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Physical properties of local upland rice kupang east nusa tenggara, indonesia

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ABSTRACT

Local upland rice (*Oryza sativa* L.) is a type of cereal crop that has the potential for dry land areas. Farmers in Kupang plant upland rice/local rice that has been consumed and used for generations and is considered by the surrounding community as part of their ancestral heritage. The materials used in this research were local upland rice varieties as a result of exploration. The varieties of six local upland rice of Kupang studied in this research had different rice characters in terms of its weight, volume, density and yield.'Aen Molo' has the highest weight per grain and per 1000 grains, namely 0.024 g and 24.95 g, also the highest volume of 1000 grains of rice is 30 ml, while 'Aen Lekes' has the lowest weight per grain and per 1000 grains, namely 0.020 g and 19.66 g and also the lowest volume of 1000 grains, namely 23 ml. The Iodine test results showed that the local rice of Kupang was classified in the regular or non-glutinous rice group. Meanwhile, Alkali test results show that the six samples of local upland rice have a high gelatinization temperature which indicates that local upland rice in Kupang Regency has high amylose content.

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INTRODUCTION

Rice (*Oryza sativa* L.) is a group of seed plants (cereals) that produce rice which contain carbohydrates and also as a source of fibre (Fernando, 2013) . Apart from corn, sorghum, bananas and tubers, the people of East Nusa Tenggara also utilize germplasm of rice as a staple food in meeting their carbohydrate needs. Rice germplasm is very diverse, whether in hybrid, superior and local rice.

Local upland rice is germplasm of rice that has been cultivated for generations by a certain group of people and has good adaptability to biotic and abiotic stresses in the original environment where it grows. Local rice is a wealth of germplasm that needs to be preserved or utilized in plant breeding for the assembly of superior varieties. The existence of local upland rice is rarely found along with the emergence of superior rice varieties and hybrid rice (Sitaresmi, Wening, Rakhmi, Yunani & Susanto, 2013). Farmers in East Nusa Tenggara are known to grow local upland rice.

Kupang Regency is one of the areas in East Nusa Tenggara Province which has agricultural potential, both rice fields and dry land agriculture, which includes gardens and fields. The area for upland rice and lowland rice harvested in 2013 reached 18,470 ha with a production of 60,469 tons. The highest harvested areas were in the districts of East Kupang, Sulamu, West Fatuleu, East Amfoang and Central Kupang District. Meanwhile, the lowest harvested area was in Fatuleu District, Amabi Oefeto Timur District and Nekamese District (BPS Kabupaten Kupang, 2013).

Nekamese district had the lowest rice harvest area of 84 ha due to the hilly and rocky topography of the area with an altitude of 1400 mdpl (BPS Kabupaten Kupang, 2016). Farmers in this area plant the rice using an agricultural system and only rely on irrigation from rainwater. Farmers in Nekamese District, especially farmers in Oemasi Village and Oenif Village, only plant upland rice/local rice.

This local upland rice is the type of rice that has been consumed and used for generations and is considered by the surrounding community as part of their ancestral heritage. The existence of each type of local rice in this area is spread across several farmers where each farmer planting two to three types according to their preferences and land availability. Apart from being a food ingredient, local rice is also used as traditional medicine by the local community. In Timor Tengah Utara District, this plant has become an important crop in the dry land farming system. Besides, it has also become the part of the local agricultural civilization (Basuki, 2004).

The morphological character of rice is one of the parameters that can be used to differentiate rice varieties (Hanas, Kriswiyanti & Junitha, 2017). Observations of morphological characters such as color, size, weight, volume, density and starch characters can be used to describe the physical properties of rice. The physical properties of rice grown by farmers in Kupang district are not known until now. This study aims to describe the physical properties of local rice Kupang by observing the morphological characters of rice. One way to encourage the development of local upland rice in East Nusa Tenggara province is by optimizing the utilization of various potentials diversity of local upland rice. Therefore, the introduction of the characteristics of local rice is needed in an effort to optimize its utilization..

RESEARCH METHODS

Research Design

This study uses the method of exploration and direct observation. Exploration was carried out in Oenif Village (10˚18' 06"S 123˚38' 10"E) and Oemasi Village (10˚16' 06"S 123˚38' 44" E), Nekamese Subdistrict, Kupang Regency to obtain samples of local upland rice. Furthermore, the physical properties of the local upland rice samples were observed.

Population and Samples

The local upland rice seeds used as samples were taken randomly from each variety of rice that was explored. The weight of rice grains was weighed with an analytical balance against 1 and 1000 grains of rice.

Instruments

The equipment used in this study included: KERN analytical scale for weighing rice samples, measuring cup used to determine the sample volume, oven for incubate samples, electron microscope for observation of starch grains, erlenmeyer as a container for boiling samples, hotplate for heating samples and bottle glass as sample incubation container.

Procedures

Rice Weight and Volume

The weight of rice grains was weighed using an analytical balance against 1 and 1000 grains of rice.

Bulk density of rice

Rice seeds were put in a measuring cup and compacted to the specified volume. All samples of rice seeds from the measuring cup were then removed and weighed. The bulk density of was determined in g/ml (Tiwari, Dayma & Sharma, 2017).

Water absorption capacity

Pour 20 ml of water into a 100 mL test tube and heated at 80 ℃. After that, 2 g of rice was put into a measuring cup and heated for 20 minutes, drained and weighed after boiling (Lalel, Zainal & Lewi, 2009).

Alkali spread value

Six grains of rice were placed in a transparent bottle glass containing 10 mL of 17% KOH that have been arranged properly so the grains did not come into contact. The bottle glass was then incubated at 30℃ for 23 hours. The appearance of rice is assessed visually and given a score of 1 to 7 according to the changes in grain.

Amylum

Rice was crushed into flour, sprinkled with water and Iodine solution then observed the shape, size and color change of amylum under a microscope. The flowchart for this research is Figure 1.

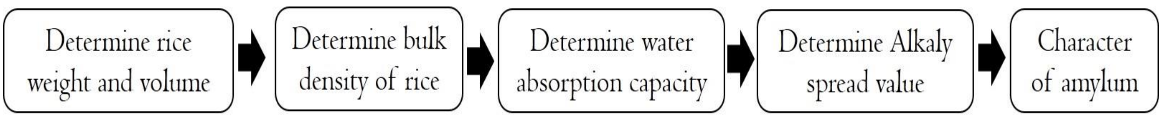


Figure 1. Flowchart of research.

Data Analysis

Data analysis was performed by describing the results of measurements and observations. The quantitative data obtained is the repeated average of the measurement results which are then statistically tested using the SPSS application. The follow-up test was carried out by the smallest significant difference test at the level of P = 0.05.

RESULTS

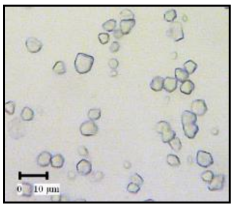
The results of observations of rice morphological characters such as rice color, weight, volume, density and yield of local Kupang rice are presented in Table 1. From the observations, it was shown that there were differences in the morphological characters of each rice variety.

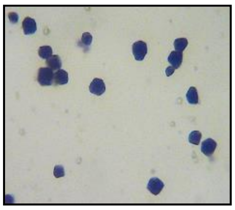
Table 1. Weight, volume, density and yield of kupang local rice

No.	Variety	Rice Color	Weight of rice grains (g)	Weight of 1000 grains of rice (g)	Volume of 1000 grains of rice (ml)	Density of 1000 grains of rice (g / ml)	Rice yield (%)
1	Aen molo	White	0.024 [c]	24.95	30	0.83	84.97
2	Aen lekes	Brown	0.020 [a]	19.66	23	0.85	78.60
3	Aen muti	White	0.021 [a]	21.03	25	0.84	82.73
4	Aen me'e I	White	0.021 [ab]	21.81	27	0.80	82.61
5	Aen me'e II	Brown	0.021 [ab]	21.86	27	0.80	82.83
6	Aen metan	Black	0.022 [b]	21.78	26	0.83	80.63

Information: the numbers in the same column and followed by different letters show a significant difference at the 5% test level.

The results of observations on the character of starch in the form of shape and size of starch grains, color changes with iodine test, endosperm type, efflorescence and aroma test of rice and local kupang rice kar are shown in Figure 2 and Table 2.





Note: a. shape and size of starch, b. starch color after dripping with Iodine

Figure 2. Shape, size and color change of local upland rice starch grains in Kupang

Table 2. The characteristics of amylum, alkali development value, aroma and absorption capacity of local gogo rice in kupang

No.	Variety	Form of starch	Size of starch (µm)	Change in color of starch	Type of endosperm	Alkali Development Value	Aroma of rice	Water absorption Capacity (%)
1	Aen molo	Polygonal	7.39	Dark Blue	Non-glutinous	Low	Not Fragrant	47,5
2	Aen lekes	Polygonal	6.21	Dark Blue-Purple	Non-glutinous	Low	Slightly Fragrant	33
3	Aen muti	Polygonal	7,00	Dark Blue	Non-glutinous	Low	Not Fragrant	50
4	Aen me'e I	Polygonal	5,34	Dark Blue	Non-glutinous	Low	Not Fragrant	40
5	Aen me'e II	Polygonal	5,36	Dark Blue-Purple	Non-glutinous	Low	Slightly Fragrant	36
6	Aen metan	Polygonal	4,55	Dark Blue-Purple	Non-glutinous	Low	Fragrant	42,5

DISCUSSION

The color of local upland rice from Nekamese District is very diverse: 'Aen Molo', 'Aen Muti', 'Aen Me'e I' is white with brownish white aleuron; 'Aen Lekes', 'Aen Me'e II' is red with brownish red aleurone and 'Aen Metan' is black with purple aleurone. However, all local upland rice has a white endosperm. The different color of local upland rice in Kupang Regency is due to the difference in the color of the epidermis (aleurone) which is caused by differences in the content of anthocyanin pigments in the aleurone. The difference in rice color is greatly influenced by the anthocyanin pigment content in the aleurone. Brown rice and black rice have very high anthocyanin content, which makes the color of the rice brownish red or blackish purple (Yodmanee, Karila & Pakdeechanuan, 2011; Ilmi, Pratiwi & Purwestri, 2018). Cracked rice for 6 local upland rice varieties in Nekamese District, Kupang Regency has a variety of weight, volume, density and rice yield (Table 1). The highest weight per grain and weight of 1000 grains of cracked rice belonged to local upland rice 'Aen Molo' (0.024 and 24.95 g), while the lowest weight belonged to local upland rice 'Aen Lekes' (0.020 and 19.66 g). The highest volume of 1000 grains of cracked rice was owned by local upland rice 'Aen Molo' (30 ml), while the lowest volume was also owned by 'Aen Lekes' (23 ml). The weight of 1000 grains of local upland of cracked rice from Kupang Regency (19.66-24.95 g) is greater than the weight of 1000 grains of local upland rice from Bengal-India (9.31-24.74 g) which has been reported by Semwal, Pandey, Bhandari, Dhariwal, & Sharma (2014). However, it is lower than the weight of 1000 grains of local upland rice Ratchaburi-Thailand (21.76-37.00 g) which was reported by Phunngam, Nichakorn, Natnaree, Jaruwan, & Uraiwan (2017).

The high density value is owned by local upland rice 'Aen Lekes' (0.85 g/mL); then "Aen Muti" and "Aen Metan" (0.84 g/mL) which then followed by 'Aen Molo' and 'Aen Metan' (0.83 g/ ml). This shows that the five local upland rice, if stored or transported in the form of rice, do not occupy much space. On the other hand, for the same number of cracked rice grains, local upland rice of 'Aen Me'e putih' and 'Aen Me'e merah' have low density values of rice (0.80 g/ ml), so that if stored in the form of cracked rice, it will require more storage space. The yield of cracked rice can be obtained from the ratio between the weight of the cracked rice and the weight of grain in the form of percent. The higher yield of cracked rice, the greater the yield of milled rice produced (Ulfa,Hariyadi & Tjahja, 2014; Hassan, 2014).

The highest yield of cracked rice was owned by local upland rice with the highest weight of 1000 grains and high density of grain, namely local upland rice 'Aen Molo' with 84.97%. Meanwhile, the lowest yield of cracked rice and lowest grain density was owned by local upland rice with the weight of 1000 grains, namely 'Aen Lekes' with 78.60% (Table 1). This shows that the bulk density of grain and the weight of 1000 grains have an effect on the yield of cracked rice. The greater the density and the weight of 1000 grains of cracked rice, the greater the yield of cracked rice produced.

Local upland rice in Kupang Regency has the characteristics of starch grains that are not much different. Starch grains have a polygonal shape ranging from square, pentagon to hexagon with an average diameter of 4.55-7.39 μm (Table 2). The shape and size of local upland rice starch grains in Kupang Regency are not much different from the shape and size of the local Rancakalong-Sumedang starch grains reported by Irawan & Purbayanti (2008), which are polygonal with a diameter between 2.5 -10 μm. Based on the presence or absence of aroma, rice can be classified into aromatic rice and non-aromatic rice. Local upland rice of 'Aen Molo', 'Aen Muti' and 'Aen Me'e I' when cooked does not produce aroma (non-aromatic). This is in contrast to local upland rice of 'Aen Lekes', 'Aen Me'e II' and 'Aen Metan'. 'Aen Lekes' and 'Aen Me'e II' when cooked will have a mild aroma, while 'Aen Metan' will have a very strong aroma (aromatic). This shows that the Aleurone layer of local upland rice of 'Aen Lekes', 'Aen Me'e II' and 'Aen Metan' contains aromatic compounds. This is consistent with the report of Elsera, Jumail & Kusbiantoro (2014); Routray & Rayaguru (2017), who stated that the distinctive aroma of aromatic rice comes from volatile compounds, namely 2-Acetyl-1-Pirroline (2-AP) which is found in the aleurone layer of rice.

The aroma of rice is one of the determinants of rice quality in addition to the taste and texture of the rice produced. Rice with a good size, delicious and aromatic taste is more in demand by the community so that it has opportunities at high prices both in the local and global markets. Aromatic rice is also often a recommendation in rice plant breeding with an effort to produce quality aromatic rice (Prodhan & Qingyao, 2020). Kupang local upland rice, especially brown rice and black rice, which is included in aromatic rice, needs special attention to be used as part of the aromatic class of rice germplasm.

The Iodine test on starch grains in the non-glutinous rice group can turn dark blue to purple, while the glutinous rice group turns red (Irawan & Purbayanti, 2009). The iodine test on the starchy grains of local upland rice, Nekamese District, Kupang Regency, resulted in dark blue to purple colors with starch grains tending to be scattered (Figure 1). Therefore, it can be concluded that the six local upland rice varieties were included in the regular rice group with the Endosperm type being non-glutinous or has no adhesive substance.

The Alkali test is a test carried out to estimate the indication of the known gelatinization temperature by soaking the rice in a 17% KOH solution for 23 hours, then it can be determined by looking at the efflorescence of the rice (Badi, 2013). The results of the Alkali test for local upland rice in Nekamese Subdistrict, Kupang Regency, resulted in a low Alkali test value, which was indicated by the absence of changes in the radiance in the six rice samples (Table 2).

The low alkali test value indicates that the local upland rice rice sample has a high gelatinization temperature. This indicates that the local upland rice in Kupang Regency takes a longer time to cook into rice and also has a higher amylose content. Lalel *et al.* (2009) reported that the results of the Alkali test on local upland-red-rice in Ende produced a relatively low alkali test value with a high gelatinization temperature between 74.5-80°C This is different from the results of the alkali test on several local aromatic rices which showed low to moderate gelatinization temperatures. However, the local Kupang rice alkali test is not much different from Indian aromatic rice which shows low alkali test results with a relatively high gelatinization temperature, which is above 74° C (Suhartini & Wardana, 2011). This property has implications for the length of time it takes to cook these rices or other processed products and also the amylose content of rice. Alkali development values are reported to have a positive correlation with cooking time. It is also positively correlated with the Amylose content of rice (Pang, Ali, Wang, Franje, Revilleza & Xu 2016).

Local upland rice in Kupang Regency is likely to have high levels of amylose. As the result, if cooked will produce rice with a higher degree of efflorescence so that to produce more rice only requires less amount of rice. this result also has the same conclusion as the report by Jain, Sughosh, Sarika, Abhinav, Swapnil, Sanjeeb, Nishant, Ashish, Naisarg, Vibhav & Chitra (2012), who stated that the higher the Amylose content of rice, the more efflorescence the rice produced.

The texture of rice is also closely related to the amylose content in rice. The high amylose content in rice will make the rice produced has a high swelling volume, hard and dry texture. In fact, the lower amylose content will result in soft, sticky rice. The higher the amylose content of the rice, the less the texture of the rice and the lower the amylose, the fluffier the texture of the rice (Mardiah, Rahmi, Indasari & Kusbiantoro, 2016). Kupang local gogo rice which is thought to have high amylose content if it is likely to produce rice with a hard and dry texture.

An estimate of high amylose levels and also the non-glutinous properties of local upland rice based on iodine and alkaline tests, it can be assumed that upland rice contains anthocyanin compounds that function as antioxidants. The amylose content in both white and black rice also affects the content of antioxidant compounds, where the higher the amylose content, the higher the antioxidant compounds in rice (Setyaningsih, Hidayah, Saputro, Lovillo & Barosso, 2015).

The alleged high amylose content in local upland rice in Kupang Regency probably has a low glycemic index so it can be recommended for consumption by diabetics. This is in accordance with the report from Jain *et al.* (2012) and Septianingrum, Liyanan & Kusbiantoro (2016), that rice with high amylose levels tends to have a low glycemic index so it is recommended for consumption by diabetics.

In addition, local upland rice in Kupang Regency could also be used in the food industry because it is thought to have high amylose levels, thus it can be recommended for making various noodles. This is based on Sasaki (2018), who stated that high amylose content plays an important role in the formation of gel tissue and noodle structure. High amylose rice too needed as raw material for bread (Wahyuningsih, Dwiwangsa, Cahyadi & Purwani, 2015).

Water requirements for each variety of rice are different. This is due to the fact that water absorption is closely related to the amylose content of rice, the volume of water needed and also the increase in size and weight of rice. The greater the water absorption rate, the greater the volume of water needed to cook rice. In addition, the ability of rice to absorb water when cooked is also closely related to the increase in the size and weight of rice produced (Suhartini & Wardana, 2011; Thomas Wan-Nadiah & Bhat, 2013; Yadav, Malik & Yadav, 2016).

The result of observation on local upland rice in Kupang Regency which were boiled for 20 minutes at 80 ℃ shows that the highest water absorption is owned by local upland rice of 'Aen Muti Oenif' (50%) while the lowest water absorption is owned by local upland rice of 'Aen Lekes' (33%). Local upland rice in Nekemese District, Kupang Regency, has lower water absorption compared to Ende local upland rice, which has a water absorption capacity between 48-91% (Lalel *et al.* 2010).

Research on rice characteristics is needed for information on the quality and quality of rice. Information on the quality and quality of rice is also needed in an effort to utilize and manage the potential for rice germplasm, especially local rice. Rice with special and unique characteristics in terms of structure, texture and good compound content can be utilized in the food management industry, innovative food selection, meeting people's nutritional needs and in plant cultivation and breeding (Purwani & Wardana, 2018).

CONCLUSION

Local upland rice in Kupang has a variety of physical properties, namely weight, volume and density. The Iodine test results show that local upland rice in Kupang can be categorized in the regular or non-glutinous rice group. Alkali test results also show that the six samples of local upland rice have a high gelatinization temperature which indicates that local upland rice in Kupang Regency has a higher amylose content and is estimated to have a low glycemic index. Thus, it can be recommended for consumption for those who have high levels of dietary restrictions of blood sugar.

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