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Potential Storage Methods to Maintain the Quality of Local Bangka Rice Seeds

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ABSTRACT

The success of rice production is partly determined by the quality of the seeds used. The main challenge in maintaining seed quality is proper management to ensure that seeds remain preserved during storage. This study aims to evaluate the effect of storage methods on the quality of local Bangka rice seeds, as well as the chemical composition of the seeds after being stored for 8 months. The research period is from February to December 2024, conducted at the Seed Laboratory and Plant Breeding of the Bangka Belitung University. The study uses an experimental design of a Completely Randomized Design in a split-plot pattern. The first factor consists of 6 accessions of local Bangka rice (Mukot, Jawa, Ungu, Pulut Hitam, Balok Merah, and Mayang Hutan). The second factor consists of 7 storage media (cans, 40-micron plastic, 120-micron plastic, plastic sacks, plastic jars, seed trays, and panicles). Each treatment was repeated 4 times. The results show that the Balok Merah accession exhibited the best performance, supported by the highest maximum growth potential, germination rate, vigor index, uniformity of growth, and normal seedling dry weight, along with more consistent moisture content. The panicle storage medium showed the best results in maintaining seed quality during storage, supported by the highest maximum growth potential and germination rate. The best treatment combination was the storage with panicles of the Jawa accession, supported by germination rate and the highest maximum growth potential. Proximate analysis indicated that the highest moisture content, ash content, and protein levels were found in Balok Merah. The highest fat content was in the Pulut Hitam accession, while the highest carbohydrate content was in the Mukot accession. There was a strong positive correlation between maximum growth potential and germination rate.

Keywords: Accession; Germination rate; Seed preservation; Storage media; Vigor index

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INTRODUCTION

The Bangka Belitung Islands is one of the provinces in Indonesia with a high diversity of genetic resources. Agreeing with Kencana et al. (2022), the province of Bangka Belitung is known for its potential biodiversity, including rice plants. According to Mustikarini et al. (2019), Bangka Belitung has 26 local rice accessions that have been identified as part of the genetic wealth of rice in this region. Local accession rice is a variety that has adapted to the local environment and has important genetic value (Sitaresmi et al. 2013). Bangka local rice, as a superior variety, shows good adaptation, resistance to pests and diseases, and a distinctive taste (Mustikarini et al. 2019).

Improvement of local rice accession needs to continue to be developed to increase the diversity of existing accessions, so that it can produce quality seeds (Limbongan and Djufry 2015). Seed quality consists of genetic quality, physical quality, physiological quality, and pathological quality (Wahyuni et al. 2019). Genetic quality is in the form of superior traits inherited by the parent, physical quality can be seen in the morphological structure, physiological quality includes viability and vigor of seeds, and pathological quality can indicate disease and seed health (Febriani and Widajati 2015).

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The challenges in maintaining the quality of local rice seeds in Bangka vary greatly, especially in storage. Improper storage methods can lead to a physiological decline in seeds, which leads to a decline in growth power (Yuniarti et al. 2019). Some factors that affect seed deterioration include humidity, temperature (Pramono et al. 2019; Hidrawati et al. 2022), and storage duration (Triani 2021). Storage duration causes seeds to suffer damage caused by various factors, including seed early vigor, harvest process, and storage environment conditions (Kolo and Tefa 2016). The seed storage factor is an important aspect that greatly affects the quality of seeds, so it needs the right storage space and container (Sari et al. 2017). The use of appropriate storage containers can help slow down the decline in seed quality. A good storage container must be able to maintain the respiration and moisture levels of the seeds (Suhartanto 2013).

Farmers in Bangka Belitung typically use traditional storage containers, such as plastic sacks and burlap sacks, which are not airtight. Improper storage containers can cause rapid seed regression during the storage period (Anugraheni and Asngad 2018). Seed regression is usually characterized by reduced germination ability and decreased vigor. Agreeing with Kartika and Sari (2015), the vigor and viability of seeds will decrease as the storage duration increases. The use of the correct storage container is crucial in maintaining seed quality (Nurhayani and Wulandari 2019). Seed quality degradation during storage can be corrected by setting appropriate storage conditions and using the right storage containers (Yustisia and Arham 2022). Good storage of rice seeds will maintain the quality of the seeds for a certain period of time (Bista et al. 2022).

Storage of rice germplasm seeds in hermetic plastic bag packaging and plastic bags at a temperature of -5°C maintains their quality well (Maharani et al. 2022). The method of storing rice seeds using aluminum foil packaging and ethylene plastic sacks maintains the quality of rice seeds by keeping a moisture content of 11.63% (Suparto et al. 2021). Seed storage with panicles still showed good vigor and viability in several local rice accessions in West Bangka Regency for 8 weeks (Marini and Mustikarini 2024). The storage of rice seeds with panicles is a research topic that needs to be studied because panicles are part of the stem that contains cellulose, hemicellulose, lignin, starch, sugar, silicate (SiO2), and water that can be used as an energy reserve. Panicles contain key carbohydrates such as starch and sugar that play a role in the process of reshuffling food during storage (Roberts 2007). The protein content in rice can help maintain the quality of the seeds during the shelf life (Andesmora et al. 2019). This research is expected to contribute to the development of the local food system and ensure the availability of high-quality seeds for the future, while also helping to strengthen the local food system and increase food security in Bangka Belitung.

MATERIALS AND METHODS

Research activities will be carried out from February to November 2024. The research was carried out at the Seed and Plant Breeding Laboratory, Department of Agrotechnology, Faculty of Agriculture, Fisheries and Marine Affairs (FPPK), University of Bangka Belitung. The method used was a complete randomized design experiment split-plot pattern. The first factor consists of 6 local rice accessions consisting of Mukot, Jawa, Ungu, Pulut Hitam Balok Merah, and Mayang Hutan. The second factor consists of 7 seed storage methods, namely with panicles, without panicles, cans, 40micron plastic, 120micron plastic, plastic sacks and plastic jars. There were 42 experimental units that were repeated four times each, so there were 168 experimental units. The characteristics observed are in the form of maximum growth potential (%), germination power (%), normal germination dry weight (g), moisture content (%). In addition to these characters, chemical content measurements were carried out on seeds in the form of tests for ash content, fat content, protein content and carbohydrate content. Data analysis in this study used the F test (Fisher Test) at 95 and 99% confidence levels and continued with the Duncan's Multiple Range Test (DMRT) test with 95 and 99% confidence levels to determine the difference between treatments. Correlation analysis was carried out to determine the relationship between characters using the DSAASTAT application.

RESULTS AND DISCUSSIONS

The study on the physiological resilience of Bangka local rice accession seeds through storage method tests aims to understand how storage factors affect seed quality. The Stroge methodes used can be seen in the Figure 1. The results obtained provide an overview of the effectiveness of each accession and storage method in maintaining seed quality, which is expected to contribute to the development of optimal storage techniques for Bangka local rice seeds (

Table **1**).

The results of the various fingerprints show that the F value calculated in he table shows the character of maximum growth potential and germination power, showing a very real influence. Research shows that accession and storage methods affect the quality of seeds, depending on the length of storage. Early storage shows that accession affects genetic characteristics that favor germination and uniform growth. According to Zhou et al. (2020), seed storage capacity is determined by intrinsic genetic factors and extrinsic storage environment. Hussain et al. (2018), stated that accession selection can affect plant adaptability and productivity. Agreeing with Limbongan and Djufry (2015), local rice accession has unique characteristics that affect plant productivity. Bewley and Black (1994), stated that genetic characteristics affect the seed quality of a plant at the beginning of storage. Optimal storage conditions, such as low temperatures and controlled environmental humidity, can affect the growth rate and increase the dry weight of the sprouts. According to Copeland and McDonald (2001), the right temperature and humidity can maintain the viability of the seeds well. Storing seeds under low temperatures can extend the storage life of seeds, while high temperatures accelerate respiration so as to accelerate changes in food reserves in seeds which have an impact on decreasing the viability and vigor of seeds. According to Bueso et al. (2014), the ability of seeds to maintain viability during storage, is influenced not only by their genetic makeup but also by the storage environment. Agreeing with Abadía et al. (2024), the quality of seeds decreases during storage depending on relative humidity, temperature, and oxygen concentration.

Seed quality greatly affects seed growth and vigor (Ningsih et al. 2018). Seed physiology refers to the internal conditions of seeds that involve biological and chemical processes that affect the ability of seeds to germinate and grow (Kamil 1982). Processes, such as metabolism and enzyme activity, are greatly influenced by internal (such as seed genetics) and external (temperature, humidity, and moisture content) factors (Hanum et al. 2022). Seeds that experience physiological decline, due to storage, will experience a deterioration in quality. According to Saenong et al. (1999), seed regression is a decline in the physiological quality of seeds, resulting in a decrease in seed viability. According to Singh et al. (2018), the purpose of conducting a germination test is to determine the level of likelihood of seeds capable of germinating from a group or unit of seed weight. Germination power in seeds is influenced by water content to trigger physiological activity in seeds. The average character to the accession treatment during storage is presented in Table 2.

The storage method was tested to assess its effect on the physiological resilience of local rice seeds in West Bangka. Seven storage methods used show variation in yields in maintaining seed quality during the storage period. Some storage media proved to be more effective in maintaining the viability and vigor of the seeds, while others showed a significant decline in quality over time. The results showed that the length of storage life with different storage methods had an effect on several observed characters. Bangka local accession rice seeds stored for 8 months showed significant differences in the average range compared to the initial condition of the seeds before storage.

(a) (b) (c) (d) (e) (f) (g)

Remarks: (a) Jar, (b) Can, (c) Plastic 40micron, (d) Plastic 120micron, (e) Sack, (f) Whitout panicles and (g) With Panicles

Figure 1. Variousseed storage methods

Table 1. Analysis of the effect of accession, storage method and combination of the two on test characters during 8 months of storage

Characters	Accession		Storage Methods		Interaction		CV
	F-Cal.	Pr>F	F-Cal.	Pr>F	F-Cal	Pr>F	(%)
Maximum Growth Potential (%)	9.40	0.00**	74.03	5.41**	2.65	0.00**	15.70
Germination Power (%)	6.39	1.33**	100.41	1.11**	1.90	0.00**	12.83
Germination Rate (days)	1.06	0.38tn	0.38	0.31tn	1.22	0.07tn	09.27
Moisture Content (%)	0.67	0.20tn	4.17	0.00**	2.02	0.00*	26.35
Vigor Index (%)	1.96	0.13tn	101.25	5.04**	2.08	0.00**	24.99
Evenness Growing (%)	4.79	0.00**	96.56	4.35**	2.23	0.00**	23.58
Normal Sprout Dry Weight (g)	1.35	0.28tn	38.24	1.38**	3.44	1.36**	8.96

Remarks: Pr>F = probability value, ** = very real effect * = real effect, tn = intangible effect, CV = Coefisience of variation

Table 2. Average characters on the access treatment over 8 months of storage

Characters	Accession						Standar Error	Sig.
	Balok Merah	Jawa	Mayang Hutan	Mukot	Pulut Hitam	Ungu		
Max. Growth Potential (%)	73.00b	79.00a	72.60c	69.10d	65.57e	62.82f	1.88	9.40
Germination Power (%)	47.64d	61.28a	51.50b	49.32c	44.78e	43.75f	2.51	6.39
Germination Rate (days)	3.71a	3.32a	5.56a	3.78a	3.82a	3.75a	0.76	0.41
Moisture Content (%)	7.61a	10.64a	6.52a	10.23a	10.95a	8.85a	2.18	0.67

Vigor Index (%)	41.82a	50.60a	44.10a	39.25a	34.53a	38.53a	3.93	0.01
Evenness Growing (%)	44.92d	56.21a	49.07b	45.39c	38.67f	41.64e	2.79	0.00
Normal Sprout Dry Weight (g)	0.08a	0.15a	0.12a	0.10a	0.07a	0.06a	0.02	1.35

Remarks: Numbers followed by the same letter on the same line show no significant difference based on the 99% confidence DMRT test

The results showed that the length of storage life with different storage methods had an effect on several observed characters. Bangka local accession rice seeds stored for 8 months showed significant differences in the average range compared to the initial condition of the seeds before storage. This proves that, the longer the seeds are stored, the vigor and viability of the seeds will decrease and can even be damaged. According to Mustakim et al. (2020), the best storage time is for 2 months, where in this period the highest germination power and growth potential are recorded, as well as faster germination time. Anna (2017), suggested that the storage period of rice seeds that can increase the viability and vigor of seeds is about 3 months. The average character in the treatment of storage methods during the storage life is presented in Table 3.

Seed storage is an important step to maintain the quality and physiological durability of seeds over a long period of time. Seeds that are well stored and do not suffer mechanical damage will have better germination potential. Wang et al. (2022), also revealed that, extreme temperatures, either too high or too low, can inhibit the germination process. Table 3 shows that the storage method has a significant influence on the growth character.

Storage media with cans and panicles gives the best results on the character of maximum growth potential and germination power. Seed germination and dry weight of normal germination are the benchmarks of seed viability (Febriani and Widajati 2015). In contrast, storage methods such as 40-micron plastic and sacks show lower yields, especially after longer storage periods. Bradford et al. (2020), conventional seed packaging materials including polypropylene, burlap and porous cloth bags are ineffective at preventing seeds from moisture absorption and damage. This shows the importance of selecting appropriate methods to maintain the quality of seeds during storage. Agreeing with Wang et al. (2019), a good storage medium can maintain moisture and prevent mechanical damage to seeds.

The DMRT results at the level of 1% showed that the storage method produced the highest germination power, which was 82.27%, in storage with panicles. Marini and Mustikarini (2024), seed storage with the malai method still shows good vigor and viability in several local rice accessions in West Bangka Regency for 8 weeks. The panicle method takes advantage of natural conditions, such as relatively stable temperature and humidity in an enclosed and isolated room (Suparto et al. 2021), which can help maintain seed quality. Mobolade et al. (2019), stated that traditional storage methods can better maintain some of the quality of seeds if carried out according to the right procedures. The way seeds are stored varies greatly depending on the type of seeds, the number of seeds, the packaging technique, the duration of storage, as well as temperature and humidity. Correlation analysis provides important insights into how plant characteristics are interrelated and affect the final yield. Positive correlations indicate mutually supportive interactions between certain characteristics, while negative correlations indicate no relationship between these characteristics. The correlation analysis data between the tested characters can be seen in Table 4 and Table **5.**

The shelf life of 8 months of the character of maximum growth potential has a perfect correlation with the character of germination power and moisture content with values of 0.942 and 0.935 respectively. The germination power character has a perfect correlation with the moisture content character with a value of 0.978. The correlation analysis between the characters in tables 5 to 6 shows a strong relationship between maximum growth potential and germination power. This shows that seeds with high growth potential tend to have good germination. However, there are also some characters that show negative correlations, such as the dry weight of normal sprouts which is negatively correlated with germination power. A high correlation value (≥0.6) indicates that seeds with high growth potential tend to have good germination. This gives implications that the selection of accession with high growth potential can increase the expected yield. However, some characters show negative correlations. For example, the dry weight of normal sprouts was negatively correlated with germination power. This suggests that seeds that have a higher normal germination dry weight may experience a decrease in germination, possibly due to sub-ideal conditions during storage.

Table 3. Character average on storage method treatment over 8 months of storage

Characters	**Storage Methods**								
	By Panicle	**Tin**	**Sack**	**120 µplastic**	**40 µ plastic**	**Tub**	**Jars**	**Standar Error**	**Sig.**
Max. Growth Potential (%)	87.2a	65.0e	86.6b	35.5g	56.0f	85.4c	76.4d	2.25	74.0
Germination Power (%)	71.2b	33.5d	71.1b	14.8f	30.2e	72.3a	54.5c	2.34	100.4
Germination Rate (days)	4.0a	4.0a	3.7a	4.2a	4.1a	3.6a	3.9a	0.23	0.45
Moisture Content (%)	6.8c	12.0b	13.5a	4.5d	8.0e	12.1b	4.8d	1.84	0.01
Vigor Index (%)	58.7c	26.7e	63.1a	10.7g	22.9f	62.b	45.3d	2.22	0.04

Evenness Growing (%)	65.1c	31.7e	66.5b	13.6g	27.5f	67.1a	50.2d	2.21	0.01
Normal Sprout Dry Weight (g)	0.4c	0.2d	0.4a	0.1e	0.2d	0.4b	0.2c	0.02	38.2

Remarks: Numbers followed by the same letter on the same line show no real difference based on the DMRT test of 99% confidence level

Table 4. Correlation between characters on 0-month storage

	MGP	VI	EG	NSDW	GR	MC
MGP	1					
VI	-0.08	1				
EG	0.57	0.60	1			
NADW	0.45	0.11	0.50	1		
GR	0.81	-0.31	0.35	0.63	1	
MC	-0.14	-0.55	-0,53	-0.25	-0.18	1

Remarks: Correlation value 0.00-0.20 (no correlation); 0.21-0.40 (weak correlation); 0.41-0.60 (moderate correlation); 0.61-0.80 (strong correlation); 0.81- 1.00 (perfect correlation). The (-) sign at the beginning of the number indicates that the negative correlation value that the relationship between characters is inversely proportional, while the (+) sign at the beginning of the number indicates that the positive correlation value that the relationship between characters is unidirectional. MGP= maximum growth potential, VI= vigor Index (%), EG= evenness growing (%), GR= growth rate, MC = moisture content, NSDW = dry weight of normal sprouts.

Table 5. Correlation between characters on 8-month storage

	MGP	VI	EG	NSDW	GR	MC
MGP	1					
VI	0.93	1				
EG	0.94	0.99	1			
NADW	0.73	0.78	0.77	1		
GR	0.61	0.49	0.55	0.32	1	
MC	-0.33	-0.21	-0.25	-0.10	-0.41	1

Remarks: Correlation value 0.00-0.20 (no correlation); 0.21-0.40 (weak correlation); 0.41-0.60 (moderate correlation); 0.61-0.80 (strong correlation); 0.81- 1.00 (perfect correlation). The (-) sign at the beginning of the number indicates that the negative correlation value that the relationship between characters is inversely proportional, while the (+) sign at the beginning of the number indicates that the positive correlation value that the relationship between characters is unidirectional. MGP= maximum growth potential, VI= vigor Index (%), EG= evenness growing (%), GR= growth rate, MC = moisture content, NSDW = dry weight of normal sprouts.

CONCLUSIONS AND SUGGESTIONS

Conclusions

Balok Merah accession showed the best results, supported by the character of the highest maximum growth potential, germination power, and dry weight of normal sprouts, and more consistent moisture content. The storage method with panicles showed the best results in maintaining the quality of seeds during storage, supported by the character of the highest maximum growth potential and germination power. Proximate analysis showed that the highest moisture content, ash content and protein content were found in the Balok Merah. The highest fat content in the accession of Pulut Hitam Rice. Highest carbohydrate levels at Mukot accession. There is a strong positive correlation between maximum growth potential and germination power.

Suggestions

West Bangka local rice accession in the form of Balok Merah can be stored for 8 months. The use of effective storage methods, such as panicles or airtight packaging (cans), can be applied by farmers and the public in storing Bangka local rice accession seeds to maintain seed quality. Further research is needed to explore other storage methods with various local rice accessions in Bangka to support agricultural productivity in Bangka Belitung.

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