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Research paper



Fruit Characterization and Evaluation of Hybrids Mango (*Mangifera Indica L.)*

S. Husen

Faculty of Agriculture and Animal Husbandry, University of Muhammadiyah Malang, Indonesia
Jl. Raya Tlogomas No.246 Telp. (62-0341) 464 555.HP.08125295125
Email :Syarifhusen.hasan@gmail.com

Abstract

Variety improvement to get a unique and exotic mango being one of the mango breeding program in Indonesia. This study aims to perform the characterization and evaluation of mango hybrids by morphological characteristics and chemical properties as well as fruit yield. The material is 17 mango plants hybrid (F1), 3 years old, the cultivars from crosses Arumanis -143 (Cg-48) which has a green color on the fruit skin with 6 clones of Cukurgondang red mango. To find fruit diversity, 16 characters quantitative and 23 qualitative characters are observed using Descriptors for Mango of The International Plant Genetic Resources Institute 2006, and the evaluation done on the characters of weight fruit, fruit pulp thickness, total soluble solids, fruit yield and fruit color. The results showed that the vast diversity only occur on characters of the weight of the fruit, seed and endocarp weight, while others have a narrow diversity. Principal component analysis on 23 qualitative characters of fruit formed 6 major components with the cumulative diversity of 81.9%, the highest proportion (PC1) of 23.2%. which is the character of the shape of fruit apex, skin color of ripe fruit, fiber length in the pulp, and cluster analysis of 13 genotypes formed two clusters. Evaluation of hybrid with high yield occur in F1-15 and F1-87, while high total dissolved solids occur in F1-02, F1-22, F1-49 and hybrid red fruit skin is F1-31, F1-47, F1-44 and F1-09 successively.

Keywords: *Characterization, Fruit, Hybrid Mango, Variability*

1. Introduction

Production of mango in Indonesia ranks the sixth of the world production of mangoes after India, China, Thailand, Pakistan and Mexico are 1,478,204 metric tons (Litz, 2009), then in 2011 the production reached 2,129,608 tons, consist of 1485 tons export, and 989 tons import. A considerable gap between the production and export volume shows mango Indonesia's competitiveness in the global market is still low (Puslitbang Hortikultura, 2012), consequently to overcome this problem required a unique and exotic superior varieties of mango that can increase production and competitiveness of the mango market exports.

Ideal character of mango either for export or for fresh consumption are attractive skin color (red-yellow-orange), thick flesh with thin beans, flavor, aroma, texture and fine fibers and has a long shelf life (Bally et al., 2009; Ministry for Research and Technology, 2000). Attempts to obtain varieties with red color on the skin of mango fruit has been performed by hybridization of Arumanis-143 (Cg-48) with red clones Cukurgondang mango which began in 2001 to 2004 Results have been obtained 65 cross hybrid (F1) and was cloned by grafting techniques and in 2007 planted at the Experimental Farm Mango, Cukurgondang, Pasuruan East Java. Constraints faced for the characterization and accession of evaluation is the long juvenile phase. A study done to solve these problems, among others, study the generative phase induction seedling (Sadwiyanti et al., 2002) and determining the selection criteria for red mango seedling phase (Rebin et al., 2002), but the results cannot be used for evaluation, then Husen et. al (2009) did early selection juvenile phase in the hybrid by using Simple Sequence Repeat (SSR) with primers Scaris 18 and shows that there are 5 candidates hybrid character as elder male red-skinned fruit. This study aimed to characterize and evaluate some mango hybrids (F1) based on morphological characters of fruit and fruit chemistry.

2. Materials and Methods

The experiment was conducted at the Experimental Farm Cukurgondang, Pasuruan, East Java belong to Tropical Fruit Research Institute (Balitbu) SMF-West Sumatra with garden conditions as follows: altitude of ± 50 m above sea level, soil type complex latosol, climate type D (according to Smith and Ferguson), rainfall is 1332 mm / year with 99 days of rain, temperatures average 27 ° C (21 ° C-34 ° C) and relative humidity 65%. Analysis of fruit chemistry performed at the Laboratory of Food Science Technology Faculty of Agriculture and Animal Husbandry, University of Muhammadiyah Malang.

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Experimental plant material is 17 mango hybrid (F1) 3 year old mango cultivars from crosses Arumanis -143 (Cg-48) which has a green color on the skin of the fruit with 6 clones red mango Cukurgondang with code Cg-232, Cg 293, Cg- 112, Cg 196, Cg, and Cg-299-181 respectively, each hybrid were coded by Balitbu as follows: 1 (F1-15), 2 (F1-21), 3 (F1-46), 4 (F1- 27), 5 (F1-02), 6 (F1-35), 7 (F1-22), 8 (F1-09), 9 (F1-31), 10 (F1-18), 11 (F1-53), 12 (F1-33), 13 (F1-87), 14 (F1-16), 15 (F1-47), 16 (F1-44) and (F1-49) respectively. Plants planted 4 x 4 meters spacing with optimal maintenance.

To find fruit diversity is observed 16 characters and 23 character pieces quantitative qualitatively with reference to the book Descriptors for Mango of The International Plant Genetic Resources Institute (IPGRI, 2006). The fruit quantitative characters are: fruit length (cm), fruit weight (gr) fruit skin thickness (mm), fruit pulp thickness (cm), pulp content (%), total soluble solids (° Brix), pulp titrable acidity (%), ascorbic acid (%), stone length, stone width, stone thickness, stone weight, length of fiber stone, seed length, seed width, seed weight, while 23 qualitative characters o the fruit are: fruit shape, fruit shape of apex, fruit color attractiveness, fruit ground color, blush fruit, fruit skin surface texture, depth of fruit stalk cavity, fruit stalk attachment, fruit prominence neck, shoulder ventral slope of fruit, fruit beak type, fruit type sinus, skin color of ripe fruit, pulp color of ripe fruit, fruit adherence of skin to pulp, the quantity of latex oozing from peduncle, quantity of fiber in the pulp, adherence of fiber to fruit skins, fiber length in the pulp, pulp aroma, fruit waxiness skin, texture of ripe fruit pulp, pulp juiciness.

Analysis of the diversity of the fruit is measured by each character of observation by determine the average order value, variance and standard deviation, while the value is determined by phenotypic variants of Steel and Torry (1995). A character has a wide variability when it has a value of genetic variants that are larger than two times the standard deviation of the genetic variant, and vice versa if the genetic variability relatively narrow genetic variant is smaller than two times of the standard deviation of the genetic variants of the character in question (Kurniawan and Wicaksono, 2006). Principal component analysis is done by extracting the value range of the Eigenvector of the principal Eigen-value with the highest level of diversity using multivariate analysis in SPSS version 16, then to determine the degree of similarity and cluster analysis are presented in the form of images of Dendrogram.

3. Result and Discussions

3.1. Diversity fruit character

The results of the analysis of the diversity of sixteen pieces of quantitative characters (Table 1), indicating a wide degree of variation only on the characters of weight of the fruit, seed weight and endocarp weight, while the others showed a narrow diversity. Genetic diversity occurs because of the influence of genes and interactions between different genes in a population (Crowder, 1990). This diversity is caused by genetic recombination due to hybridization or mutation (Makmur, 1988), and the importance of diversity described by Falconer (1981) that a character in a population with a broad genetic diversity will give great hope to the work of the selection of the character we want to be successful, instead of the narrow genetic diversity means that the population is homogeneous, as a result the crop improvement programs by means of selection become less effective, therefore the diversity being major concern in plant breeding. On mango, the vast diversity of the cultivars will be useful for genetic improvement through hybridization especially mango for fruit that cover export competitiveness. Genetic improvement of commercial mango is short fibers, high length, width thickness, weight of fruit and high contents of pulp (Human and Rheeder, 204; Lopez. et al 2010). Tresnawati (2011) study of kinship accession of cloves and found that the character of the vast genetic diversity need to be considered when the selection is to get the plant as a parent with high production. Makinde and Ariyo (2010), using multivariate analysis to determine genotype diversity of peanut (Arachis hypogaea L.) of 33 characters that were examined and contained 42 to 55% of variability in plant height, stem pigmentation, number of leaves per plant and the length of the node with high variation. The results of the diversity of this genotype will be useful in plant breeding programs peanuts on the next time. Rajwan (2011) identified and characterized of 17 genotypes of mango in Pakistan based on the character of trees, leaves, flowers and fruit, both morphological and chemical properties, and he found five cultivars (Kala Chaunsa, Sufaid Chaunsa, End Ratole No. 12, Camal Wala & Faiz Kareem) which has a distinctive fruit character and the potential to be developed commercially.

Table 1: Variability of fruit characters

Fruit Character	Mean	StDev	2 StDev	Variance	Discription
Fruit length (cm)	11.86	1.618	3.236	2.616	narrow
Fruit weight (gram)	352.2	118.9	237.8	146.5	wide
Fruit skin thickness (mm)	1.0663	0.1537	0.3074	0.0236	narrow
Fruit pulp thickness (cm)	2.5712	0.4124	0.8248	0.1701	narrow
Pulp content (%)	3.4092	1.1323	2.2646	1.2821	narrow
Total soluble solids (ºBrix)	15.429	2.472	4.944	6.113	narrow
Titrable acidity (%)	0.6182	0.5388	1.0776	0.2903	narrow
Ascorbic acid content (%)	0.09496	0.03945	0.0789	0.00156	narrow
Stone length (cm)	8.923	1.298	2.596	1.684	narrow
Stone width (cm)	4.088	1.163	2.326	1.354	narrow
Stone thickness(cm)	1.981	0.2826	0.5652	0.0798	narrow
Stone weight (gram)	46.16	15.4	30.8	237.23	wide
Length of stone fiber (cm)	1.8906	0.6428	1.2856	0.4131	narrow
Seed length (cm)	7.102	1.214	2.428	1.474	narrow
Seed width (cm)	3.1945	0.4398	0.8796	0.1934	narrow
Seed weight (gram)	25.154	6.162	12.324	37.974	wide

3.2. Analysis of principal component and cluster

Principal component analysis on 23 qualitative characters of fruit formed 6 major components with a cumulative rate of 81.9% diversity, with the highest proportion in the first major component of 23.2% (Table 2). Further analysis of the eight major components has a close correlation with 23 observed variables, as shown in Table 3 of the value of feature vector. From Table 3 of the main component I (PC1), which has a strong correlation is to the variable of the shape of the fruit tip, the color of ripe fruit, while the second principal component

(PC2) is a form of fruit, indentation depth handle on top of the fruit, the fruit angle type, attachment to the skin on the fruit flesh and the amount of sap flowing in the stalk tassel, and for the third major component (PC3) is the base color of the fruit, skin surface texture, kind of the bottom half of the fruit, flesh texture, the fiber content of the fruit flesh and the flesh of the fruit water content, and the main component of the fourth (PC4) is attractiveness of fruit, flesh color and aroma of ripe fruit, while the main component of the fifth (PC5) just dip of ventral fruit bodies and the sixth major components (PC6) is the color on top of the fruit and the protrusion of the fruit stalk. Maji et al. (2012) examined 123 Oryza sativa rice germ plasm and results obtained by principal component analysis the first two components with Eigen value greater than 1 with a 78% cumulative diversity. These results are useful for developing improved rice varieties and new varieties.

Table 2: Eigen-value for six principal component of fruit qualitative characters

Principal Component	Eigen Value	Proportion (%)	Cumulative (%)
1	4.8769	23.2	23.2
2	3.7951	18.1	41.3
3	3.4188	16.3	57.6
4	2.1618	10.3	67.9
5	1.6815	8	75.9
6	1.2655	6	81.9

Table 3: Eigen-vector for six principal component of fruit qualitative characters

Fruit Characters qualitative	PC_1	PC_2	PC_3	PC_4	PC_5	PC_6
H_1_Fruit shape	0.36	-0.03	-0.18	0.00	-0.14	-0.06
H_2_Shape of fruit apex	0.26	0.07	-0.35	0.08	-0.14	-0.02
H_3_Fruit attractiveness	0.21	0.19	0.07	-0.44	0.19	0.06
H_4_Fruit ground colour	0.03	-0.36	0.00	-0.36	-0.26	0.06
H_5_Fruit blush	-0.25	-0.04	-0.33	-0.21	-0.15	-0.15
H_6_Fruit skin surface texture	0.19	0.30	-0.01	0.12	-0.12	0.53
H_7_Depth of fruit stalk cavity	0.30	0.29	-0.11	0.11	-0.02	-0.03
H_8-Fruit stalk attachment	-0.09	0.35	0.10	-0.08	-0.41	-0.21
H_9_Fruit neck prominence	0.00	-0.34	0.19	0.31	0.13	0.32
H_10_Slope of fruit ventral shoulder	0.26	0.07	-0.35	0.08	-0.14	-0.02
H_11_Fruit beak type	-0.35	0.15	-0.14	0.11	0.08	0.09
H_12_Fruit sinus type	0.13	0.05	-0.02	-0.17	0.52	-0.48
H_14_Skin colour of ripe fruit	0.06	0.03	-0.30	-0.44	0.03	0.33
H_15_Pulp colour of ripe fruit	0.16	-0.38	-0.20	0.16	-0.03	-0.05
H_17_Adherence of fruit skin to pulp	0.18	-0.03	0.36	0.07	-0.37	-0.03
H_18_Quantity of latex oozing from peduncle	0.02	0.45	0.16	0.13	0.15	0.02
H_19_Quantity of fibre in pulp	-0.35	0.15	-0.14	0.11	0.08	0.09
H_20_Adherence of fibre to fruit skin	-0.32	0.05	0.00	-0.31	-0.16	0.21
H_21_Fibre length in the pulp	-0.10	-0.02	-0.42	0.20	0.23	0.20
H_23_Pulp aroma	0.23	-0.05	0.23	-0.24	0.31	0.32
Ket:H_13_Fruit skin waxines (Constant 1 Every accessions)						
H_16_Pulp texture of ripe fruit(Constant 2 Every accessions)						
H_22_Pulp juiciness(Constant 2 Every accessions)						

The results of cluster analysis of 13 hybrid genotypes showed the formation of two clusters with similarity scale images presented in Dendrogram 1. Cluster I consists of F1-15, F1-21, F1-27, F1-02, F1-35, F1-22, F1-09 , F1-3, (F1-18, F1-53, F1-33, F1-87, F1-16), F1-47, F1-44, F1-49 and Cluster II only F1-46. Fruit characters on the cluster I was as follows: shape of fruit apex is obtuse, skin color of ripe fruit is green, is low adherence of fiber length and fiber in the pulp is low, whereas in cluster II has the following characteristics: shape of fruit apex is acute , skin color of ripe fruit is green with a blush, and fiber length is in the pulp is medium.

* * * H I E R A R C H I C A L C L U S T E R A N A L Y S I S * * *

Dendrogram using Average Linkage (Between Groups)

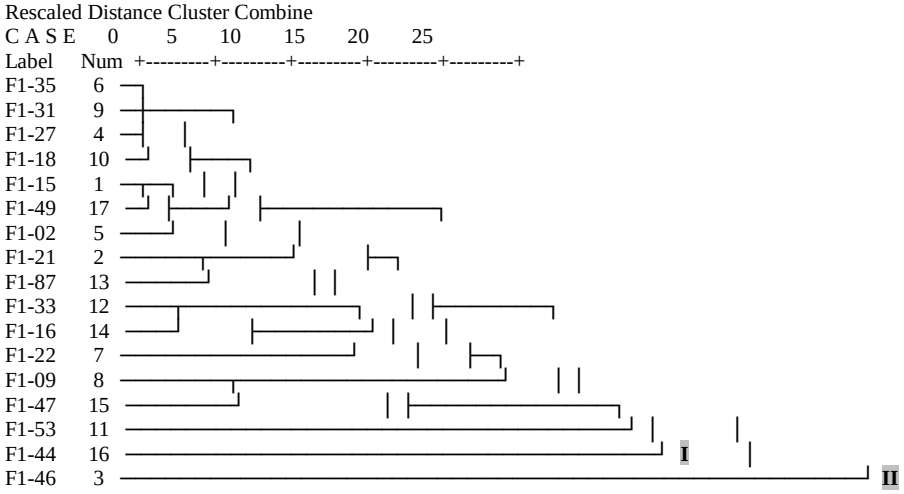


Fig 1: Dendrogram of some mango hybrids

Principal component analysis and cluster for characterization than on mango hybrid was also made by Reza (2001) to assess the genetic diversity of Agropyron desertorum, and revealed that the four main components that are important accounts for about 98.2 percent of the total variation among tested properties. The first component consists of the root length, plumule length, seedling length and seed vigor and accounted for 52.2 percent of the total variation among traits. This component is entitled as seed germination ability. Cluster analysis classified in four groups of genotypes. Furthermore Fitmawati (2010) assessing the diversity of 83 cultivars of mango morphology and molecular markers using RAPD , and cluster analysis showed that 83 cultivars of mango formed nine major clusters and genetic similarity coefficient was 0.69 to 0.98 in mango cultivars. Pradeepkumar (2006) also has examined the diversity of physico-chemical characters of 31 genotypes of mango fruits, and the analysis of this species diversity is useful in a breeding program, especially the importance of the genotype as a source of obtaining the desired character of superior fruit. Fruit character study qualitatively and quantitatively also reported by Bhuzan and Cobras (2007) and they recommends that such research will aid in the selection of mango varieties for fresh consumption, for processing and for several varieties in the improvement program.

Bally et al (2009) and Brettell et al (2004) reported that the constraints on breeding of mango is the of heterozygosis level. The existence of polyembryony, a long period of juvenile plants and the persistence of incompatibilities in crosses, a high diversity of genotypes of mango however, will provide opportunities on improving mango varieties with better commercial competitiveness.

Ideal character of mango either for export or for fresh consumption is skin and flesh color (red-yellow-orange), thick flesh with thin beans, flavor, aroma, texture and fiber as Arumanis-143, as well as better shelf-life. Selection on the fruit, especially emphasized on the attractiveness of fruit skin, thickness of fruit flesh > 2.5 cm and the sweetness (TTS > 15 ° Brix), weight per piece > 350 g, but Samson (1980) has written a list of advantages and disadvantages of commercial cultivars and concluded that there is no single ideal cultivar that has all the desired character. Low cultivars with medium sized fruit (200 g) require good quality properties, capable to produce every year.

Karsinah and Rebin (2011) has also been successfully performed initial selection in hybrid mangoes and showed that from the initial evaluation of the character of the fruit, F1-38 has a weight of 350 gram fruit, with taste and aroma like Arumanis-143, with thick flesh with fine fiber, and F1- 25 weight 600 gram, sweet flavor with yellow flesh color. Candidate of hybrid with high yield potential in red skin of red fruit in this study is still needed for further evaluation to find genetic stability.

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