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To cite this article: R Hayati *et al* 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **523** 012029

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Sensory evaluation with descriptive method on Aceh local rice (*Oryza sativa* L.) mutant M₆ using Gamma-ray irradiation

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Abstract. Aceh is the richest province in Indonesia in the context of diversity with the local rice varieties. Therefore, it requires conservation efforts within this issue. The weakness parameters of local rice are long-lived and low production. One of the technologies that have been used to obtain the characteristics of short-lived local rice and high production is by using gamma-ray irradiation technology. This research aims to know the quality of sensory evaluation with descriptive method on Aceh local rice Mutant M₆ by gamma-ray irradiation. The Aceh local rice Mutant M₆ that has been used in this study were I-CKU-6, UF1 B4-9-2017, O-SGP, O-10D, S-103, S-97, S-01 (conventional and organic cultivation), O-39 e, O-10 d, O-57 e (organic cultivation), S-97, S-84 dan UFi-B (conventional cultivation). The approach that has been used in this research was using Completely Randomized Design (CRD) non factorial with three replicates. The result showed that local rice with irradiated gamma-ray (M₆) had a very significant effect on the flavour, color, texture, shape, and overall acceptance of rice by conventional and organic cultivation. The local rice O-SGP (5.82) is the local rice that has been received by panelists, followed by local rice S-103 (5.75), O-10D (4.95) and S-97 (4.70), while the aroma was favored by panelists is O-SGP (4.92). The S-84 local rice which was grown conventionally was preferred by panelists with a value of 9.85.

1. Introduction

Rice (*Oryza sativa* L.) is an important commodity because it is the staple food crop in Indonesia and also in several other countries [1]. The rice has a high nutrient content of 360 calories carbohydrates, most carbohydrates of rice consist of starch (89-90%), and a small parts are pentose, cellulose, and hemicellulose, and 6.8 g of protein, mineral content such as 6 g of calcium, 0.8 g of iron and 0.2 g of vitamin [2]. The rice development of local Aceh varieties are starting from Sanbei varieties that have a high-yield potential. The weakness of the Sanbei varieties is that it has a relatively longer plant life, causing the flowering period reached 96 days and it will be lead to a long harvest time.

Due to this issue, it is necessary the improvement efforts to assemble high-yielding varieties on early maturity, the high-yield potential and resistant to various abiotic and biotic stress if planted in different locations, one of them is by improving the plants through mutation and induction using of gamma-ray irradiation[5]. The application of gamma-ray irradiation shows a different genetic variability such as a shorter crops, early maturity, and high-yield potential. The mutation technique has also been shown to be highly functional in increasing of rice yields [4,5,6,7].

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On the other hand, the other important factors to be noted in the development of new varieties are not only based on a high-yield result, but also the quality of rice and rice flavour are more important to note[8]. The way to assess the rice quality is by using a sensory evaluation. There are many methods were used in sensory evaluation, one of them is descriptive analysis. The advantages of those method are to get a method that can be performed by a trained panelist not only by an expert, but also able to give a clear explanation for all the sensory product, and can be done on products that have been exist in the market, herb, an idea or a new product that have not being in competitor yet[9,10,11]. The purpose of this research is to evaluate the sensory characteristics of the Aceh local rice mutant M₆ with gamma-ray irradiation by using descriptive method.

2. Materials and Methods

2.1. Time and place of research

This research was conducted at the Laboratory of Seed Technology, Agrotechnology Department; and the Laboratory of Food and Agricultural Product Analysis, Department of Agricultural Product Technology, Faculty of Agriculture, Syiah Kuala University in Darussalam Banda Aceh. This research took place from November 2017 to February 2018.

2.2. Tools and materials research

The tools that has been used in this research were analytical scale, folio envelope, plastic, seed blower, mortar-wood, Canon camera of type EOS700. The materials used in this research were the rice which obtained from Industry and Seed Technology Laboratory, Agrotechnology Department Faculty of Agriculture, Syiah Kuala University, it was grown from rice cultivation at the Main Seed Centers, Samahani Aceh Besar. This rice was a Sanbei variety genotype M₆ by gamma-ray irradiation with doses 250 Gy for 36"15' in the Center of Isotopes and Radiation Technology produce which is the one of nuclear energy agency facilities in Jakarta on March 10, 2015 and generate M₁ genotype, while this research using of 8 genotype M₆ strains. The strains are irradiated by gamma-ray which consists of 7 strains namely: I-CKU-6, UF1B4-9-2017, O-SGP, O-10 D, S-10 3, S-01, S-97 and 1 strain of Sanbei first elder that is 6-ISNB-1 as a comparison (the strain was not irradiated by gamma-rays). Each replication in this research was used the rice per strain, taken from the best of 5 clumps and then each clump is taken for 5 best panicles.

2.3. Experimental design and data analysis

This research used a Completely Randomized Design (CRD) non factorial with 3 replications. The treatments studied were genotype consisting of Aceh local rice mutant M₆, namely: I-CKU-6, UF1 B4-9-2017, O-SGP, O-10D, S-103, S-97, S-01 (conventional and organic cultivation), O-39 e, O-10 d, O-57 e (organic cultivation), S-97, S-84 and UFi-B (conventional cultivation). The data obtained were analyzed by F test, using the mathematical model as follows:

$$Y_{ij} = \mu + \tau_i + \beta_j + \varepsilon_{ij} \quad (1)$$

If the F test shows a significant effect between the treatment factors, then it was continued with the test of Honestly Significance Difference (HSD) on level 5% (0.05) both of the treatment level.

$$HSD_{0,05} = t_{0,05} \text{ (dbg)} \sqrt{\frac{KTg}{r}} \quad (2)$$

2.4. Sensory evaluation

The implementation of sensory evaluation was using the human senses as a primary tool for assessing the quality of Aceh's local rice. Sensory evaluation with descriptive method was performed

to determine the attributes (flavour, color, texture, shape and overall acceptance) that will be assessed by panelists, and furthermore together with researchers will equate the perception in determining the characteristics based on attributes that have been mutually agreed. This method was used 15 panelists and each panelist has been tested to get the same thoughts in determining the attributes that will be generated in this study. The panelists came from students and laboratory staff of the Agrotechnology Department, Faculty of Agriculture, Syiah Kuala University.

3. Results and discussion

Based on the result of F test, the analysis of variance showed that the treatment of genotype Aceh local rice by gamma-ray irradiation (M6) has a very significant effect of the attributes on the flavour, color, texture, shape and overall acceptance of rice. The average sensory evaluation attributes can be found in Table 1 and Table 2.

3.1. The rice (uncooked)

3.1.1. The flavour of rice. Sensory evaluation indicated that panelists preferred to the O-SGP genotype scent with a score of 4.92 followed by other genotypes there are O-10D, S-103, UF1 B4-9-2017, and I-CKU-6 genotypes. According to Juliano[12] the flavour of rice is influenced by its varieties of rice. In addition to being influenced by varieties, the scent or flavour will also change with the length of storage. Unrefined rice by 100% will have a smell bad (stale) after being stored for a long time. Scent changes in storage is faster than color change. It was also added by Haryadi[13], the flavour in the rice can be survive with coating by using maltodextrin.

Table 1. Sensory evaluation attributes on the flavour, color, texture, shape, and overall acceptance of Aceh local rice Mutant M6 by gamma-ray irradiation (conventional and organic cultivation).

Rice (uncooked)	Sensory Evaluation Attributes				
	Flavour	Color	Texture	Shape	Overall Acceptance
I-CKU-6	4.30 ^{bc}	4.40 ^b	4.27 ^c	4.10 ^b	4.23 ^b
UF1B4-9-2017	4.47 ^{cd}	3.32 ^a	3.35 ^a	3.48 ^a	3.33 ^a
O-SGP	4.92 ^d	6.13 ^d	5.52 ^e	5.67 ^d	5.75 ^e
O-10D	4.82 ^{cd}	4.85 ^c	4.53 ^c	5.08 ^c	4.95 ^d
S-103	4.80 ^{cd}	4.32 ^b	4.52 ^c	4.83 ^c	5.82 ^e
S-97	3.80 ^{ab}	4.27 ^b	4.92 ^d	4.77 ^c	4.70 ^{cd}
S-01	3.68 ^a	3.27 ^a	3.30 ^a	4.35 ^b	4.47 ^b
HSD 5%	0.54	0.38	0.31	0.43	0.37

Description: The numbers followed by the same letter in the same column are not significantly different (HSD Test at 5% level)

3.1.2. Rice color. In the color attribute panelists choose the genotype O-SGP, this is caused by the color of the rice is affected by degrees, amylose levels and changes during rice storage, high degrees resulted in more and more epidermis released so that the color of the rice becomes whiter. In addition, the acceptance of the color of a material varies depending on natural factors, geographical, and social aspect of society.

3.1.3. Rice texture. The sensory assessment use of the hedonic test on the preferred texture attribute of rice with the gamma-ray irradiated rice on the M6 genotype yields a value of between 3.30 and 5.52 with somewhat dislike, neutral and rather like. The high texture of the genotype O-SGP is significantly different from the genotype S-01, UF1 B4-9-2017, I-CKU-6, S-103, O-10D, S-97. Texture is the surface appearance of an attribute of a foodstuff produced by a combination of physical properties and chemical properties that are widely accepted by their touching, visualization, and listening. Texture is

also defined as the properties of a food that can be observed by the eyes, skin, and the mouth muscles[14].

3.1.4. The shape of rice. In the perspective of rice shape attribute, the lowest score was shown by genotype rice UF1 B4-9-2017, which was significantly different from the genotype I-CKU-6, S-01, S-97, S-103, O-10D, O-SGP. The size and shape of rice are the dominant character derived from the genetic properties of the parent and can be used as the parameter of purity determination of a variety. Long character and shape of rice are influenced by genetic factor, agro ecosystem and soil fertility[15].

3.1.5. Overall Acceptance of Rice. The highest overall attributes acceptance was on S-103 rice which was not significantly different from O-SGP rice with the criteria is rather like. The lowest overall acceptance value of rice is UF1 B4-9- 2017. But it is significantly different from I-CKU-6, S-01, S-97, O-10D rice. This showed that the panelists are selecting rice from gamma-ray irradiation on S-103 and O-SGP rice.

3.2. Cooked rice

Table 2. Sensory evaluation of the shape, texture, flavour, internal and eksternal color, and acceptance a whole rice of Aceh local rice Mutant (M6) by gamma-ray irradiation in conventional and organic cultivation.

Cooked rice	Sensory Attributes					
	Shape	Texture	Flavour	Internal color	Exsternal color	Overall Acceptance
O-39e	11.39 ^{abc}	9.27 ^b	7.76 ^{ab}	8.57 ^a	12.17 ^{ab}	11.18 ^{bc}
O-10d	8.35 ^a	7.30 ^{ab}	6.76 ^a	8.46 ^a	15.19 ^{bc}	9.15 ^{ab}
O-57e	14.37 ^{cde}	6.76 ^a	6.86 ^a	8.45 ^a	10.96 ^a	10.04 ^{ab}
S-97	17.40 ^e	7.09 ^a	7.43 ^{ab}	10.65 ^b	13.99 ^{ab}	12.23 ^c
S-84	9.39 ^{ab}	8.02 ^{ab}	9.85 ^b	8.80 ^a	11.20 ^a	10.09 ^{ab}
UF1-B	12.45 ^{bcd}	8.58 ^{ab}	7.91 ^{ab}	8.77 ^a	12.02 ^{ab}	8.77 ^a
HSD 5%	1.90	1.90	2.67	1.39	3.71	1.94

Description: The number followed by the same letter in the same column are not significantly different (HSD Test at 5% level). O-39e, O-10d, O-57e in organic cultivation, S-97, S-84, UF1-B cultivating conventionally.

3.2.1. The shape of rice. Table 2 shows the highest average of rice shape is shown by S-97 rice strain not significantly different from the M0-Snb and O-57e rice strains, but significantly different from the O-39e, O-10d, S-84 and UF1-B. The lowest rice form was found in the O-10d rice strain which was not significantly different from the O-39e and S-84 rice strains, but was significantly different from the M0-Snb, O-57e, S-97 and UF1-B rice strains.

The size and shape of rice grains (dimensions) are the basis in determining the quality of rice in the international market. Based on the length / width of rice observed ranged from 1.82 to 2.77 mm. For M0-Snb strain, O-57e and S-97 are round, while O-10d, S-84 and UF1-B strain are medium and O-39e are slightly rounded. From the preferred test data of rice form, the best results are shown by S-97 rice strains not significantly different from the M0-Snb and O-57e rice strains. This suggests that panelists prefer a rounded shape of rice rather than oval or slightly rounded shape.

3.2.2. Rice texture. Table 2 shows the highest average of rice texture found in O-39e rice strain which not significantly different to M0-Snb, O-10d, S-84 and UF1-B strains, but significantly different to O-57e and S-97. The lowest rice texture was found on the O-57e rice strain which was not significantly different to M0-Snb, O-10d, S-84, S-97 and UF1-B rice strains but was significantly different to O-39e

rice strain. According to Kartika[16] texture is a sensation of pressure that can be observed by mouth (bitten, chewed and swallowed), or touching by fingering.

3.2.3. Rice flavour. Table 2 shows the average level of the highest rice flavour is shown by S-84 rice strain that not significantly different to M0-Snb, O-39e, S-97 and UF1-B, but significantly different to O-10 d and O-57e. The lowest rice flavour was found in the O-10d rice strain which was not significantly different to O-57e, M0-Snb, O-39e, S-97 and UF1-B, but differed to S-84. According to De Mann[17], in the food industry flavour testing is considered important because it can provide results assessment of the product related to the acceptability or absence of a product.

3.2.4. Internal color of rice. Table 2 shows the average internal color of the highest rice is shown by M0-Snb rice strain which are not significantly different to S-97, but significantly different to O-39e, O-10d, O-57e, S-84 and UF1-B. The lowest internal color rice was shown by O-57e rice strain which was not significantly different to O-39e, O-10d, S-84 and UF1-B strains, but significantly different to S-97 and M0-Snb rice strains. According to Winarno[18], the color plays a role in determining the level of consumer acceptance of a product, although the product is of high nutritional value, good taste and good texture but if the color is not attractive it will cause the product is less desirable.

3.2.5. External color of rice. Table 2 shows that the average of the highest eksternal color of rice is shown by M0-Snb rice strain which is not significantly different to the O-10d rice strain, but significantly different to the O-39e, S-97, O-57e, S-84 and UF1-B. The lowest eksternal color rice was found in O-57e rice strain which is not significantly different to the O-39e, S-97, O-57e, S-84 and UF1-B rice strains but significantly different to the O-10d and M0- Snb. There are factors that affecting a white color on rice, the degrees of rice and storage conditions. The longer the rice is pounding the more color is becoming white because many layers of aleuron are lost[19].

3.2.6. Overall acceptance of rice. Table 2 shows the highest average overall attributes acceptance of rice shown by S-97 in rice strain. It's not significantly different to O-39e rice strain, but significantly different to M0-Snb, O-10d, O-57e, S-84 and UF1-B. The lowest of acceptance a whole rice was found on the M0-Snb rice strain which was not significantly different to O-10d, O-57e, S-84 and UF1-B rice strains, but significantly different to O-39e and S-97 strains. The S-97 rice strain had the highest acceptance rate with 12.23. The acceptance testing of overall rice is an assessment of all observed quality factors including shape, texture, flavour, internal and eksternal colors. This test intends to find out the level of panelist acceptance of a product. The best results are shown by S-97 rice strain, this is due to the genotype has the best form, flavour and the best color that suits the tastes and can be accepted by consumers. According to Soekarto[19], the physical and chemical tests also nutritional test can indicate a high quality product, however it would be meaningless if the product can not be consumed because it is uncomfortable or the nature of the sensory is not appetizing or unacceptable to the consumer.

4. Conclusion

The treatment of Aceh local rice genotype by gamma-ray irradiation (M6), which are grown in a conventional and organic cultivation, has a very significant effect on the flavour, color, texture, shape and overall attributes acceptance of rice. On the other hand, the treatment of Aceh local lines mutant rice genotype with conventional and organic cultivation has a very significant effect on a test favorites of shape, texture, flavour, inside and outside color and the acceptance of whole rice. The local rice O-SGP (5.82) has been received by panelists, followed by local rice S-103 (5.75), O-10D (4.95) and S-97 (4.70), while the aroma is favored by panelists is O-SGP (4.92). S-84 local rice which is grown conventionally is preferred by panelists with a value of 9.85.

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