CURRENT STATUS AND CHALLENGES FOR CONSERVATION AND SUSTAINABLE USE OF BIODIVERSITY

Editors

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PREFACE

As the human population increases, so does the pressure on ecosystems, since we draw ever more resources from them. Our ecological footprint on the planet is unsustainable and will become unbearable unless we change our consumption patterns and our behavior in general.Use of biological diversity in a sustainable manner means to use of natural resources at a rate that the Earth can renew them. It's a way to ensure that we meet the needs of both present and future generations.

Today our only option is to manage productivity and resources in a sustainable manner, reducing waste wherever possible, using the principles of adaptive management, and taking into account of traditional knowledge which contributes to the maintenance of ecosystem services. Sustainable activities can also be applied in many sectors, including organic farming, environmental impact assessments, certification and eco-labelling, management of protected areas, productivity, etc.

The management and conservation of biodiversity has gained serious social concern during the past few decades both nationally and internationally. Educating youngsters is one of the major steps for conservation as they have to protect nature. In this context an international seminar was organized to highlight the importance of appropriate planning for solutions in some of the burning environmental problems which we face in the century.

This book presents unique information on various aspects of Environmental science, Environment and society, Biodiversity, Entomology, Fishery science, Toxicology, Molecular biology, etc. We sincerely hope that it will be of great asset to researchers, field scientists, policy makers, etc. in the conservation and biodiversity.

Editors
Dr.S. Sheeba.
Dr. N. Ratheesh.

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CHAPTER 39

ANALYSIS OF MORPHOLOGICAL VARIABILITY IN TWO DIFFERENT VARIETIES OF *CARICA PAPAYA* (L.)

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ABSTRACT

Carica papaya (L.) is widely grown throughout the tropics. It consists of different varieties. The objective of the present study is to analyze the morphological variability among two varieties (*C. papaya* var. *yellow* and *C. papaya* var. *red lady*) of papaya cultivated in Kerala. Four accessions from each variety were collected from different localities of Thiruvanathapuram and Kollam districts. Observations on twenty four qualitative and ten quantitative characters were taken from all accessions. Quantitative characters were subjected to one way ANOVA. Qualitative and quantitative characters showed significant variations among the two varieties except fruit length, fruit width and petiole length. In principal component analysis, the first principal component accounted for 68.88% variation followed by 11.73% and 9.92%. The highest loaded variables in PC1 are colour of petiole, colour of fruit, colour of sepal, colour of petal, colour of fruit in young condition and odor of leaf. The highly loaded characters in PC2 and PC3 are fruit length and fruit width respectievely. Major trait that accounted for more variability in PC1, PC2 and PC3 is the color of petiole. UPGAMA cluster analysis showed two principal clusters. The accessions of two varieties form separate clusters due to dissimilarity in most of the characters. It shows that the two varieties of *Carica papaya* have distinct morphological characters. These characters will help in the proper identification of these two varieties for large scale cultivation and in crop improvement programmes.

Key words: *Carica papaya*, Caricaceae, ANOVA, Principal Component Analysis, UPGMA

Introduction

Carica papaya (L.), belongs to the family Caricaceae, is widely grown throughout the tropics. It is a native of Central and South America. It is appreciated not only for its delicious and nutritive fruits, but also it contains the enzyme papain, which is extensively used in medicines, as meat tenderizer, for softening textiles, silk and leather and in beer production. The papaya plant is a small, sparsely branched tree, usually with a single stem growing from 5 to 10m tall, with spirally arranged leaves confined to the top of the trunk. The lower trunk is conspicuously scarred where leaves and fruits are borne. All parts of the plant contain latex in articulated laticifers. *Carica papaya* consists of different varieties. Morphological characters are powerful tool for the identification and characterization of plant species and varieties. There are several reports about the characterization of germplasm using morphological markers. Suvalaxmi *et.al* (2019), assessed the genetic diversity on the basis of morphological and molecular characterization among 12 popular

papaya varieties of India. The objective of the present study is to analyze the morphological variability among two varieties (*C. papaya* var. *yellow* and *C. papaya* var. *red lady*) of papaya cultivated in Kerala.

Materials and Methods

The plants selected for the present study are *Carica papaya* var. *yellow* and *Carica papaya* var. *red lady*. It belongs to the genus *Carica* in the family Caricaceae. Four accessions from each species were collected from different localities of Thiruvananthapuram and Kollam districts. Specific codes were allotted to each accession. The details of collection of different accessions were represented in Table 1.

Observations on 24 qualitative and 10 quantitative characters were scored in all accessions. Vegetative, floral and fruit characters were studied in all the 8 accessions collected. In all accessions, ten observations were taken for each qualitative and quantitative character. The quantitative and qualitative characters selected for the study were recorded in Table 2 and Table 3 respectively. The measurements were taken using standard rulers.

For morphometric analysis, the quantitative data were subjected to one way ANOVA using SPSS Version 16. Multivariate analyses were performed using the procedure of principal component analysis (PCA). Data was subjected to cluster analysis based on UPGMA method to find out the similarity and dissimilarity among the 8 accessions.

Table 1. Accessions collected from different localities

Sl. No	Accession code	Place of collection	Genetic group
1	CPOV	Varkala	*Carica papaya* var.*yellow*..
2	CPOC	Chirayinkizhu	*Carica papaya* var.*yellow*..
3	CPOK	Kallambalam	*Carica papaya* var.*yellow*..
4	CPOKo	Kollam	*Carica papaya* var.*yellow*..
5	CPRV	Varkala	*Carica papaya* var. *red lady*
6	CPRC	Chirayinkizhu	*Carica papaya* var. *red lady*
7	CPRK	Kottarakkara	*Carica papaya* var. *red lady*
8	CPRKo	Kollam	*Carica papaya* var. *red lady*

Results and Discussion

Morphological analysis

The qualitative and quantitative vegetative, floral and fruit morphological characters were studied in different accessions of *C. papaya* var. *yellow* and *C. papaya* var. *Red lady*. The observations on different quantitative characters are represented in Table 2.

Vegetative morphology

In the present study the qualitative vegetative characters of *C. papaya* var. *yellow* and *C.*

papaya var. *red lady* showed some variations and more similarity. *C. papaya* var. *yellow* and *C. papaya* var. *red lady* are trees, leaf type is simple, phyllotaxy is alternate and venation is reticulate. The leaf shape is similar in all accessions. Leaf shape, leaf base, leaf apex and leaf surface are star shaped, acute, parted and smooth respectively. In *C.papaya* var. *yellow*. the petiole color is green and in *C. papaya* var. *Red lady* is brown. Leaves possess medium aroma in variety *red lady* and mild aroma in variety *yellow*.

Quantitative characters showed variations. From the quantitative characters highest leaf length in C. *papaya* var. *yellow* was found in accession CPOV(130cm) and shortest leaf length was found in CPOC (112cm). In Red lady highest leaf length was found in CPRV (98.75cm), shortest leaf length was found in CPRC (95.75cm). In yellow variety highest petiole length was found in CPOV (86.25cm) and shortest petiole length was found in CPOK (77.25cm). In the case of variety *red lady* highest petiole length was found in CPRV (67.5cm) and shortest petiole length was observed in CPRK and CPRC(65cm). So the leaf length and petiole length were highest in yellow variety when compared to the variety *red lady*.

Floral morphology

Floral morphology shows minute variations among the two varieties. Inflorescence is solitary type, aestivation of sepal is valvate and petals are twisted. The flower colour in *C. papaya* var. *yellow* is light yellow and *C. papaya* var. r*ed lady* is cream . In *C. papaya* var. *yellow* sepal colour is light green and in *C. papaya* var. *red lady,* it is light yellow. Petal colour in variety *red lady* is cream and light yellow in variety yellow.

Quantitative floral morphological characters also showed significant variations. In yellow variety, longest sepals were found in accession CPOV (0.33cm) and shortest sepal length was found in accession CPOC (0.195cm). In variety *red lady*, the accession CPRV showed the longest sepal length (0.31cm) and shortest sepal length was found in accessions CPRC and CPRK (0.21cm). In the case of variety yellow, the accession CPOV possesses highest petal length and shortest petal length in accession CPRKo. In variety red lady, the accession CPRK possess highest petal length and CPRV showed shortest petal length.

Fruit morphology

The fruit is a berry. The unripe fruit color in yellow variety is dark green and in variety red lady, it is green. The ripened fruit color in *C. papaya* var. yellow is orange and in *C. papaya* var. *red lady,* it is dark red in some accessions and light red in certain accessions . The shape of the fruit is pyriform in variety yellow and elongated in variety red lady. Shape of the seed and color are same in all accessions. The fruits of yellow variety possess mild aroma and variety red lady possess medium aroma.

The quantitative characters also showed variations in two species. In *C. papaya* var. *yellow*, longest fruit length was found in accession CPOKo (19.25cm) and shortest fruit length was found in accessions CPOK (17.75cm). In the case of *C. papaya* var. *red lady*, the highest fruit length was found in CPRC (18.35cm) and shortest fruit length was found in CPRK and CPRKo (16.27cm). In variety red lady, highest fruit diameter was observed in CPRV (9.27cm) and lowest diameter was found in CPRKo (7.65cm). In yellow variety, highest fruit diameter was found in accession CPOC and lowest diameter in CPOV. In yellow variety, the highest fresh fruit weight was found in accessions CPOV and lowest in accession CPOKo. In the case of variety Red lady highest and lowest fruit weight are found in accessions CPRK and CPRKo respectively.

In *C. papaya* var. *yellow* highest numbers of seeds are present in CPOV and lowest in CPOK. In the case of Red lady highest numbers of seeds were observed in CPRC and lowest in CPRK.There are several reports about the significance of morphological characters in diversity analysis, cultivar identification etc. Ruquale *et al.* (2016) reported the morphological analysis in Olive cultivar. Nishimwe (2019) reported the morphological analysis of four varieties of papaya cultivar.

Table 2. Quantitative morphological characters observed in *C.papaya* var. *yellow* and *C. papaya* var. *red lady*

Name of accession	LL (cm)	PL (cm)	SL (cm)	PTL (cm)	NOS	FL (cm)	FRW (g)	FD (cm)
CPOV	130 ± 2.20	86.25 ± 1.07	0.33 ± 0.126	5.15 ± 0.311	532.5 ± 8.8	17.77 ± 1.48	1015.7 ± 1.29	7.8 ± 1.24
CPOC	112.2 ±1.08	78 ± 1.16	0.195 ± 1.73	5 ± 0.65	493.2 ± 4.2	19.07 ± 2.45	925 ± 2.50	9.4 ± 2.33
CPOK	121.75 ± 3.46	77.25 ± 2.18	0.320± 0.102	5 ± 0.26	452.7 ± 4.2	17.75 ± 0.96	770 ± 16.71	7.75 ± 0.92
CPOKo	116.5 ± 3.06	78.25 ± 3.96	0.210 ± 1.41	4.95 ± 0.574	469.25 ± 4.18	19.25 ± 2.06	660 ± 5.96	8 ± 0.587
CPRV	98.75 ± 2.98	67.5 ± 2.65	0.31 ± 0.5	4.52 ± 0.330	230 ± 8.13	17.67 ± 0.39	823.75 ± 1.52	9.27 ± 1.18
CPRC	95.75 ± 3.14	65 ± 2.45	0.21 ± 0.5	4.8 ± 0.35	259 ± 5.4	18.35 ± 0.574	626.25 ± 8.16	8.6 ± 0.483
CPRK	98 ± 2.83	65 ± 2.45	0.21 ± 1.70	4.95 ± 0.21	163.5 ± 5.68	16.27 ± 0.56	872.5 ± 4.03	8.77 ± 0.699
CPRKo	96.75 ± 2.83	66 ± 3.0	0.23 ± 2.16	4.7 ± 0.163	168.25 ± 3.98	16.27 ± 0.56	505 ± 2.78	7.65 ± 0.532

LL- Leaf length, PL- petiole length, SL- sepal length, PTL- Petal length, NOS-Number of seeds, FL- Fruit length, FRW-Fruit weight, FD-Fruit diameter

Morphometric analysis

Analysis of variance

Analysis of variance carried out in different quantitative characters showed significant variation ($p<0.05$) in the most of the characters except fruit length, fruit width and petiole length.

Principal component analysis

In principal component analysis, the first principal component accounted maximum variation (68.88%). The first principal component had traits with highest loadings are leaf length, petiole length, sepal length, petal length, number of seed, color of petiole, color of flower, sepal color, petal color, color of fruit in young, fruit pulp color, presence of odor in leaves.(Table 6).

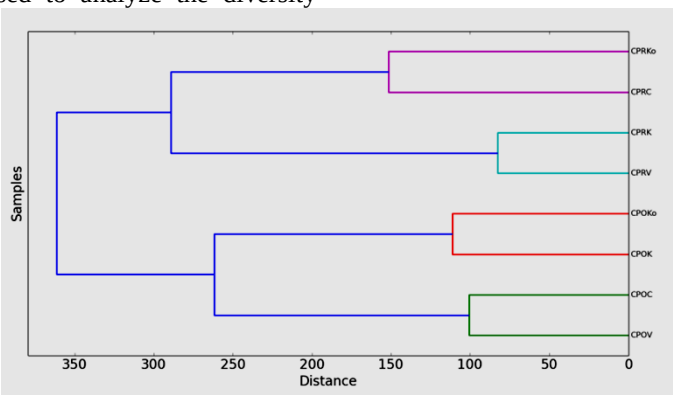
The second principal component accounted for 11.73% of variation with highest loadings are leaf length, number of seed, length of petal, fruit length, width and weight, color of petiole, and shape of fruit. The third principal component accounted for 9.921% of variations with number of seed, fruit width and weight, color of petiole, and shape of

fruit. Major trait that accounted for more variability in PC1, PC2 and PC3 is the color of petiole. The highest loaded variables in PC1 are colour of petiole, colour of fruit, colour of sepal, colour of petal, colour of fruit in young condition and odor of leaf, in PC2, it is fruit length and in PC3 it is fruit width.

Cluster analysis

UPGAMA cluster analysis showed two principal clusters (Fig 1). All accessions of *C. papaya* var. *red lady* are grouped in the first principal cluster. It consists of two sub clusters. The first sub cluster consists of CPRKO and CPRC and second sub cluster consists of CPRK and CPRV. All accessions of *C. papaya* var. yellow form the second principal cluster. It consists two sub clusters. The first sub cluster consists of CPOKO and CPOK and the second sub cluster consists of CPOC and CPOV. The accessions of two varieties form separate clusters due to dissimilarity in most of the characters. It shows that the two varieties of *Carica papaya* have distinct morphological characters helps in the identification of these two varieties.

In the present study, principal component analysis was used to analyze the diversity among the two varieties. The most widely used analysis methods in characterization of plant genetic resources are principal component analysis (PCA) and cluster analysis. PCA enables visualization of differences among individuals, identification of possible groups and relationships among individuals and variables. Principal component analysis is a way to highlight similarity and differences (Mattos *et al.*, 2010). Cluster analysis has been employed to assess similarities among genotypes in plant breeding programmes (Rakonjac *et al.*, 2014). In the present study, PCA helps to identify the characters which show more variations in the two species studied and the cluster analysis helps to assess the similarity and dissimilarity among different accessions of the same variety and between two varieties. The character that showed more variability in PC1, PC2 and PC3 is the color of petiole. The highest loaded variables in PC1 are colour of petiole, colour of fruit, colour of sepal, colour of petal, colour of fruit in young condition and odour of leaf, in PC2, it is fruit length and in PC3 it is fruit width. So we can use this characters as morphological markers in *C. papaya* for varietal identification. This will be helpful for farmers and plant breeders.



Conclusion

The qualitative vegetative, floral and fruit characters showing variations in leaf petiole color, color of flower, color of sepal, color of petal, unripe fruit color, fruit pulp color, shape of fruit, odor of leaves and fruits. The quantitative vegetative, floral and fruit characters showing significant variations are length of leaf petiole, weight of fruit and moisture content. In principal component analysis, the first principal component accounted for 68.88% of variation, second principal component accounted for 11.73% of variation and third principal component accounted for 9.921% of variation. Major trait that accounted for more variability in PC1, PC2 and PC3 is the color of petiole. The highest loaded variables in PC1 are colour of petiole, colour of fruit, colour of sepal, colour of petal, colour of fruit in young condition and odor of leaf, in PC2, it is fruit length and in PC3 it is fruit width. In cluster analysis, the accessions of the two varieties are grouped in two separate principal clusters.

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