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The performance of several papaya genotypes (*Carica papaya* L.) as crossing results

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Abstract

Efforts to improve papaya quality can be achieved by genotypes crossbreeding. The crosslines are expected to have superior quality compared to the elders. This study aims to get the information as regards character of the crossbreeding results in several papaya genotypes. This research was conducted in Saree Village, Lembah Seulawah, Regency of Aceh Besar and Horticultural Laboratory, Faculty of Agriculture, Syiah Kuala University from March to July 2017. This study used 11 genotypes of papaya as a treatment (4 elders are Calina (USK4), Carmida(USK6), Dapina (USK7), Carisya (USK1) and 7 genotypes were the crosslines). The design used was Randomized Completely Block Design with Non Factorial pattern. The number of crossline is 7, and 4 elders as a comparison, so there are 11 experimental treatments. Data analysis was performed by using Analysis of Variance (ANOVA) to determine the effect of genotypes tested. If the ANOVA test shows a real effect, then proceed with the Tukey Test at the 5% level ($Tukey_{0.05}$). The results of this research showed there was a high diversity in the performance and character of papayas production from the crosslines to the comparison parents, and it was found that the genotype USK1 (elder) and USK1 X USK7 (crossline) are genotype that have the preferred quality of the consumer based on qualitative quality, organoleptic test and the measurement of the sweetness of the fruit pulp (13.40 and 11.89 Brix).

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Introduction

Papaya (*Carica papaya* L.) is tropical plants from horticulture groups whose fruits are very popular in Indonesia. Papaya fruit has a sweet taste with yellow-reddish fruit color with high water content. According to Millin and Gurditta (2011), besides of popular fruit taste papaya has nutrients and health benefits ranging from its fruits, leaves and seeds. According to data from Papaya Australia (2007), papaya pulp contains nutrients such as water, energy, protein, fat, carbohydrates, sugar, fiber, potassium, calcium, magnesium, iron, zinc,beta-carotene, thiamin, riboflavin, niacin, vitamin C and vitamin A. Arafind*et al.,* (2013) added, papaya fruit rich in three sources of antioxidants, namely: vitamin C, vitamin A and vitamin E.

Diversity in each genotype of papaya such as color, size, shape and thickness of the pulp is the nature or genes derived from each parent of the papaya genotype.According to Rahmatillah (2016) genotipeaffects on morphological character of papaya fruit. To produce papaya fruit with an appealing appearance and sweet taste that consumen love, many plant breedingactivities have been done.

Plant breeding is an activity that aims to produce plants with a new superior character that preferred.Sujiprihati *et al., (*2006) stated, plant breeding activities are important to be done in order to produce optimal production with good quality results. Some steps in plant breeding activitiesnamely: exploration and collection of germplasm, a combination of properties such as crossbreeding, character selection, evaluation, and release of varieties(Syukur *et al,*. 2015). According to Hafsah *et al.* (2007), papaya plant is a cross-pollinated plant naturally, so the artificial crosses must be done immediately before the natural pollination takes place.

After crossing, the process can be continued by characterizing of the crossing, which is important to implement. According to Soemartono (1992) a character can be used as a selection criterion if it meets the requirements, (1) there is a real relationship between the crossed character with the intended character and (2) the selected character has a high heritability that can be inherited to the offspring. If the genetic variation in a large population, it can be concluded that individuals in the population vary so that the chances of obtaining the expected genotype will be large. Information on the character trait is strongly influenced by genetic factors or environmental factors. So through the process of characterization can be known to what extent the nature of the elders can be derived in the next generation (Rosalina, 2011).

Based on the above description, it is necessary to conduct research on the performance of several genotypes of papaya which is the result of crossing. This study aims to obtain information about the character of the crossbreed of several genotypes of papaya in the harvest period.

Materials and methods

This research was conducted in Saree Village, Lembah Seulawah, Regency of Aceh Besar and Horticultural Laboratory of Syiah Kuala University from March to July 2017. The materials used are 11 genotypes of papaya as a treatment, of which 7 genotypes among them were the crosslines from four elders namely (USK1), Carmida (USK6), Dapina (USK7) and Carisya (USK1) with combination of crosses are USK4 × USK6, USK6 × USK4, USK4 × USK7, USK7 ×USK4, USK6 × USK7, USK7 × USK6, USK1 × USK7.

The design used was Randomized Completely Block Design with Non Factorial pattern and the crosslines and elders as single factor. The number of crosslines is 7, and 4 elders as a comparison, so there are 11 experimental treatments. Each treatment was repeated three times, and each replication consisted of 2 plant samples to obtain 66 plant population observed. Data analysis was performed by Ms.Excel 2013, using Analysis of Variance (ANOVA) to determine the effect of genotypes tested. If the ANOVA test shows a real effect, then proceed with the Tukey Test at the 5% level ($Tukey_{0.05}$).

The observed character consists of qualitative and quantitative characters. Qualitative characters include: the shape of papaya fruit, the shape of the base of the fruit, the color of the ripe fruit and the shape of the fruit cavity that observed by the Descriptor for Papaya issued by the International Board for Plant Genetic Resources (IBPGR) (1988), and the Individual Testing Guide that issued by Plant Variety Protection Center (PVPC) (2006). Quantitative observations include: fruit length, fruit diameter, whole fruit weight, fruit thickness, cavity diameter and fresh fruit sweetness content.

Genetic correlations between characters were obtained by using data processing techniques SPSS 20.

The correlation was performed to see the relationship on plant generative character to quality and yield.

Results

Based on results, there is differences of fruit shape, shape of base fruit, the color of the ripe fruit and shape of fruit cavity on genotype papaya that has been tested (Table 1).

Table 1. Qualitative qualities of some papaya genotypes.

Genotype	Shape of fruit	Shape of base fruit	Skin color of ripe fruit	Cavity shape of fruit
USK4	Lengthened cylindrical	Depressed	Greenish orange	Round
USK1	Oval	Flattened	Orange	Star shaped
USK3	Oval	Depressed	Orange	Star shaped
USK7	Elongated	Depressed	Orange	Star shaped
USK4 × USK6	Eliptic	Flattened	Greenish orange	Star shaped
USK6 × USK4	Eliptic	Flattened	Greenish orange	Star shaped
USK4 × USK7	Lengthened cylindrical	Flattened	Orange	Star shaped
USK7 × USK4	Elongated	Flattened	Greenish orange	Star shaped
USK6 × USK7	Eliptic	Depressed	Greenish orange	Star shaped
USK7 × USK6	Eliptic	Depressed	Orange	Star shaped
USK1 × USK7	Elongated	Flattened	Orange	Star shaped

There are variations in the characteristic values of fruit length, fruit diameter and total fruit weight of each tested genotype. The highest average fruit length values were found in USK6 × USK7. The average value of the highest fruit diameter was found in USK6 × USK7 and the mean value of the highest total fruit weight was found in USK6 × USK7 which is also significantly different from other genotypes based on statistical tests (Table 2).

Table 2. Average quantitative character value of fruit length, fruit diameter and intact fruit weight.

Genotype	Lenght of fruit (cm)	Diameter of fruit (cm)	Intact fruit weight (kg)
USK4	18.16 bcd	9.33 a	1.02 b
USK1	14.78 a	8.78 a	0.45 a
USK3	16.03 ab	10.68 a	0.87 ab
USK7	21.19 de	10.32 a	1.04 b
USK4 × USK6	18.00 bc	10.94 a	0.86 ab
USK6 × USK4	18.42 bcd	11.08 a	1.08 b
USK4 × USK7	17.58 ab	10.74 a	1.02 b
USK7 × USK4	18.82 bcd	10.30 a	0.95 b
USK6×USK7	22.30 e	14.44 b	1.72 c
USK7 × USK6	18.78 bcd	11.57 a	1.11 b
USK1×USK7	20.81 cde	10.83 a	1.08 b
Tukey 0.05	3.13	2.85	0.46

Description: The number followed by the same letter in the same column is not significant in Tukey test 0.05.

The highest flesh thickness parameters were found in USK6 × USK4. The highest cavity diameter was found in USK6 × USK7. On the measurement parameter of sweetness of flesh pulp, genotypes with the highest levels of sweetness were found in USK1 (Table 3).

Table 3. Average value of quantitative characters thick of fruit flesh, cavity diameter and fruit sweetness.

Genotype	Thickness of Fruit Pulp(cm)	Diameter of Cavity (cm)	Sweetness Content of Fruit pulp (Brix)
USK4	2.91 ab	3.23	8.70 ab
USK1	2.50 a	3.12	13.40 f
USK3	3.27 b	3.76	11.22 de
USK7	3.07 ab	3.60	10.08 bcd
USK4 × USK6	3.08 ab	3.33	9.13 abc
USK6 × USK4	3.34 b	3.73	9.51 abcd
USK4 × USK7	2.93 ab	4.02	8.22 a
USK7 × USK4	2.81 ab	3.71	9.67 abcd
USK6 × USK7	3.14 ab	4.54	8.88 ab
USK7 × USK6	3.23 b	3.94	10.80 cde
USK1 × USK7	2.85 ab	3.70	11.89 ef
Tukey 0.05	0.68	-	1.77

Description: The number followed by the same letter in the same column is not significant in Tukey test 0.05.

The results of the organoleptic test show the variation of the results on the color test parameters, aroma, texture, taste and overall acceptance. Genotypes with the highest color scoring were found in the USK1 that not significantly different with USK1 × USK7. The highest assessment on the character of papaya fruit aroma was found in USK7 that not significantly different with USK3, USK4 × USK6, USK6 × USK4, USK4 × USK7, USK7×USK4 and USK6 × USK7. Assessment of the highest fruit taste was found in genotype USK1 which was significantly different with USK4.

The highest overall acceptance assessment was found in USK1 which was an elderly genotype, followed by USK1 × USK7 which was the genotype of crossover (Table 4).

Table 4. The average value of organoleptic test results of several papaya genotypes.

Genotype	Color	Aroma	Textur	Flavors	Overall reception
USK4	52.00 ab	48.78 a	60.11 ab	54.94 a	52.67 a
USK1	81.50 f	67.50 d	58.96 a	89.29 b	78.56 d
USK3	55.79 bc	60.83 abcd	66.63 bcd	70.76 ab	63.22 bc
USK7	65.43 cd	62.43 bcd	70.97 d	67.64 ab	71.10 cd
USK4 × USK6	66.83 de	66.83 cd	67.33 cd	66.67 ab	66.83 bc
USK6 × USK4	56.65 bcd	60.67 abcd	66.89 bcd	63.94 ab	60.31 ab
USK4 × USK7	49.88 ab	54.44 abc	64.45 bcd	57.67 a	53.89 a
USK7 × USK4	41.67 a	55.22 abcd	71.33 d	62.11 a	60.89 b
USK6 × USK7	51.33 ab	54.11 ab	66.00 bcd	65.50 ab	65.67 bc
USK7 × USK6	66.89 de	60.33 abcd	62.56 bc	68.22 ab	74.89 d
USK1 × USK7	76.22 ef	55.22 abcd	53.45 a	85.44 b	78.00 d
Tukey 0.05	10.40	12.56	8.06	26.16	7.99

Description: The number followed by the same letter in the same column is not significant in Tukey test 0.05.

The result of correlation analysis showed that the fruit length character correlated very real positive to fruit diameter, whole fruit weight and cavity diameter. Fruit diameter character correlated very real positive to the weight of whole fruit, thickness of fruit flesh and cavity diameter. The character of the intact fruit weight correlated very significantly positive to the diameter of the cavity and the sweetness of pulp, as well as the positive real positive correlation to the thickness of the pulp.The thickness character of the pulp correlated significantly to the sweet content. (Table 5).

Table 5. Correlation of papaya characters.

Characters	Diameter of fruit	Intact fruit weight	Thickness of fruit pulp	Diameter of cavity	Sweetness content of fruit pulp
Lenght of fruit	0.66**	0.83**	0.30^{tn}	0.58**	-0.38^{tn}
Diameter of fruit		0.89**	0.56**	0.89**	-0.38^{tn}
Intact fruit weight			0.52*	0.84**	-0.56**
Thickness of fruit pulp				-0.41^{tn}	0.49*
Diameter of cavity					-0.37^{tn}

Discussion

Based on Table 1 to Table 3, the results of the analysis can be stated that the difference in mean values on each parameter observed is influenced by the genotype being tested.

This is in line with the statement of Rahmatillah (2016), which states that the genotype has an effect on the real character of whole fruit such as length, diameter and weight of fruit. Subharandhu and Nontaswatsri (1997) added that the length, weight, and fruit diameter variables were influenced by the additive and non-additive genes with the additive gene as the main effect.

Table 1 showed differences qualitative qualitiy of papaya fruit. Visual appearance or physical quality of the fruit is a factor that affects the level of consumer preferences of papaya fruit on the market. Muliyani (2010) states the size of papaya fruit desired by consumers is the size of a medium fruit with a length fruit ranging between 15-25 cm. Suketi *et al.* (2010) also added that the size of papaya fruit based on the weight of whole fruit can be grouped into three types, namely small type fruit with whole fruit weight ranges from 300-700 g, medium type with intact fruit weight of 800-1500 g, and large type fruit with weight whole fruit ranges from 2000 to 4000 g. Based on these types it can be grouped that the genotype belonging to the small fruit type is the genotype of USK1.

Base on Table 2, genotypes included in moderate fruit types are genotypes USK4, USK3, USK7, USK4 × USK6, USK6 × USK4, USK4 × USK7, USK7 × USK4, USK6 × USK7, USK7 × USK6 and USK1 × USK7. The carrier genes of intact fruit weight, fruit diameter, and cavity diameter(Table 3) have strong heirs that are easily inherited from the elders to their offspring and the selection of these traits can be performed in the early generations. Sunyoto *et al.* (2014) stated that phenotypic appearance, such as thickness of meat, is more influenced by environmental factors than genetic factors, while fruit weight, fruit lenght, fruit diameter and fruit cavity diameter are more influenced by genetic factors than environment.

The results of organoleptic tests on Table 4 show that characters such as fruit color and taste of the pulp determine the level of consumer preference. The better the color will be more in demand by consumers. According to Aisyah (2002) the color of the fruit pulpchoose by consumers is a reddish color, while the color of the fruit is yellow or pale not favored by consumers. According to Poespodarsono (1988), a positive correlation that occurs in one or more characters will facilitate the selection because it will be followed by the improvement of one nature with the other, so it can be determined one trait or a selection index. Conversely, if negative correlation occurs, it is difficult to obtain the desired characters of fruit.

Conclusion

There is a high diversity in the characteristics of papaya fruit seen based on qualitative and quantitative observation. Genotype USK1 (elder) and USK1 X USK7 (crossline) are genotype that have the preferred quality of the consumer based on qualitative quality, organoleptic test and the measurement of the sweetness of the fruit pulp(13.40 and 11.89 Brix). Genotype USK1 X USK7 is the best crossline of papaya crossbreeding in this research. It is recommended that this research can be continued to the next stage (F2).

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