Morphology, production, and chemical content performance of black rice Matesih accession with several comparisons

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Abstract. Rice (Oryza sativa L.) is an important food crop in Indonesia. In Matesih area, Karanganyar, recently found new varieties of black rice cultured by local farmers which morphology and chemical content have not yet identified. The purpose of this research was to obtain information of morphology, production, and chemical content of black rice matesih accession and to compare the appearance in order to detect the superiority of black rice matesih accession with the comparison of other accession of black rice. There were four accessions of black rice tested, namely Matesih Accession, Klaten Accession, Toraja, and Cempo. Research data were divided into qualitative data which processed by scoring, and quantitative data are processed with simple descriptive statistic. The kinship test was done by using NTSYSpc program with SIMQual and SIMInt function. The observation of qualitative properties indicates that accession matesih has a form that is relatively similar to other accessions. Qualitatively, accession matesih superior at leaf length, leaf width, plant height and culm diameter. Klaten accession has higher production than accession matesih. Matesih accession has the advantage of having shorter period on heading time and harvest time than other accessions. Matesih accession has the highest amylose content, lower protein content than klaten accession and lower content of anthocyanin than toraja accession. The kinship analysis showed that matesih accession and klaten accession has close kinship.

1. Introduction

Rice (Oryza sativa L.) is an important food commodity in Indonesia, South East Asia and some country. Rice for people need always increase from year to year similar with increasing of people number. There is some kind of rice consumed of people in Indonesia like white rice, red and black rice.

One kind of rice in Indonesia is black rice that has black colour of pericarp. Black rice is a locally variety that has cultured by farmers. Actually, the black colour mean of anthocyan contain in pericarp, aleurome and endosperm that have compound of red-blue and deep of purple colour. [1] reported that anthocyanin has functionally as antioxidiant and catch free radical then secure from aging, cancer and degenerative disease.

Black rice cultivar is less popular than white rice and so not much research about this varieties like identification of morphology and biochemistry aspect. Identification of locally black rice is important in order to know the specific characters need for breeding program later. One location of black rice developing and culturing is Matesih district of Karanganyar resident. Some farmer developing and
culturing the locally black rice but they don’t know about specifically and production potential also where the originally of this rice. Research is important and aim to know about performance of Matesih accession including the morphology and chemical content compared with some local black rice varieties to know but the superiority of Matesih accession has. Identification need to improve the quality of important characters and reduce the lack of characters in order to developing new variety that has a high productivity [2].

2. Methods
Research conducted in March-December 2016 in Ngadiluwih district of Matesih Karanganyar resident Central Java Indonesia. Experiment method in paddy land to know Matesih variety productivity compared with other local varieties of Klaten, boyolali, Toraja and Cempo varieties. From the research can be determined about specific characters of each variety. Analysis of data used simple statistics for quantitative data and descriptive qualitative. There were 43 variables observed for performance, morphology characters, production, chemical contain of grains and taste of rice. Cluster analysis used by SIMQUAL (Similarity Qualitative) and SIMINT (Similarity Interval.).

3. Results and Discussion

3.1. Plant Morphology

3.1.1 Leaf Morphology
Morphology of leaves paddy observed showed that Matesih variety have the longest and widest then other varieties (Table 1). Size of leafs is determining the function for light number, nutrition and water take and growth and development of paddy. physiological process occurred in leaf related with resistance against disease, and response of plant against environment stress and yield depend on leaf size [3]. [4] reported that their positive correlation between leaf measure and paddy grain yield.

| Characters           | Matesih       | Klaten        | Toraja        | Cempo         |
|---------------------|---------------|---------------|---------------|---------------|
| Length              | 45.93 ± 6.66  | 38.67 ± 4.32  | 37.06 ± 4.98  | 37.56 ± 4.67  |
| Width               | 1.1 ± 0.10    | 1 ± 0.09      | 1.07 ± 0.07   | 1.04 ± 0.06   |
| Angle               | Upright       | Upright       | Upright       | Upright       |
| Colour shape        | Green         | Green         | Young green   | Young green   |
| Characters          | Hairs         | Hairs         | Hairs         | Hairs         |
| Colour of neck      | Green         | Green         | Young green   | Young green   |
| Colour of tongue    | White         | White         | White         | White         |
| Form of tongue      | 2-cleft       | 2-cleft       | 2-cleft       | 2-cleft       |
| Colour of ear       | White         | White         | White         | White         |
| Leaf blade colour   | Green         | Green         | Green         | Green         |
| Flag angle leaf     | Straight      | Straight      | Straight      | Straight      |

Table 1. Morphology of black rice leaf characters
Qualitative character leaf colour of Matesih variety was different with Toraja and Cempo variety but same with Klaten variety. Green colour mean with more chlorophyll content of leaf compared with young green colour. The higher chlorophyll content of Matesih very related with higher rate of photosynthesis because more light quality absorbed [5] higher chlorophyll indicated of higher photosynthesis rate. Other characters same belong of four varieties were leaf angle, hair on leaf shape, colour of neck, colour of tongue, form of tongue, colour of ear leaf, colour of blade, and form of flag leaf angle.

3.1.2. Stem Morphology Matesih variety has plant height and heighest of plant diameter compared by other varieties. [6] said about paddy, decreasing of plant height become semi dwarf is a primary target in order to improve the resistance against plant collapsed, but the result of [7] showed that improving semi dwarf of paddy can limitate of canopy for photosynthesis and number of biomass and then decrease grain yield.

| Characters       | Matesih       | Klaten        | Toraja        | Cempo         |
|------------------|---------------|---------------|---------------|---------------|
| Plant height     | 136.6 ± 7.02  | 126.5 ± 6.46  | 97.2 ± 7.46   | 118.43 ± 10   |
| Stem Diameters   | 0.57 ± 0.11   | 0.57 ± 0.11   | 0.51 ± 0.08   | 0.52 ± 0.10   |
| Stem Power       | Strong        | Strong        | Strong        | Strong        |
| Stem angle       | upright       | Upright       | Upright       | Upright       |
| Colour of stem segment | golden yellow | golden yellow | golden yellow | golden yellow |

Matesih Variety has heighest diameter of stem it was same with Klaten variety. Result of research [8] showed that stem diameter is important to measure because it was related with photosynthesis rate and resistance against stem breakness. [5] reported that breakness in paddy devided of two category ie: collapse of root and stem collapse. Root collapse because root not enough to catch to the soil then all stem breaked. Breakness of stem because crooked or cutting of segment based of stem by stress of up stem. Strongness of stem or thickness of bending stem important in supporting resistance against breaked mainly at up of stem part. Qualitative characters of Matesih variety was same with other varieties in thickness, angle and yellow colour of stem segment.

3.1.3 Panicle Morphology Measurement morphology of panicles only for three varieties, that is matesih, klaten and Toraja accessions because one variety cempo was harvesting failure. Some factors according to [9] empty grains cause of not occur fertilization, less of water supply when generative phase, or environment not supported.

| Characters       | Matesih       | Klaten        | Toraja        | Cempo         |
|------------------|---------------|---------------|---------------|---------------|
| Length of panicle| 20.30 ± 1.92  | 20.31 ± 1.31  | 18.91 ± 1.37  | -             |
| Panicle Type     | Compact, medium | Compact, medium | Compact, medium | -             |
| Secunder panicle branch | Many | Many | Little | - |
Longest of panicle owned by Klaten followed by Matesih. Panicle long take effect to how many grains in panicle, number and density of spikelet, rate of filled grains, and grain size made long of panicle as character that can influence rice yield [10, 11]. Panicle type at three varieties was same that is between compact and medium while panicle branch of Matesih and Klaten have many branch and the smallest is Toraja owned.

3.1.4 Morphology of Grain

Table 4. Morphology of Black Rice Grain

| Character          | Matesih              | Klaten             | Toraja              | Cempo   |
|--------------------|----------------------|--------------------|---------------------|---------|
| Lemma and Palea colour | Brownish brown    | Brown spotting    | Brownish brown     | -       |
| Hair existence at |                      |                    |                     |         |
| Lemma and Palea   | Short hairy          | Short hairy        | Short hairs         | -       |
| Grain hair        | No hairy             | No hairy           | No hairy            | -       |
| Long Grain        | 9.74 ± 0.48          | 9.52 ± 0.56        | 9.89 ± 0.51         | -       |
| Wide Grain        | 2.97 ± 0.19          | 3.03 ± 0.14        | 3.16 ± 0.17         | -       |
| Thickness Grain   | 1.88 ± 0.10          | 1.78 ± 0.12        | 1.90 ± 0.08         | -       |

Result of observation in lemma and palea showed the variation between variety. Lema and palea in Matesih and Toraja is brownish brown and Klaten has brown spotting lemma and palea at background of straw. Lemma and palea of three varieties showed short hairs. Unknown function of hair on lemma and palea but in according research result of [12] hairs and bumps at husk shape (lemma dan palea) contain of hight silica. Size of grain in according scale of [13] including very long ( > 7.50 mm). Size and form of grain is stabil variety properties. Slim and long grain. Butir ramping usually has many damage of the short and thick grain made the specific tool in processing [14]. According to [15] slim grain usually break at processing.

3.2. Flowering and Harvesting Age

Matesih variety has early in flowering and harvesting age compared with other varieties. According to [16] long harvest age of rice if above 151 days after planting medium if 125 - 150 days after planting and short harvest age if harvest at 105 - 124 days after planting then very short harvest age if 90 - 104 days after planting then ultra short harvest age if below 90 days after planting.

Table 5. Flowering age and harvest age of Black rice

| Character    | Matesih | Klaten | Toraja | Cempo |
|--------------|---------|--------|--------|-------|
| Flowering age| 52      | 55     | 59     | 98    |
| Harvest age  | 117     | 121    | 126    | -     |

3.3 Production

According to [17] higher number of clumps as characters need in rice production because number of clumps very related with panicle number. According to [14] 1000 grain weight gave information about size and density of grain. Matesih variety has grain weight many than Toraja own but smaller than Klaten.
Table 6. Production of Black rice

| Character               | Matesih         | Klaten          | Toraja          | Cempo            |
|------------------------|-----------------|-----------------|-----------------|------------------|
| Total clumps           | 12.27 ± 2.61    | 12.50 ± 3.22    | 11.86 ± 3.70    | 12.67 ± 3.98     |
| Total productive clumps| 10.82 ± 3.25    | 12.46 ± 2.89    | 11.25 ± 3.31    | -                |
| Weight 1000 seeds (gram)| 32              | 30              | 28              | -                |
| Grain weight per clump (g) | 17.01 ± 5.72  | 21.62 ± 7.50    | 14.97 ± 7.05    | -                |
| Production per Ha (ton) | 2.136           | 2.715           | 1.88            | -                |

3.4 Chemical Content

According to [18] rice protein more quality because contain of eight of ten amino acid essential compared with other plant own. According to [19] grain with little amilosa gave the sticky and clot if cool. Chemical contain in black rice very important to know is antosianin. Anthocyanin made black rice as healthy food [20] with antioxidant that can inhibit inflammation, anti cancer, increase blood circulation, slow down damage and aging decreasing cholesterol and sugar, and stomach acid [21].

Table 7. Chemical contents of grain

| Character    | Matesih | Klaten | Toraja | Cempo |
|--------------|---------|--------|--------|-------|
| Protein (%)  | 6.38    | 6.78   | 6.38   | -     |
| Amilosa (%)  | 23.61   | 23.44  | 8.92   | -     |
| Antosianin (ppm) | 2250.96 | 1807.77 | 4347.56 | - |

3.5 Organoleptic Test

Rice grain colour of three accessions black rice actually purple is blackish. According to [22] colour is form of precipitation of pigment anthocyanin in large quantities on the surface of rice. Organoleptic test of three kind of rice showed difference among varieties. Matesih and Klaten has hard texture while Toraja accession has more lenient related with amilosa content. Fragrances of three accessions rice was same there is a little fragrant.

Table 8. Organoleptic Test of Rice

| Character | Matesih | Klaten | Toraja | Cempo |
|-----------|---------|--------|--------|-------|
| Rice colour | Purple | Purple | Purple | -     |
| Texture   | Sticky  | Sticky | Thin   | -     |
| Aroma     | slightly | slightly | slightly | - |

3.6 Similarity Analysis

3.6.1 Qualitatif Characters

Table 9. Similarity coefficient of black rice based on qualitative character

|          | AksesiMatesih | AksesiKlaten | AksesiToraja |
|----------|---------------|--------------|--------------|
| Matesih  | 1.000         |              |              |
| Klaten   | 0.870         | 1.000        |              |
| Toraja   | 0.739         | 0.739        | 1.000        |
There is similarity analysis showed that Matesih has similar with Klaten accession 0.87 while Toraja and Klaten has similarity coefficient of 0.74. Even though in breeding selection genetic distance not the only thing to be reckoned but the other interesting characters need to be included. Correlation factor of vegetative and generative important to be calculated so that more focused and effective [23].

3.6.2. Quantitative Character

| Table 10. Matrixs of similarity coefficient based on quantitatif characters |
|-------------------------------------------------|
|        | Matesih | Klaten | Toraja |
| Matesih | 0.000    |        |        |
| Klaten  | 110.882  | 0.000  |        |
| Toraja  | 524.282  | 635.006| 0.000  |

Figure 2. Dendogram of morphology based on quantitative characters
Dendogram of morphology characters based on quantitative characters showed that Matesih accession has similarity with Klaten accession compared with Toraja accession. On wide of leaf, stem diameter, long of panicle, number of clump, and amilosa content.

4. Conclusions
From this study it may be concluded that Matesih accession has qualitative characters relatively same among accessions with low variation like long of leaf, wide leaf, plant height, and stem diameter that Matesih has better than comparisons accessions. Klaten accession has more grain yield than Matesih accession. Matesih accession has superiority about early flowering and harvesting age compared with there comparisons. Matesih accession has high amilose content but lower protein content than Klaten accession and lower anthocyanin content than Toraja accession had highest amylose content. Matesih and Klaten accession has similarity coefficient compared with Toraja.

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