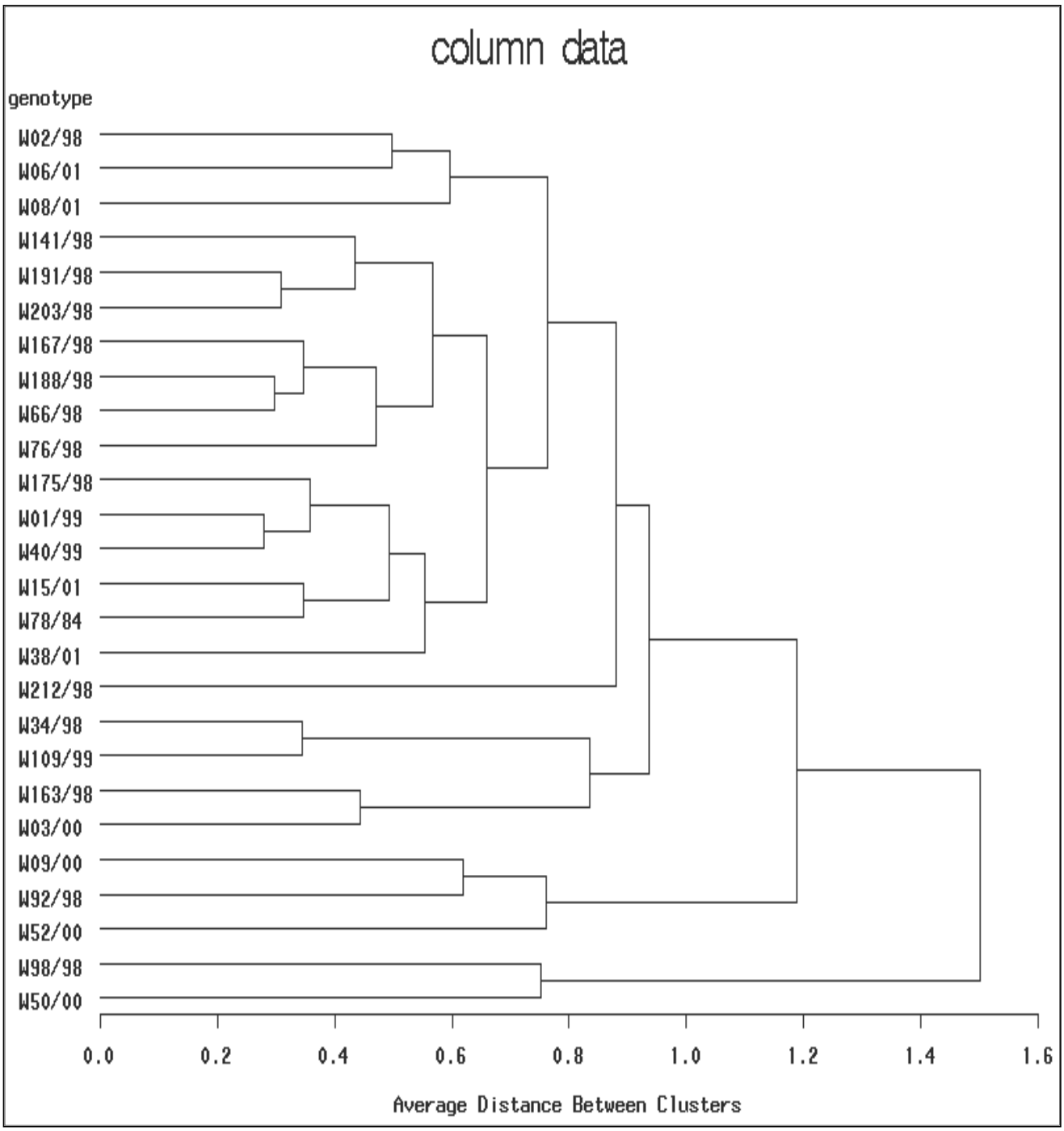
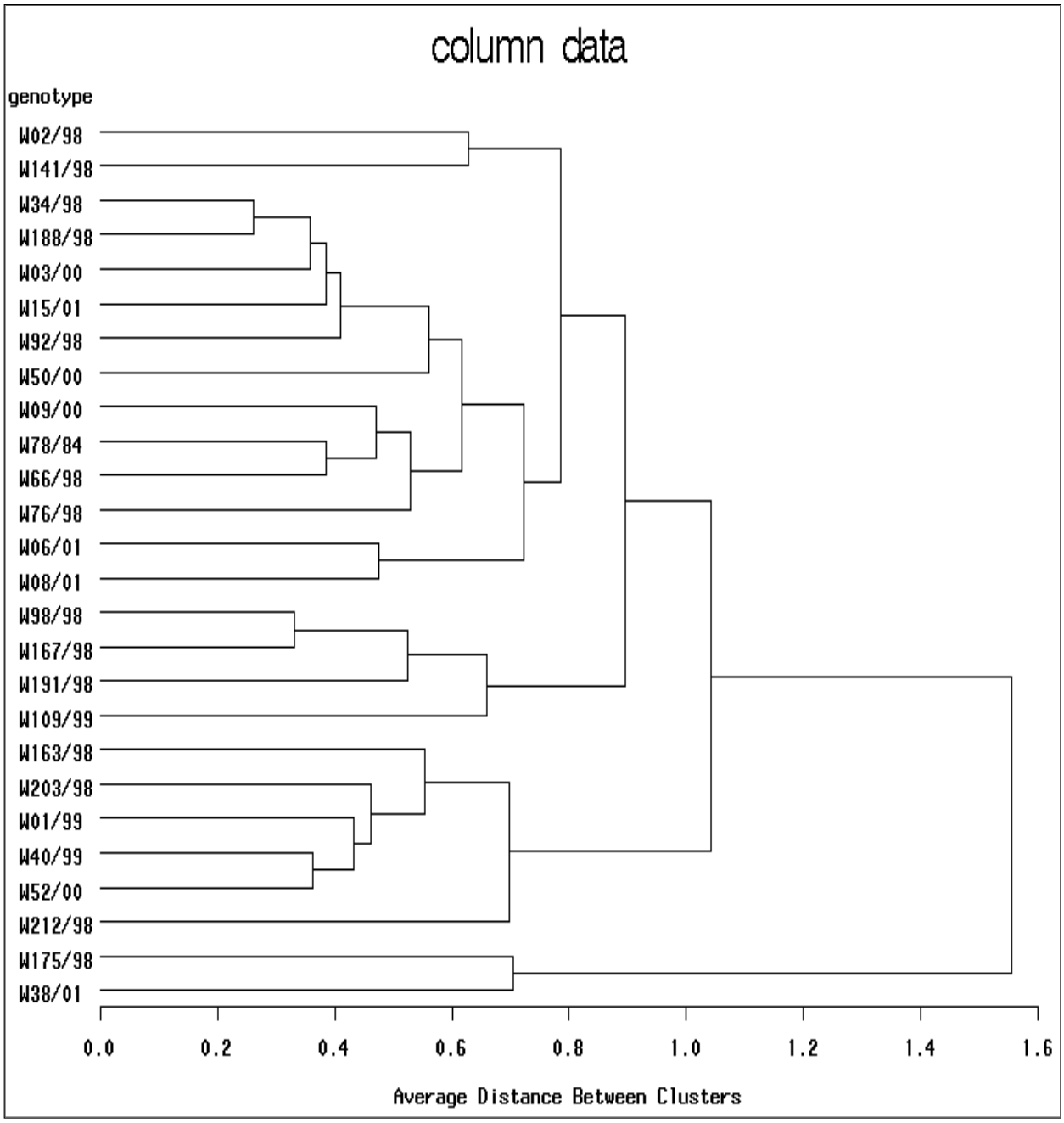


Figure 2: Dendrogram showing hierarchical clustering patterns of coffee accessions based-on organoleptic traits at Mugi



Conclusion

Analysis of variance of combined result manifested that non significant difference among genotypes although 7 and 6 traits of 8 traits showed significant difference at Mugi and Haru respectively. From this it is possible to understand, the existence of significant different among genotypes for most traits at individual location which indicated that the availability of genetic variability among genotypes. The non significant difference among genotypes for combined result caused from high GxE interaction against which genotype mean square tested for significant. Most organoleptic traits showed highly significant different ($p<0.01$) in GxE interaction. This pointed that inconsistent performance of Coffee genotypes under the study across locations. This forced to divide locations in to area similar in edaphic and climatic condition with Mugi and other area similar to Haru location and focuses to develop Coffee varieties acceptable in quality and met customers need.

The 26 coffee genotypes clustered in to 4 and 3 groups at Haru and Mugi. At Mugi accessions under cluster II showed better performance in most cup quality tributes traits which resulted very good in over all cup quality. Accessions under Cluster IV showed better performance in most organoleptic traits at Haru. As a consequence, these accessions are very good in over all cup quality at these locations.

The genetic distance among all clusters was highly significantly different ($P<0.01$) at both locations. This implies that the availability of genetic diversity at individual location which is very important for quality improvement. At Haru, the highest Malanobis distance recorded between Cluster IV and II next to cluster IV and III. Cluster III and I showed highest distance following cluster III and II at Mugi. Thus, priority should be given to accessions under clusters that showed highest Malanobis distance during breeding program. This is due to high heterosis expected during hybridization breeding activities. The current study elucidate that the presence of genetic diversity among genotypes; and great opportunity for coffee quality improvement for the next breeding work.

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