Comparative Study of Three Rice Brands’ Quality through Measuring Broken Rice Percentage using Sortex A ColorVision (Buhler) Optical Sorters

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Abstract. This study is focusing on comparing three rice brands quality in determining the percentage of broken rice by using the ejection system method. Broken rice is referred to rice grains broken into smaller pieces in length and could adversely impact rice quality and marketing price. Generally, conventional methods using micrometers to separate broken rice from normal rice are used to determine broken rice percentage. However, these methods are laborious and time-consuming. Therefore, this study was set to employ an ejection system method by using Sortex A ColorVision optical sorter machine to compare the quality of three rice brands (Jati, Cap Rambutan and Faiza Emas) in terms of their broken rice percentages. The broken rice ratios were measured three times and expressed as average values. The Sortex A ColorVision optical sorter could deliver an acceptable efficiency in optical sorting. The sorter uses up to two types of visible wavelengths, where it allows for excellent detection by color, shape, and length of an object. Hence, the Sortex A ColorVision could successfully determine the percentage of broken rice. According to the results obtained, among the three rice brands investigated only Faiza Emas rice brand was found to meet the requirements set forth by the government of Malaysia for broken rice percentage which is the maximum of 5% for packed rice. While the broken rice percentage in Cap Rambutan and Jati rice brands were stood at 7% and 13%, respectively. As a conclusion, the Sortex A ColorVision Optical machine sorting rice was found as a rapid reliable method to determine broken rice percentage and to compare commercial rice brands on the market.

Keywords: Broken Rice; Rice Classification; Image Processing; Rice Grading

1. Introduction

Paddy (Oryza Sativa) is a staple food for Asian people including Malaysian. Rice has been the second important crop production in the world, where Asia has been the biggest buyer and producer [1].

In Malaysia, rice is still the most important staple food although the demand has been declined due to modernization that offer variety of other foods [2] from other grains like wheat and corn. Hence, the rice production needs to be expanded and enhanced to ensure Malaysia have enough stock of rice in a long run since only 7% of rice production in the world had traded [3].

There are a few local brands that offer their own uniqueness based on physical characteristics and quality that come with different prices. The demand for a better quality of rice by consumers was increased [2]. However, quality assessment of rice grain is hard since it associates with a lot of parameters and processes [4].
Physical rice grain structure is one of the components used in grading rice which involves the identification of head rice and broken rice. Conventional method has been using micrometers to separate broken rice from normal rice to determine broken rice percentage. A new method of image eject processing technique has been developed to detect and identify the head and the broken rice based on its physical properties such as area, perimeter, shape, and length of rice [5].

Padiberas Nasional Berhad (BERNAS) has classified rice quality into three classes, which are standard, premium and super. Standard contains more than 45% of broken rice and may contain 100% defect grain. For premium class, it contains more than 45% of broken rice as well but the defect grain should not over than 2%. Meanwhile, super class can be divided into three classes, which are Super Tempatan with 15% broken rice, Super Special Tempatan 10% (contains 10% of broken rice) and Super Special Tempatan 5% (contains 5% of broken rice) [5]. The percentage of broken rice will determine the selling price of the grain in the market. Hence, this study was conducted to employ an ejection system method by using Sortex A ColorVision Optical Sorter Machine in order to determine the percentage of broken rice of local rice brand in Malaysia to determine whether the local rice meets the specific grading criteria that has been set by the government.

2. Methods
The Machine Sortex A ColorVision Optical Sorting in Fig. 1 was used in sorting rice as a method of identifying and determining the percentage of broken rice. Three brands of local rice, which are Cap Rambutan, Faiza Emas and Jati have been used in this study. The operator poured the rice manually before it conveyed into vibrator tray to deliver the products to chutes.

![Figure 1. The Sortex A ColorVision Optical Sorting machine](image-url)

2.1. Mechanics
This machine is designed to detect and remove contaminants using advanced proprietary inspection system. This machine has broadband LED lighting featuring SmartEject™ technology by detecting colour defects, material types, shape and size of grains. The machine is equipped with touch screen graphical user interface (GUI) and showing model number and serial number, current working mode, machine status, feed rate and ejector rates. It also has buttons to enable/disable the machine, calibration and help.

This machine consists of three cameras which two of them located in front of the machine and one is inside the back of the machine. The functions of the cameras are to capture the image need to eject by the ejector of the machine by following the shape that required ejecting.

2.2. Digital Camera Scanning
The overall flow of determining the percentage of broken rice using this machine is shown in Fig. 2. Firstly, the accept samples of rice grain were selected to be scanned. In this process, 10 pieces of rice
samples for three rice brands were put through the chutes of the machine to measure the shape, size, length and area in process ejecting the rejected rice. The rejected rice known as broken rice.

The camera scanned the rice into two categories, which are dropping the broken rice at chutes manually with 10 pieces of rice as rejected rice and then drop 10 pieces of the non-broken rice as accepted rice. The rice samples need to drop one by one for camera scanning.

The calibration was done with medium speed of 50ms⁻¹ of air force from compressor. The function of the compressor is to maintain the area in a machine in dry condition and reduce the error in collecting data. The functions of vibrators are to move the rice slowly one by one through the chutes part and drop into the sorting cart.

**Figure 2**: The flow to determine the percentage of broken rice

2.3. **Image Segmentation**

The length and the shape of rice especially the head of rice are among important characteristics in determining broken rice. The data generated automatically by the machine as shown in Fig. 3 with their perimeter, length, area, width, and shape. The maximum length of rice that the camera can detect is 1.5cm.

The area is used in the ejection system to reject the selected rice. The area was influenced by the length of rice to measure the distance ejection of rice between rice. The bigger the area in the ejection process is good to ensure all reject rice is ejected accurately and efficiently.

**Figure 3**: The attributes are displayed in the control screen

2.4. **Threshold**

The process of thresholding is to classify the rice with accepting and reject depends on the physical properties of rice. Before the process of thresholding begins for replication, rice detection needs to wipe the chutes to ensure the area in the chutes are clear from unknown object or any leftover from previous use. The wipe access is helping by the air pressure from the compressor.

The maximum capacity for this machine is 10kg. In this project, the capacity used to determine broken rice is 5kg per bag of three local rice brands. Rice samples poured into the hopper and then justify the rice at vibrator tray to ensure all pieces of rice are going through the chutes.
3. Results and Discussion
The classification of rice from thresholding process is divided into three types, which are reject (broken rice), accept (non-broken rice) and spillage. Accept rice in this project known as “pure rice” or “not broken rice”. Spillage is an item of rice that was out from the chutes or missed out during rice ejection process during thresholding. The particle classifier uses feature vectors (area) to identify samples based on their shape and length.

During the first thresholding, the amount of broken rice at the reject cart needs to be put into the hopper again in order to get the accurate amount of broken rice. In this project, the amount of broken rice was put into the hopper for further thresholding twice for all brands. Missed out rice does not have a bigger amount to calculate because it just missed out during process ejection of broken rice. The amount of missed out rice was about one to 10 pieces of rice. Missed out rice was classified manually as reject or accept rice.

The result of reject rice is shown in Table 1. To determine the percentage of broken rice, the average of reject rice was divided by the total weight of rice and multiplied by 100. The highest weight of broken rice of three rice brands is Jati with 673.45 gram per bag or 13.5% of broken rice. Among the three brands, only Faiza Emas has met the requirement of selling 5% broken rice as displayed on the packaging which follows the rules and laws in rice marketing. Among the brands used, the highest of pure rice is Faiza Emas because it has only 5% of broken rice compared to Jati and Cap Rambutan where they are got higher than 5%. Faiza Emas was indicating the purest rice among the three brands. While Cap Rambutan brand has average of 358.16 gram of broken rice or 7.2%.
Table 1. The weights of reject rice for each tested brand

| No | Rice Brands   | Replication 1 | Replication 2 | Replication 3 |
|----|---------------|---------------|---------------|---------------|
| 1  | Jati          | 650.45 g      | 620.88 g      | 673.45 g      |
| 2  | Cap Rambutan  | 353.38 g      | 375.35 g      | 345.75 g      |
| 3  | Faiza Emas    | 256.93 g      | 265.55 g      | 263.85 g      |

The percentage of broken rice was shown in Fig. 4 it is based on the weight of broken rice of every tested rice brand in Malaysia. When comparing with Faiza Emas brand, Jati brand has the biggest gap of broken rice in the packaging with 7.5% while the difference between Faiza Emas and Cap Rambutan is only 2.2%.

Figure 4. Mean percentage of broken rice

4. Conclusion
As a conclusion, the Sortex A ColorVision Optical Sorting Rice machine has been proven to be very useful to separate the pure rice from the broken rice for rapid screening of commercial rice brands in Malaysia. The percentage of Jati and Cap Rambutan brands has exceeded the limit of 5% broken rice that has been set in the marketing rules of rice in Malaysia. However, this study is not considering the handling methods applied during transporting and storing which may strongly affect the final rice conditions. Hence, further study must include the external factors that may contribute to broken rice.

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