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Effect of moisture content and drying method on the amylose content of rice

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Abstract. Rice is a primary source to all human beings. It gives energy and supply carbohydrate in human daily life. It is also one of the main sources of employment for people living in the rural area to generate incomes. In this study, determinations of quality of rice dried in an oven and in a Laterally Aerated Moving Bed (LAMB) dryer were performed., tTe drying in an oven was performed with initial moisture content (MC) of 18% reduced to 14% w.b. at temperatures of 35, 45, 55, 65 and 75 0C. The amylose contents of the rice were 20.78, 21.81, 21.53, 21.63 and 22.50 %, respectively. Furthermore, drying of paddy with temperature of 45 0C and initial moisture content of 15 % w.b was performed with different final moisture content of 14, 12, 10 and 8 % w.b using oven drying. The amylose content were 21.79, 20.17, 20.85, 26.35 %, respectively. As for paddy dried in LAMB dryer, it was found that the amylose content were in the intermediate range (20 – 25.50 %). The drying temperature of the LAMB dryer was at 25 0C with 100 to 200 L/min of air flowrate resulted in the intermediate amylose content of the rice despite the final moisture content reduced to 8 % w.b.

1. Introduction

Rice is a primary source to all human beings. It gives energy and supply carbohydrate in human daily life. It has been consumed by larger amount of people on Earth. Besides, it is also one of the main sources of employment for people living in rural area to generate incomes. Rice quality can be divided into two types of characteristics, which are physical and chemical characteristics. Basically, the differences of physical and chemical characteristics might change the consumers’ acceptability in terms of few properties such as its colour, shrinkage, nutritional substances, rehydration capability and microstructure [1].

The determination of rice quality is depending on their physical and chemical characteristics. Both of these characteristics may define how well the quality of the rice that has been produced. Based on the physical characteristics, the physical analysis of the rice will be evaluated based on its dimensions, chalkiness, colour and Head Rice Yield (HRY) or known as whole grain percentage. Whereas, in chemical characteristics is to indicate the rice is cooked very well as its texture and

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hardness when eaten. The chemical characteristics could be indicated by performing few analysis such as Amylose Content, Gelatinisation Temperature, and Gel Consistency [2].

Harvested paddy usually contains the moisture content in between 20-25% w.b and it must be dried until it reaches the optimum MC around 12-14% for long storage condition[3]. According to the study by Wiset et al. [4], they had stated that the drying conditions of paddy may affect some of the sensory quality and its processing quality that may affects the consumer acceptability. Besides, a study from Cnossen et al. [5] has showed that, the high drying and tempering temperature are correlated to HRY. According to the researcher, the kernels of the rice may fissure during the drying process. If severe drying occurs it may cause the increasing number of kernels that fissured after drying [5].

Therefore, thorough out this study the effectiveness evaluation based on the rice quality of the Laterally Aerated Moving Bed (LAMB) dryer has been performed. This study will focus on the analysis of amylose content for paddy of PR1 variety that will be dried in LAMB Dryer System and using Oven MERMMET in order to understand the eating and cooking quality.

2. Materials and methods

2.1. Materials

Paddy (PR1) from Papar, Sabah was selected as the raw material for this experimental. The harvested paddy with initial moisture content about 18 – 22% w.b was initially determined by using the moisture analyser (Sartorius model MA35) with readability of 0.01%, Commercial Rice (Local Rice), 95 % Ethanol, 1M Sodium Hydroxide, 1M Acetic Acid, Iodine-Potassium Iodide, Amylose from Potato (SIGMA – ALDRICH) and Distilled Water.

2.2. Experimental design

2.2.1. Determination of Amylose Content

The amylose content was determined according to method from Haqim et al. [6]. 0.1 g of grinded rice was added into 100 mL of volumetric flask. 1.0 ml of 95% of Ethanol and 9.0 mL of NaOH was added into the 100 mL volumetric flask. The sample was shaken well and was boiled over the shaking water bath (BS-31) for 10 minutes. After that, the solution was cooled and was made up to 100 mL using distilled water.

Next, 5 mL from the 100 mL sample was pipetted out to another 100 mL of volumetric flask. Then 1 mL of 1 M acetic acid and 2 mL of I-KI was added into the solution and its volume was made up to 100 mL. The solution was shaken and stand for 20 minutes and the absorbance of the solution was determined at wavelength of 620 nm using UV-Vis Spectrophotometer JASCO V-650. The amylose concentration of the sample was determined from the standard curve.

2.2.2. Drying oven method with different temperature (35, 45, 55, 65 and 75 ^{0}C)

25 g of paddy was weighed and dried in an oven (MEMMERT UM 400). The drying process was performed without air ventilation inside the oven. The experimental was carried out with three replications.

The drying of paddy was carried out with three different temperatures at 40^{0}C, 50^{0}C and 60^{0}C in order to achieve 14 % w.b. The moisture loss of paddy was determined by weight loss. Each weight loss of paddy was considered as moisture loss in paddy. The moisture content in w.b was calculated from equation (1).

$$MC = W_0 - W_d \quad (1)$$

where, W_o is the initial weight of the paddy sample (g) and W_d is the weight of the dried sample (g). This method was adopted by Kong and Janaun [7]. Then, the amylose content analysis was determined based on method 2.2.1.

2.2.3. Drying oven method with different moisture content (14%, 12%, 10% and 8% wb)

Drying oven method was performed by repeating method 2.2.2 with the temperature of oven was fixed at 45^{0}C while the moisture content of the paddy was varied from 14, 12, 10 and 8 % w.b. After that, the amylose content analysis was performed by repeating method 2.2.1.

2.2.4. Paddy drying in LAMB Dryer System

Paddy with PR1 variety was dried in the 10 kg LAMB dryer system. Each run of the experiment will have different drying specification as shown in Table 1. The final moisture content of each run of the experiment was different with the different drying conditions.

Table 1: Experimental specification in LAMB dryer

Run	Initial moisture content (% w.b)	Final moisture content (% w.b)	Inner Tube Design Parameters, Z	Temperature (^{0}C)	Flowrate (L/min)
1	23	14.00	22.27	24	100
2	20	8.98	39.60	24	200
3	21	14.00	39.60	24	100
4	15	10.89	39.60	Ambient	200

The quality of the amylose content was determined (method 2.2.1) after the drying process was performed. The sample was mixed vigorously and was taken randomly. On the other hand, run 3 of the experiment, the paddy at 14 % w.b moisture content was taken at three points of the LAMB dryer system. The amylose content of commercial rice which was the local rice from Kota Belud, Sabah with varieties of “TQR, TR8 and TR7” was determined and to be compared with amylose content of rice from LAMB dryer yield.

3. Results and discussion

3.1. Relationship between the Amylose Content in Rice with Different Temperature of 35, 45, 55, 65 and 75 ^{0}C

Based on this study, the relationship between amylose concentration in rice with different drying temperatures of 35, 45, 55, 65 and 75^{0}C were determined at fixed moisture content of 14 % w.b. The drying process was performed in oven drying. The temperatures were selected in order to observe the differences of the amylose concentration in rice at 14 % w.b. Based on Figure 1, the trend of the graph shows that the amylose concentration was increased rapidly as the drying temperature increases.

As been reported reported by Zheng et al. [8], high drying temperature and fastest drying rate may lead to breakage of the paddy kernel and decomposition of the amylose content. Figure 1 shows that, at temperature of 75^{0}C the amylose concentration about 22.50% compare to the other temperatures. This can be explained by relating with Zheng et al. [8] research. The highest amylose concentration was caused by the breakage of the kernel which may cause crack on the surface of the endosperm. This can cause the amylose to leak as the moisture gradient occurs from the endosperm to the surrounding environment. While, at the temperature of 35^{0}C, the amylose concentration was 20.78%. This indicates that, it has less influence on amylose concentration in rice. When relate with the eating quality, which has been reported by Zheng et al. [8], it shows that the drying condition below 45^{0}C will not affect much on the taste quality of the rice.

According to Zheng and Lan [9], paddy drying temperature at below 45 ^{0}C will not appear any significant changes on the taste of the rice, which correlate to the amylose content. Based on Figure 1, the drying temperatures at 45, 55 and 65 ^{0}C does not shows any significant changes on the amylose concentration in rice as amylose concentration was 21.81, 21.53 and 21.63%, respectively. These values demonstrate the amylose concentration were in the intermediate region.

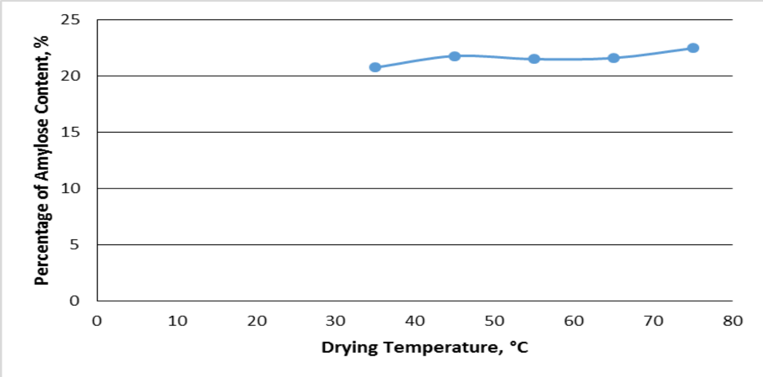

Figure 1. Amylose Concentration, % against Drying Temperature, ^{0}C.

3.2. Relationship between Amylose Concentration in Rice with different Moisture Content at Temperature of 45 ^{0}C in Oven

This study was performed to understand the effect of amylose content at temperature of 45 ^{0}C with different moisture content of 14, 12, 10 and 8 % w.b. The result obtained was tabulated in Figure 2. At 14 to 12 % w.b of moisture content, the amylose concentration was decrease from 21.79 to 20.17% respectively. However, when the drying was continued until the moisture content of the paddy reaches 10 to 8 % w.b, the amylose concentration started to increase gradually with 20.85 to 26.35% respectively.

By relating the concentration of amylose content in rice with the eating quality, it shows that the higher the amylose concentration in rice the lower the eating quality. Based on Zheng and Lan [9], they had stated that once the moisture content of rice has dropped to below 15 % w.b the taste values will decrease as well. Thus, based on Figure 2, 14 to 10 % of moisture content was acceptable to maintain the quality of the dried rice.

At 14 % w.b of moisture content, it was suitable for the milling process at the same time it can preserve the cooking smell and eating quality of the cooked rice. At this moisture content, it shows the condition of the paddy was better so, the weight of the paddy and the milling yield will not decrease. Besides, lower moisture content to 13 % or less was suitable for storage purpose.

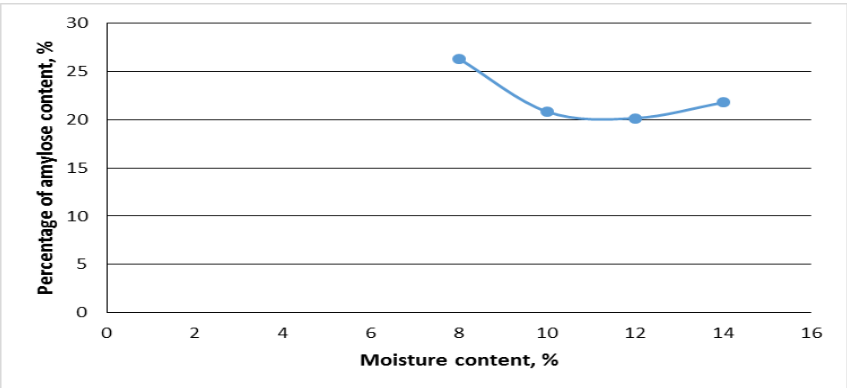

Figure 2. Amylose Concentration, % against Moisture Content Percentage in w.b, %.

3.3. Quality of rice dried in LAMB dryer system

Based on Figure 3, the amylose concentration for Run 1, 2, 3 and 4 was different. The result analysed was 20.67, 24.67, 23.17, and 25.50 %, respectively. The variation of the result obtained was likely due of the inconsistent initial and final moisture content of the paddy with different inner tube design. Therefore, the overall result has stated that Run 4 has the highest value of amylose content, follow by Run 2, 3 and lastly Run 1.

Run 1 with the initial moisture content of 23 % w.b was dried down to 14 % w.b of final moisture content was found that this drying condition of 25 ^{0}C with 100 L/min has the lowest amylose concentration of 20.67% compared to the others. It also similar as Run 3 with initial moisture content of 21 % w.b was dried down to 14 % w.b at 25 ^{0}C with 100 l/min shows that the amylose content was also in the intermediate range of 23.17%. By noticing these two Runs, it shows that the drying conditions were the same, however, the differences was the inner tube design which required for the air distribution during the drying process for the LAMB dryer system. Based on the result obtained, Run 1 has lower amylose concentration compared to Run 3 even though the drying specifications were the same. However, based on the same drying conditions of the LAMB dryer systems, it was found that the inner tube design was also one of the main causes that influence the quality of the rice. It has proved that, the design of the inner tube also may affect the amylose concentration of the rice.

Furthermore, for Run 2 with the initial moisture content of 23 % w.b was dried down to 8.98 % w.b for drying temperature of 25 ^{0}C with 200 L/min and inner tube design of Z = 39.60. The amylose concentration was also in the intermediate range of 24.67%. Thus, the result obtained not only because of the drying temperature, air flowrate and initial moisture content that affect the amylose concentration. But the inner tube design also shows the influence on the amylose concentration. Therefore, the designation of the inner tube may be one of the parameters affecting the amylose concentration. Therefore, the designation of the inner tube may be one of the parameters affecting the amylose concentration.

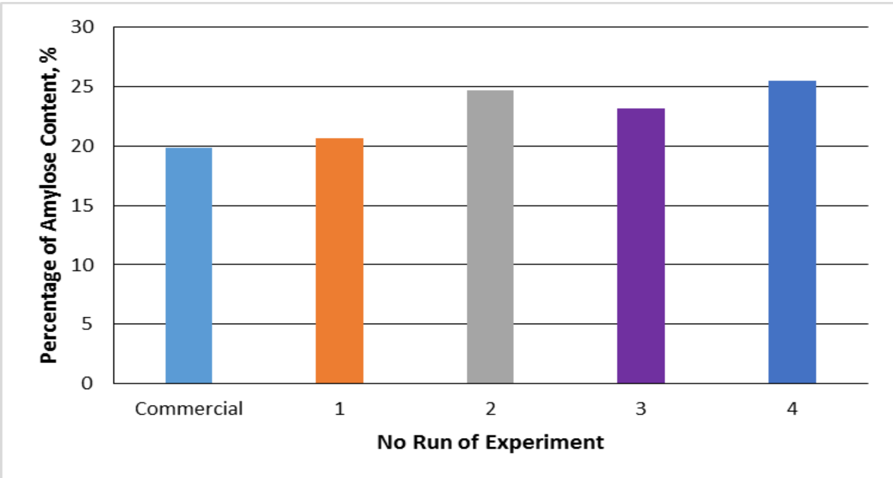

Figure 3. Percentage of Amylose Content for commercial rice and LAMB dryer (experiment run no 1, 2, 3 &4).

3.4. Comparison between Amylose Content of Rice (PR1) with Commercial Rice (Local Rice)

The comparison of the amylose content of rice (PR1) with commercial rice which was the local rice from Kota Belud, Sabah with varieties of “TQR, TR8 and TR7” is summarized in Figure 3.

The amylose concentration has been reported by Jin et al. [10] high amylose content more than 100 mg/L (>25 %) it shows the properties of the rice dry and fluffy after cooked and suddenly it become hard after cooling, while intermediate amylose content in between 80 – 100 mg/L (20 – 25 %)

shows the rice will cooked soft but it is not sticky and lastly, for low amylose content 60 – 80 mg/L (15-20 %) the rice will cooked softly and sticky.

Based on the result obtained, the commercial rice has the lowest amylose content with 19.83%, compared with PR1 Rice samples. The commercial rice sample represents as a control or standard for the PR1 rice variety. According to the rice quality standard, the commercial rice is in the range of low amylose content which will have soft and sticky texture after cooking. As for paddy drying in the LAMB dryer system, the amylose content of PR1 rice samples in experiment no 1, 2, 3 and 4 were in intermediate level with 20.67%, 24.67%, 23.17% and 25.50%, respectively.

The result obtained shows that different rice variety have different amylose content. Therefore, the rice amylose content of rice will have three classifications of low, intermediate and high. Other than that, the commercial rice has three different varieties “TQR, TR8 and TR7” therefore, it has different amylose content. While in this studies, the quality of rice respect to drying process was focused on specific variety of PR1.

4. Conclusion

In this study, the amylose content of the rice dried in an oven and a LAMB dryer were determined. By establish the relationship between amylose content with different moisture content at different drying temperature. This relationship is important to understand the optimal drying temperature for better quality of rice in terms of amylose content.

The amylose content of rice from dried paddy PR1 in LAMB dryer with different inner tube designs were in the intermediate range with the value of 20 – 25.50%, where mostly preferred by the consumers. Hence, it can be concluded that LAMB dryer is a good paddy dryer, and it has the potential to be used in a large scale paddy drying.

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