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Investigation into the Optimum Moisture Content and Parboiling Time for Milling Igbemo Rice

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Abstract

Igbemo rice is local rice commonly produced and consumed in Ekiti State and other parts of Nigeria. One of the major factors affecting the quality of Igbemo rice is kernel breakage. This study examines the optimum moisture and parboiling time that gives the minimum amount of breakages during the milling process. Paddy rice obtained from local farmers in Igbemo town, in Ekiti State was parboiled at three different moisture contents and length of parboiling of 12, 14, 16% and 35, 40, 45 minutes, respectively. The resulting rice samples were milled at five replicates to obtain the amount of kernel breakages. The results of the process reveal that to obtain a minimum amount of kernel breakages in Igbemo rice, paddy should be parboiled for 41.5 minutes and milled at 16% moisture content.

Keywords: Parboiled paddy rice; Breakages; Milling; Moisture content; Igbemo rice; Nigeria

Introduction

Rice (*Oryza sativa* L.), which is considered as a main staple food and major source of nutrients in many parts of the world, is also an important staple food in Nigeria [1]. Despite the fact that the qualities desired in rice vary from one geographical region to another [2], the demand for parboiled brown rice has been increasing because of its reputation for nutritional excellence and the health claims associated with eating this type of rice [3].

Parboiling is the hydrothermal treatment of paddy before milling [4-6], and it includes soaking, steaming and drying [7]. The primary objective of parboiling is to improve the quality of rice and obtain a higher milling yield [3]. The parboiled rice exhibits several advantages over the un-parboiled ones such as improved kernel strengthening, increased milling recovery and prevention of loss of nutrients associated with milling, and improved shelf life. It is suggested that parboiling helps fill the void spaces and cement the cracks inside the endosperm, making the grain harder and minimizing internal fissuring and thereby breakages during milling [6-9]. From the economic point of view, the quality of milled rice is of paramount importance since grain size and shape, whiteness and cleanliness are strongly correlated with the transaction price of rice [10], while the presence of broken grains mostly half the market value of head rice [11]. In general, efficient mills produce better quality rice, whereas inefficient mills waste energy, and result in losses [12]. To improve the quality of rice two main factors have to be considered: one, the quality of paddy that goes in for milling; and two, the milling technique; although Bhattacharya [8] has argued that the ultimate cause of breakage in rice milling resides more in the rice kernel than in the milling methods and equipment. Since the percentage of whole grain is the most important parameter in the rice industry, rice processing, therefore, becomes an important factor to be put into consideration in order to improve its quality [13]. To meet this gap in the case of Igbemo rice, which has been less researched in this area, this paper investigates the optimum moisture content and parboiling time for milling Igbemo rice as precursors for improving its quality. This paper argues that the breakage experienced while milling can be attributed to parboiling time and paddy moisture content. The paper focuses on Igbemo rice because it is widely consumed in Nigeria due to its agreeable taste and smell [13,14].

Materials and Method

The major raw material used for this study is Igbemo paddy rice that was obtained from the local farmers in Igbemo town in Ekiti State. Igbemo is a major rice producing town in Ekiti State, south-western part of Nigeria with a relatively higher tonnage of 3.7 tones of paddy rice per hectare [14]. For the experiment, 200 kg of paddy rice was obtained out of which 138 kg was available for use. The (138 kg) rice was divided into three equal parts of 46 kg each. Each of the 46 kg portion was soaked for twenty hours in cold water. The floating chaff and other debris were removed and the paddy weight was noted before parboiling. The paddy rice was parboiled in a drum using steaming method. The initial moisture content of paddy before soaking was 14% wet basis. Each of the cleaned 45 kg of paddy rice was parboiled at three different parboiling times of 35 minutes, 40 minutes and 45 minutes, respectively. This is consistent with the suggestions of Ibukun [4]. After parboiling, the parboiled paddy rice was re-weighed to calculate the increase in mass.

The parboiled paddy rice was further divided into three equal parts of 15 kg and sun dried to three different moisture contents of 12, 14 and 16% [15]. The moisture contents were determined directly using the Indosaw Intelligent Digital Moisture Testing Machine, Model S 2004. The testing machine measures moisture content in percentages within a range of 3.5 to 40%. The Indosaw Intelligent Digital Moisture Testing Machine is based upon the theory of conductivity of the specimen, homogenously pressed to a predetermined thickness.

The milling operation was carried out at a local commercial rice milling centre. Five replicates of each sample were milled. During the milling operation, paddy was subjected to uniform feeding rate and speed. After milling, the mass and moisture content of each replicate

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were determined. At each moisture level, it was observed that the moisture content of parboiled paddy before milling did not vary from the moisture content after milling. To determine the amount of breakages in the milled rice, 20 g of milled rice grain was obtained (at random) from each of the five replicates in the five trials. Each was sorted out by manually separating broken grains from whole grains. The mass of broken grains and whole grains was measured on a weighing balance and recorded. The amount of broken milled rice was calculated using equation (1) [16]:

$$BMR = \frac{W_1}{W_2} \times 100\% \quad (1)$$

Where, BMR is the broken brown rice (%), W_1 is the mass of the broken brown rice (g) and W_2 is the mass of the sample of total brown rice (g).

Results and Discussion

The results of parboiling and milling at different times with the resulting amount of breakages are presented in tables 1-3. At 35 minutes, the rice paddy milled at 16% moisture content has the least amount of kernel breakages of 23.49% (Table 1). The paddy milled at 14% moisture content has 26.07% breakages, while the rice milled at 12% moisture content has the highest amount of breakages of 26.56%. This shows that as the Moisture Content (M.C.) decreases the amount of kernel breakages increases.

At 40 minutes, the rice milled at 16% moisture content has the least amount of breakages of 12.9% (Table 2), while the paddy milled at 14% moisture content has 20.98% breakages. The rice milled at 12% moisture content has 24.0% breakages resulting in the highest amount of kernel breakages. The result follows the same pattern as that of the paddy rice parboiled at 35 minutes.

At 45 minutes (Table 3), the rice milled at 16% moisture content has the least amount of breakages of 15.43%. The paddy milled at 14% moisture content has 21.96% breakages, and the rice milled at 12% moisture content gave 23.92% breakages; thus, having the highest amount of kernel breakages.

$M.C._{AM}$	M_{BM} (kg)	M_{AM} (kg)	M_{BR} (g)	BR (%)
12	2.30	1.84	5.31	26.56
14	2.50	1.83	5.21	26.07
16	2.70	1.77	4.69	23.49

Table 1: Results of milling for parboiling time of 35 minutes.

$M.C._{AM}$	M_{BM} (kg)	M_{AM} (kg)	M_{BR} (g)	BR (%)
12	2.30	1.81	4.80	24.00
14	2.50	1.85	4.19	20.98
16	2.70	1.76	2.59	12.94

Table 2: Results of milling for parboiling time of 40 minutes.

$M.C._{AM}$	M_{BM} (kg)	M_{AM} (kg)	M_{BR} (g)	BR (%)
12	2.30	1.94	4.78	23.92
14	2.50	1.74	4.39	21.96
16	2.70	1.92	3.08	15.43

M.C.AM=Moisture content after milling (in%, wet basis)
MBM=Mass before milling
MAM=Mass after milling
MBR=Mass of breakages
BR (%)=Amount of kernel breakages (in%)

Table 3: Results of milling for parboiling time of 45 minutes.

Comparing the results (as shown in Tables 1-3) at the three parboiling times, it is observed that the paddy rice milled at 16% moisture content has the least amount of kernel breakages. This lowest amount of breakages was obtained at a parboiling time of 40 minutes (Table 2). The graphical illustration of the amount of breakages against moisture content, presented for each of the parboiling times, is as shown in Figure 1.

As shown in Figure 1, the minimum amount of breakages is obtained at 16% moisture content (wet basis), while the maximum amount is obtained at 12%. Optimising this in Figure 2 (at R^2=1, it means that the model can be used to predict the optimum parboiling time that will give the minimum amount of breakages), it shows that the minimum amount of breakages of 12.5% will occur at a parboiling time of 41.5 minutes (see figure 2). Although there is paucity of data on the optimum moisture content and parboiling time for milling Igbemo rice in the literature, Yadav and Jindal [17] have reported about 14% moisture content dry basis for milling paddy rice to produce polished edible grain, without any reference to parboiling time and the corresponding amount of losses. Also, for best results, Imoudu and Olufayo [15] have recommended between 12 and 14% moisture content for Ekpoma paddy rice milling, with no particular emphasize on parboiling time. On the other hand, Bhattacharya and Swamy [18] have argued that milling paddy rice at moisture content below 15% could affect milling quality. They have suggested between 15 and 19% in order obtaining better milling quality, with no reference made to parboiling time. In the study of Ibukun [4], it was found that parboiling for 45 minutes resulted in minimum amount of breakages of 19.5% at paddy moisture content of 13.6%. The implication of this study's regression model prediction over the experimental data of Ibukun [4] is that milling parboiled paddy at relatively higher moisture content (16% compared with 13.6%) will lead to relatively lower breakages (12.5%

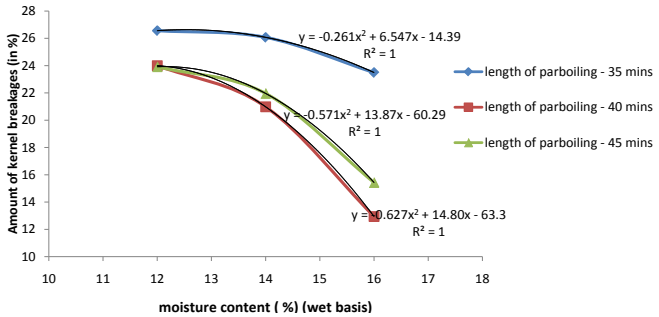

Figure 1: Amount of kernel breakages against moisture content.

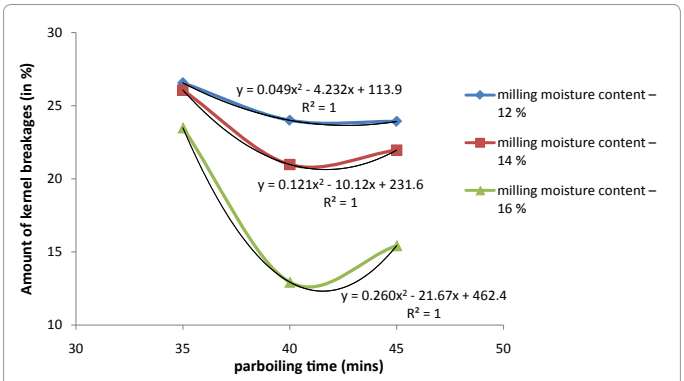

Figure 2: Amount of kernel breakages against length of parboiling (mins).

compared with 19.5%). This observation is also in agreement with Bhattacharya and Swamy [18] that milling at moisture content below 15% could affect the milling quality. Despite this impressive initial result, future research intends to go on with an experimental evaluation of these optimum conditions for milling Igbemo rice obtained from the regression model.

Conclusion

This paper has investigated the optimum moisture content and parboiling time needed to mill Igbemo rice. Findings indicate that to have a minimum amount of breakages, Igbemo rice has to be parboiled for 41.5 minutes and paddy milled at 16% moisture content wet basis. This has implication for Igbemo rice growers and processors in Nigeria as well as rice researchers and equipment/machine fabricators.

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