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Original Research Article

Evaluation of Physical Quality Characterization MRQ 107 Parboil Rice Production Using Selected Parameter

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Abstract: Rice (Oryza sativa L.) is a significant source of nourishment in most Asian countries since it is a primary source of carbohydrates, micronutrients (Fe and Zn) and vitamins, offering broad prospects for food and nutritional security. MARDI's variety, namely MRQ 107, was chosen for producing parboiled rice using the Response Surface Methodology (RSM) technique at different soaking hours (2, 4 and 6) with steaming time at intervals of 15, 30 and 45 mins with hot water temperature 70ºC and 75ºC. The results have shown that parboiled rice of MRQ 107 process at selected parameter consistently has produced a high milling percentage in the 69-70% range with conversion to Head Rice Yield (HRY) in the range 84%-97%. This finding shows that good quality MRQ 107 parboiled rice can be produced through the parameters selected with a recovery of a high percentage of rice heads (head rice) and has the potential to resolve the economic losses to millers from losing out due to a high rate of broken rice especially during parboiled rice processing.

Keywords: milling; Head Rice Yield; broken rice; MRQ 107; temperature

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1. Introduction

Rice (*Oryza sativa* L.) is a staple food for most countries in Asia, especially in Southeast Asia (FAO, 2018). Generally, rice is mainly consumed as polished rice flour in rice-based products (Maria *et al.*, 2021). Regular processing to produce rice has converted the brown rice to polished white rice, eliminating the bran and germ from the underlying endosperm. This polishing stage has removed a large share of polyphenols and vitamins, thus deteriorating the nutritional value of polished rice compared with brown rice (Babu *et al.*, 2009). This led to the development of the parboiling process to increase the nutritional quality of rice by increasing the value of Vitamin B and fiber instead of enhancing the storage stability of rice (Heinemann *et al.*, 2005; Oli *et al.*, 2014). Parboiling is a hydrothermal process consisting of various stages of soaking, steaming, and drying, impacting rice quality (Behera & Sutar, 2018). Parboiled rice is categorized as health-added rice, which is now one of the healthy diet choices of Malaysians. This is due to lifestyle changes and public awareness towards healthy food that initiated parboil rice as a new alternative daily diet, especially for those with diabetes (Nik Rahimah *et al.*, 2020).

Furthermore, an increase in the population's socioeconomic status in Malaysia also contributed to the rise in demand for parboiled rice and other similar rice. According to statistics in 2015, the country imported 18,582 metric tons of parboiled rice to meet the needs of consumers in Malaysia (Jabatan Pertanian Malaysia, 2015). In addition, Malaysia also exported 2,347 metric tons of well-milled rice. The world's encouraging demand for boiled rice, with the average trade value increasing every year, opens up opportunities for the country to increase the production of cooked rice with high health value. Investigation on the physical characterization of MRQ 107 parboil rice, including milling recovery, head rice yield (HRY) and broken rice, was determined by using selected processing parameters.

2. Materials and Methods

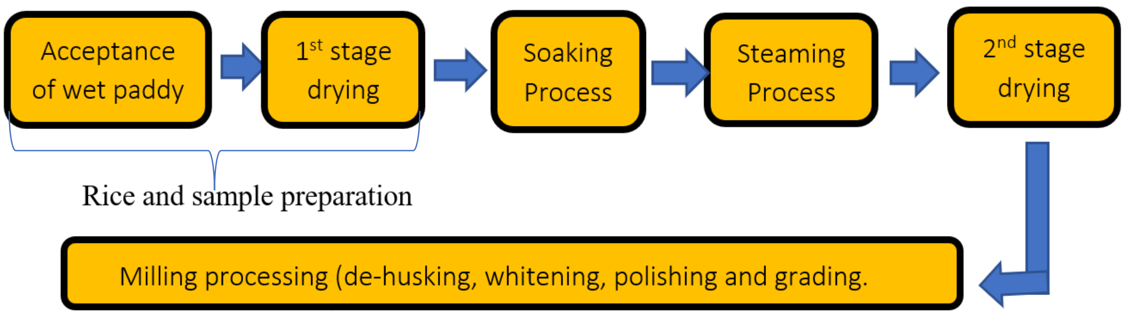

Figure 1. Experimental methodology in the study on evaluation physical quality characterization mrq 107 parboil rice production using selected parameters

Flow chart 1 has simplified the methodology involved in this study. It involved six stages, from rice and sample preparation to determining the physical characterization of MRQ

107 from the milled parboiled rice. The detailed methodology for each step is described below.

2.1. Rice and Sample Preparation (Acceptance and 1st Stage Drying)

Specialty Variety Rice (MRQ) 107 were obtained from a research plot in Sanglang Perlis. Harvested paddy was dried in a cabinet dryer at an ideal temperature of 45°C until its moisture reached a superior humidity of 12–13.5 (% M.C), suitable for storage and further processing.

Figure 2. Drying process of MRQ 76 using cabinet dryer

2.2. Soaking Process

Three (3) replicate samples with 135 g of MRQ 107 rice were prepared using a water bath for this process. Each selection has been soaked using temperatures 70ºC and 75ºC for selected interval times of 2, 4, and 6 hours.

Figure 3. Soaking process of MRQ 107 using a water bath

2.3. Steaming Process

Three (3) replicate samples of MRQ 107 from the previous soaking process have undergone the steaming process by using an autoclave at a temperature of 110ºC with interval steaming time consisting of 15 minutes, 30 minutes and 45 minutes as these parameters selected based on previous preliminary studies.

Figure 4. Steaming process of MRQ 107 using autoclave at 110ºC

2.4. Second Stage Drying

The paddy that has been through both processes of soaking and steaming undergoes 2nd stage drying using a similar setting (as stage 1.1) at 45ºC in a cabinet dryer until the moisture reaches 12–13.5% MC before being stored.

2.5. Milling Processing

The dried MRQ 107 paddy has to be the milling process to produce parboiled rice. The milling process involves various stages, such as de-husking, whitening, polishing, and grading.

2.5.1. Dehusking

The dehusking or dehulling process was done using the SATAKE Rubber-Rolls THU-35A type (Japan) Lab Scale Dehusking Machine (Figure 4) to remove the husk from the paddy. The husk is removed by applying friction from the contact of two abrasive surfaces as the paddy grains have passed that area (Kaddus Miah *et al.,* 2002; Dhankar & Hissar, 2014). The removal husk will produce brown rice and separate the husk in the container, respectively.

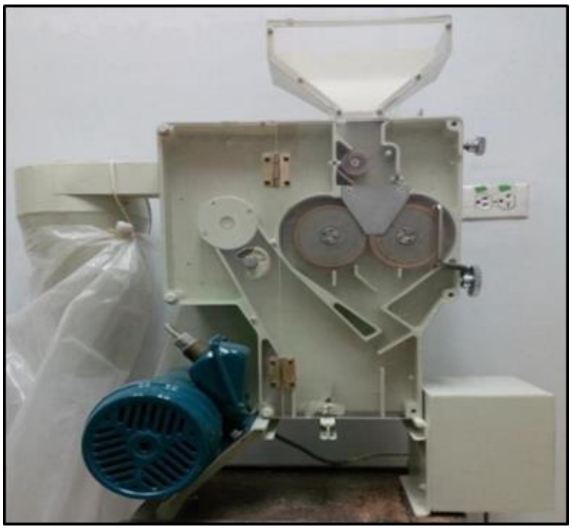

Figure 5. Lab scale SATAKE (Japan) Dehulling Machine

2.5.2. Whitening and polishing

This process aims to remove the bran layer and the germ from the paddy. This process involves using the SATAKE Testing Mill (Japan) Polisher Machine (Figure 5), where the bran layer is removed from the kernel due to contact between the paddy and the abrasive and friction polishers. There is a possibility of the production of broken grains during the process. Hence, the rice is typically fed to the polisher machine at least twice to prevent or reduce the number of broken rice.

Figure 6. Lab scale SATAKE (Japan) Whitener/Polisher Machine

2.5.3. Grading

The 100-gram polished rice will be separated into head rice, large and small broken rice using a SATAKE (Japan) Cylindrical Grading Machine (SATAKE TRG05B), as shown in Figure 6. The separation operation is done for 2 minutes. The cylinder size used for the head rice is 4.75, while rough broken rice is 3.75. The percentage of head rice yield can be calculated from the equation below:

$$\%\ \text{Head Rice Yield} = (\ \text{Total head rice} \ /\ \text{total milled rice}\ )\ \text{x}\ 100 \quad (1)$$

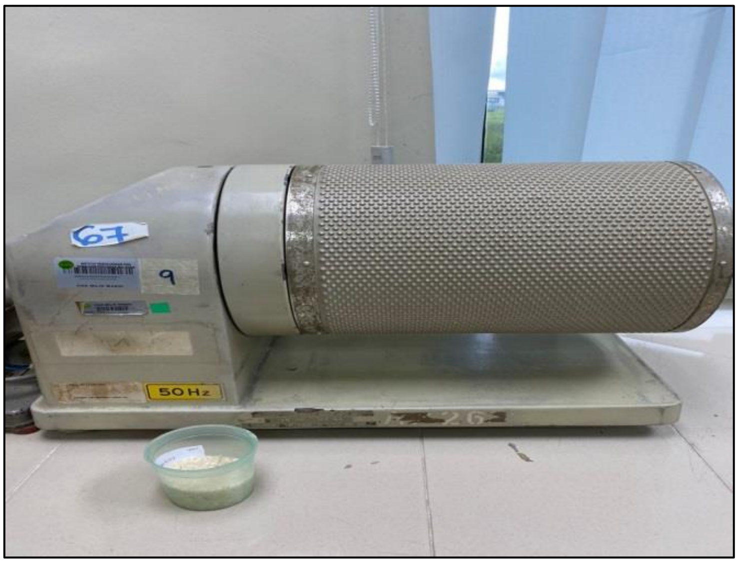

Figure 6. Lab Scale Cylindrical Grading Machine

3. Results and Discussions

Table 1. Physical Characterization of MRQ 107 Parboil Rice

Temperature °C/ Soaking Time (hours)	Steaming Time (min)	70			75		
		Mill Rice (%)	HRY (%)	Broken Rice (%)	Mill Rice (%)	HRY (%)	Broken Rice (%)
2	15	69.84± 0.06	83.96± 10.83	16.04± 10.83	70.43± 0.17	95.81± 1.36	4.19± 1.36
	30	69.26± 0.17	87.70± 0.77	12.30± 0.77	69.74± 0.21	97.17± 0.79	2.83± 0.79
	45	69.27± 0.60	96.76± 0.60	3.24± 0.60	70.07± 0.02	97.51± 0.41	2.49± 0.41
4	15	69.36± 0.44	96.62± 0.76	3.38± 0.76	69.93± 0.84	96.33± 0.15	3.67± 0.15

Temperature ºC/ Soaking Time (hours)	**Steaming Time (min)**	**70**			**75**		
		Mill Rice (%)	**HRY (%)**	**Broken Rice (%)**	**Mill Rice (%)**	**HRY (%)**	**Broken Rice (%)**
	30	70.02± 0.11	96.63± 0.36	3.37± 0.36	69.50± 0.17	97.22± 0.21	2.78± 0.21
	45	69.24± 0.60	96.64± 0.28	3.36± 0.28	70.49± 0.31	96.99± 0.24	3.01± 0.24
6	15	68.60± 0.26	96.82± 0.82	3.18± 0.82	69.78± 0.08	96.14± 0.51	2.22± 0.08
	30	70.09± 0.32	97.31± 0.17	2.69± 0.17	69.86± 0.03	97.08± 0.35	2.92± 0.35
	45	69.59± 0.21	96.64± 0.26	3.36± 0.26	69.73± 0.42	95.61± 0.46	4.39± 0.35

Based on Table 1, for a soaking time of 2 hours with a water temperature of 70ºC, there is no difference between the percentage of mill rice for a steaming time at 15, 30, and 45 min since it recorded milling percentage at 69%. However, the percentage of HRY exhibited an increment trend from 15 min, 83.96% with broken 16.04%, then increased to 87.70% HRY (with broken 12.30%) at 30 min before it reached the highest HRY conversion of 96.80% (with broken 3.24%) at 45 min. For water temperature at 75ºC, using steaming time for 2 hours has shown a consistent mill rice percentage at 70% with high HRY conversion in the range of 95-98% with broken percentage within 2.5–4% for each duration for the steaming process. Extension the soaking time to 4 hours; water temperature selected at 70ºC and 75ºC has shown a similar pattern of rice mill percentage for each wet time interval (15, 30 and 45 mins) with 70% conversion. A similar trend to the rice mill, the HRY also exhibited consistent results with a range of HRY at 96–97% with broken percentages in the 3–4% range.

Further extension of soaking time to 6 hours also did not contribute to any differences in the physical characterization of MRQ 107 parboil rice at different steaming time intervals. It has shown that the mill rice has recorded in the range of 68–70%, with the percentage of mill rice at 95–97% with broken rice percentage in the field of 5–7%. As this result was determined, it explained that the soaking process of rice in a selected temperature and time that has been implemented can assist in increasing the hardening of the kernel instead of encouraging the permeability of nutrients across the hull to the surface of rice (Behera & Sutar, 2018). Moreover, the steaming process time stabilizing the kernel also led to more nutrient absorption. Furthermore, the steaming process targets fully gelatinizing the starch, sealing fissures in the kernel endosperm that might otherwise break apart during milling. Thus, this resulted from stronger kernels that generally remain intact during the rigours of milling, thereby increasing HRYs (Martha, 2009). Therefore, both processing involved in this study has the potential to assist in reducing the risk and possibility for broken rice to occur during the milling process.

5. Conclusions

In conclusion, the results have shown that parboiled rice of MRQ 107 process at the selected parameter involved in this study has produced a high milling percentage in the 69-70% range with conversion to Head Rice Yield (HRY) in the 84%–97% range. Applying the selected parameter also resulted in the potential to resolve the problem of highly broken rice, which is frequently associated with parboiled rice production.

Author Contributions: The author has involved in the development parboil rice and characterization of rice quality.

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Conflicts of Interest: The authors declare no conflict of interest.

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