Principal Component Analysis for Quality Traits in Indigenous Moringa (*Moringa oleifera* L.)Germplasm Lines

Abstract:

The present investigation was carried out at Department of Vegetable Crops, Horticultural College and Research Institute (HC&RI), Tamil Nadu Agricultural University, Periyakulam during 2016 -2017. With twenty genotypes in order to study the genetic diversity for different Qualitycharacters of Moringa by principal component analysis. In this study, out of five principal components, only three components exhibited >0.5 eigenvalueand showed about 84.12% variability among the traits within the axes exhibited great influence on the phenotype of genotypes. The PC1 accounted for the highest variability (52.53%) to the total variability, followed by 17.66% (PC2), and 13.93% (PC3).Thus the results of the principal component analysis revealed, wide genetic variability exists in this Moringa genotype accessions.

Key words: Moringa (*Moringa oleifera* L.), Genotypes,PCA analysis, Eigen Values,

Introduction:

Moringa (*Moringa oleifera* L.), belonging to the family Moringaceae, is a highly useful vegetable crop and native of India. *Moringa oleifera* is a valuable food that has drawn attention as the 'natural nutrition' of the tropics. Both the businesses as well as scientific communities

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Comment [WU3]: Sentences not properly linked. Use a comma instead of the full stop or better still recast the second sentence starting with Twenty genotypes were used in the study....

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Comment [WU5]: (PC).

Comment [WU6]: exhibited eigenvalues greater than 0.5 and accounted for 84.12% variability..

Comment [WU7]: of the

Comment [WU8]: followed by PC2 (17.66%) then PC3 with 13.93% .

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have shown interest in this crop owing to its economic and nutritional potential. The fruit, leaves, flowers and immature pods of this tree are highly nutritious and used as vegetable in many parts of the world, especially in Africa, India, Pakistan, Philippines, and Hawaii (Anwar and Bhanger, 2003). Moringaleavespossess rich source of protein, β-carotene, vitamin C, potassium and calcium, besides high concentrations of varied natural antioxidants. Various types of antioxidants such as ascorbic acid, flavonoids, phenolics and carotenoids present in moringa leaves offer several medicinal benefits to the human beings (Dillard and German 2000; Siddhuraju and Becker, 2003). In Philippines, it is used to increase woman's milk production and is sometimes prescribed for anaemia. Therefore, moringa is called as 'mothers' best friend' (Siddhuraju and Becker 2003). Moringaoleifera, native of the western and subHimalayan tracts, India, Pakistan, Asia Minor, Africa and Arabia (Somali *et al.*, 1984; Mughal *et al.*, 1999) is now distributed in the Philippines, Cambodia, Central America, North and South America and the Caribbean Islands (Morton, 1991). In some parts of the world M. oleifera is referred to as the 'drumstick tree' or the 'horse radish tree', whereas in others it is known as the kelor tree (Anwar and Bhanger, 2003). While in the Nile valley, the name of the tree is 'Shagara al Rauwaq', which means 'tree for purifying' (Von Maydell, 1986). In Pakistan, M. oleifera is locally known as 'Sohanjna' and is grown and cultivated all over the country (Qaiser, 1973; Anwar *et al.*, 2005).(PCA) involves a mathematical procedure that transforms a number of (possibly) correlated variables into a (smaller) number of uncorrelated variables called principal component (C Chatfield and Collis, 1980).PCAis an important statistical method through which we can easily identify important polygenic characters which are of great importance in a plant breeding programme. PCA provides an idea for how to reduce a complex data set to a lower dimension to reveal the sometimes hidden, simplified structures that often underlie it. The eigenvalue of a particular principal component depicts the amount of variation present in traits and explained by that principal component which is very useful for the further breeding programme.

Materials and Methods:

The present investigation was carried out to know the variability through principal component analysis in Moringa (*MoringaoleiferaL.)*germplasmscultivated in TelanganaState at

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Comment [WU13]: Dillard and German,(2000); Siddhuraju and Becker,(2003)

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Comment [WU17]: This would be better coming up earlier immediately after the Moringacea family..

Comment [WU18]: Space.
You are just introducing this write in full then bracket the accronym

Comment [WU19]: No need for brackets its part of the definition

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Comment [WU22]: What are eigenvalues and eigen vectors.
Give a clear definition then discus hoew you are going to use it in explaining the principal components analysis.

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Germplasm

Department of Vegetable Crops, Horticultural College and Research Institute (HC&RI), Tamil Nadu Agricultural University, Periyakulam (PKM) during 2016 -2017.Twenty moringa accessions were collected from different regions of Telangana and the details of the plant materials used in the present study are listed in Table 1.

Table .1. List of moringa accessions employed in the study

S.No.	Name of theAccessions	Name of the Type	Place of collection & District	Latitude & Longitude
1.	MO 1	Long poded perennial type	Warangal, Warangal	18^{0} 0` 38.60N, 79^{0} 36'0 .10 E
2.	MO 2	Long poded perennial type	Malyal, Warangal	18^{0} 21' 48.80 N, 80^{0} 18' 23.66 E
3.	MO 3	Medium poded perennial type	Ghanpur, Warangal	17^{0} 49' 58.89 N, 78^{0} 59' 57.35 E
4.	MO 4	Short poded perennial type	Regonda, Warangal	18^{0} 23' 77.70 N, 79^{0} 77' 50.80 E
5.	MO 5	Long podedperennial type	Jagithyala, Karimnagar	18^{0} 46'0.66 N, 78^{0} 54'42 .83 E
6.	MO 6	Short poded perennial type	Peddapally, Karimnagar	18^{0} 37' 24.72 N, 79^{0} 22' 47.59 E
7.	MO 7	Short poded perennial type	Armor, Nizamabad	18^{0} 48' 37.14 N, 78^{0} 17' 7.00 E
8.	MO 8	Short poded perennial type	Nandipeta, Nizamabad	18^{0} 52' 34.06 N, 78^{0} 31' 14.68 E
9.	MO 9	MediumPoded perennial type	Rudrur, Nizamabad	18^{0} 34' 45.48 N, 77^{0} 52' 31.27 E
10.	MO 10	Short poded perennial type	Satyanarayanapuram,Nizamabad	18^{0} 32' 40.61 N, 77^{0} 53' 31.39 E
11.	MO 11	Medium poded perennial type	Basara, Nirmal	18^{0} 52' 40.63 N, 77^{0} 56' 57.01 E
12.	MO 12	Short poded perennial type	Mudhol, Nirmal	18^{0} 98' 26.81 N, 77^{0} 92' 05.10 E
13.	MO 13	Short poded perennial type	Ichoda, Adilabad	19^{0} 26' 1.02 N, 78^{0} 27' 14.82 E
14.	MO 14	Short poded perennial type	Adilabad, Adilabad	19^{0} 38' 53.14 N, 78^{0} 31' 14.68 E
15.	MO 15	Medium poded perennial type	Amaravathi,Manchiriyal	18^{0} 54' 15.05 N, 79^{0} 28' 58.30 E
16.	MO 16	Short poded perennial type	Doragaripalli, Manchiriyal	18^{0} 53' 59.5 N, 79^{0} 27' 41.2 E
17.	MO 17	Medium poded perennial type	Kyathanpalli, Manchiriyal	18^{0} 55'18.8 N, 79^{0} 28' 13.4 E
18.	MO 18	Short poded perennial type	Suryapeta, Nalgonda	17^{0} 14' 8.70 N, 79^{0} 36' 34.07 E

Comment [WU25]: Okay here you mentioned plant materials referring to the accessions, you failed to give your method of plant extraction and the plant part used for the extraction (stem, leaves, flowers, pod or seed) in the determination of your under listed data collected.
Your method of extraction even in the laboratory must be described to add value to your presentation.

Comment [WU26]: Accession Number is okay instead of Name of.
A better defined nomenclature for the accessions will also make more meaning than just MO1, MO2.....
You can arrange it with your Loc/year/MO1...
This is more traceable than having several MO1 MO2

Comment [WU27]: Accession description will be better than name.
YOU JUST DESCRIBED THE ACCESSIONS

19.	MO 19	Medium poded perennial type	Gollapally, Nalgonda	17^0 31' 23.59 N, $80^0$52' 19.91 E
20.	MO 20	Short poded perennial type	Narayanapuram,Nalgonda	17^0 10' 36.74 N, 80^0 52' 19.91 E

Twenty moringa genotypes were evaluated by using IPGRI minimal descriptors.Therecommended agronomic practices were followed. Observations were recorded forsixbiochemicalcharactersPrincipal component analysis (PCA) is an important multivariate method in modern data analysis because it is a simple, non-parametric method for extracting relevant information from confusing data sets and it was applied for assessment of genetic diversity withinmoringa genotypes.Data were recorded on six different traits *viz*. chlorophyll a (mg g^{-1}), chlorophyll b (mg g^{-1}), leaf soluble protein (mg/100g), crude protein (%), and ascorbic acid (mg/g) .The data on Quality traits were statistically analyzed on the basis of a randomized complete block design. The PCA analysis reduces the dimensions of a multivariate data to a few principal axes, generates an eigenvector for each axis and produces component scores for the characters(W. F. Massay, 1965), (I.T. Jolliffie, 1986).

Results and Discussion:

Twenty accessions of moringa collected from various parts of Telangana were evaluated for different morphological and biochemical traits. Observations on biochemical characters *viz.*,chlorophyll a (mg g^{-1}), chlorophyll b (mg g^{-1}), leaf soluble protein (mg/100g), crude protein (%), and ascorbic acid (mg/g).

The accessions exhibited wide variability for biochemicalcharacters such as tree shape, tree nature, colour of bark, young shoot colour, foliage density, nature of branch lets, leaflet shape, leaflet apex, colour of calyx and pod maturity.Four morphological descriptors *viz*., duration of plant, type of planting material, shape of corolla and shape of calyx did not reveal any variation among the 20genotypes. The traits that were showing variations revealed that most of the accessions possessed phenotypic variation among them.

PCA is a well-known method of dimension reduction that can be used to reduce a large set of variables to a small set that still contains most of the information in the large set (W. F. Massay, 1965), (I.T. Jolliffie, 1986).The result of the PCA explained the genetic diversity of the moringagenotypes. There are no standard tests to prove the significance of proper values and coefficients. Principal component analysis has shown the genetic diversity of the

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six biochemical characters

Comment [WU31]: expunge and input under introduction.

Comment [WU32]: We have several procedures for determining all these listed chemical compositions. Describe your own procedure and the plant part used.

Comment [WU33]: Are you referring to the experimental layout on the field or in the laboratory?

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Comment [WU35]: Hmm are these biochemical characters?

They are morphological characters.

Comment [WU36]: Your title has narrowed the work to biochemical analysis
I don't think this is necessary moreover you did not show any result on the morphological characters.

Comment [WU37]: You already defined PCA. This is result no more definitions thus expunge.

Comment [WU38]: I believe you can realize you have not given any result and this hinder to a great extent your discussions.

germplasmlines. (Table 2) indicated that out of five principal components, only three components exhibited >0.5 eigenvalue and showed about 84.12% variability among the traits studied. The PC1 had the highest variability (52.53%) to the total variability, followed by 17.66% (PC2), and 13.93% (PC3).

Table 2 Eigenvalues, % variance and cumulative Eigenvalues of germplasm

Traits	PC	Eigenvalue	Percentage of variation	Cumulative%
Chlorophyll a (mg g^{-1})	PC1	2.62	52.53	52.53
Chlorophyll b (mg g^{-1})	PC2	0.88	17.66	70.19
Leaf soluble protein(mg/100g)	PC3	0.69	13.93	84.12
Crude protein (%)	PC4	0.47	9.53	93.65
Ascorbic acid(mg/g)	PC5	0.31	6.35	100.00

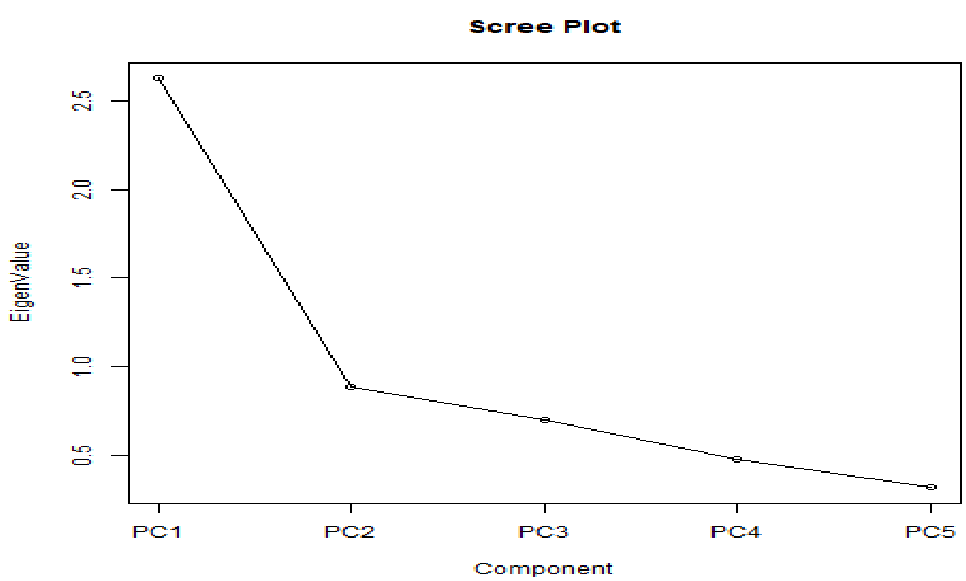

Figure 1 Scree plot

Table.3.Principal component for 5 quality traits of moringa

Traits	Principal components				
	PC1	PC2	PC3	PC4	PC5
Chlorophyll a (mg g-1)	0.478	-0.442	0.009	-0.517	-0.554
Chlorophyll b (mg g-1)	0.448	0.492	-0.333	-0.493	0.449

Comment [WU39]: I will say there is a mix up somewhere while analyzing your data.
There is no Table showing the performance of the accessions in the PCs .
This Table will be your guide in picking the best accessions for the biochemical components analysed.

Comment [WU40]: How about the accessions contributing to the components.

You need to bring out that table please. Without it you cant know the accessions you are recommending for each of those components.

Comment [WU41]: What is this scree plot telling us? It should be included in your results and discussions

Leaf soluble protein(mg/100g)	0.444	-0.173	-0.632	0.607	-0.056
Crude protein (%)	0.406	0.612	0.445	0.303	-0.412
Ascorbic acid(mg/g)	0.455	-0.397	0.538	0.166	0.563

Conclusion:

The phenotypic value of each trait measures the importance and contribution of each component to the total variance. The component contributed the maximum for phenological traits, Chlorophyll a, Chlorophyll b, Leaf soluble protein,Crude protein,Ascorbic acidare the chief contributors towards genetic divergence in moringa genotypes. Thus, the prominent characters coming together in different principal components and contributing towards explaining the variability and have the tendency to remain together this may be kept into consideration during the utilization of these characters in the breeding program.

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Comment [WU43]: You will need to work on the suggested correction relating to your results and discussions first then you will be able to give more interesting conclusions

Comment [WU44]: Update the list of references most of the cited references are old.

References:

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