Case Study

A Case Study on Milling Characteristics of *Padmini* Variety of Paddy

Monalisha Das* and Ashok Kumar Das

Faculty of Agricultural Sciences, Institute of Agricultural Sciences, SOADU, Bhubaneswar, Odisha, India

*Corresponding author

A B S T R A C T

Rice is one of the most important staple food crop of India for more than two-thirds of its population. The Rice milling is the process that remove the husk and the bran layers, produce an edible, white rice kernel. Depending on the requirements, the rice should have a minimum number of broken kernels. The paper presents results of study on the milling characteristics of *Padmini* variety of paddy in laboratory model equipments and to compare the milling recovery in a huller and single pass rice mill. From the study, it was concluded that the slenderness ratio of paddy is 4.16. The husk content and bran content of *Padmini* variety of paddy is 18 and 5.65 %, respectively. The total milling recovery is 75.1% in laboratory equipments. The capacity of huller and single pass rice mill were found to be 190 and 480 kg/h with energy consumption of 3.7 and 7.3 kWh, respectively .The milling recovery and head rice yield is higher in single pass rice mill having rubber roll sheller and horizontal abrasive polisher. The milling efficiency of single pass rice mill is 95.6% as compared to 86 % in huller.

Introduction

India is an agricultural country well known for its agro-biodiversity. Rice is the major cereal crop produced and consumed in India. India ranks second in the production and consumption of rice in the global market. It has the largest area under rice cultivation, as it is one of the principal food crops. It is in fact the dominant crop of the country. It is a part of nearly every meal, and it is grown on a majority of the rural farms. It provides about 75% of the average calories and 55% of the protein in the average daily diet of the people (Anonymous, 2002). Rice is a tropical plant, grown in hot and humid climate. It is a staple food of eastern and southern parts of India. Total production of rice during 2019-20 is estimated at record 117.47 million tonnes. It is higher by 9.67 million tonnes than the five year's average production of 107.80 million tonnes.

Grain quality in rice is determined by the factors such as grain appearance, nutritional value, cooking and eating quality (Juliano *et. al*., 1964). Rice is a nutritional staple food which provides instant energy as its most important component is carbohydrate (starch). On the other hand, rice is poor in nitrogenous substances with average composition of these substances being only 8 percent and fat content or lipids only negligible, i.e., 1 per cent and due to this reason, it is considered as a complete food for eating. Rice flour is rich in starch and is used for making various food materials. It is also used in some instances by brewers to make alcoholic malt. Likewise, rice straw mixed with other materials is used to produce porcelain, glass and pottery. Rice is also used in manufacturing of paper pulp and livestock breeding. Consumer's preference is based on appearance, milling and cooking processes, grain shape and size. The majority of the consumers prefer well-milled white rice with little or no bran remaining on the endosperm (Mohapatra and Bal, 2007). The variability of composition and characteristics of rice is really broad and depends on variety and environmental conditions under which the crop is grown. In husked rice, protein content ranges in between 7 percent to 12 percent. Over 70% of the rice husks in India are utilized in fuel for commercial rice mill steam generators to increase fuel's effectiveness, rice husks are burned and compressed into briquettes. It is essential to evaluate the energy consumption and food components retained in different forms of rice to determine whether the nutritional value of rice and the energy used in rice processing industries can be conserved (Roy and Ijiri, 2008). Rice bran is the most nutritious part and a good source of vitamin B. In India, approximately 40% of rice bran is extracted for cooking oil and remaining 60% are utilized in animal feed production. Approximately 70% of broken rice produced in India is used as feeding ingredients or made into instant noodles and snacks. In an ideal milling process, 20% husk, 8-12% bran depending on the milling degree and 68-72% milled rice. A commercial rice milling system is a multi-stages process where the rough rice is first subjected to dehusking and then to the removal of brownish outer bran layer, known as whitening (Yadav and Jindal, 2008)

The main aim of milling is to get edible, white rice kernel that is sufficiently milled and free of impurities (Singh and Sahay, 2015). The milling characteristic of paddy is important to analyse the suitability of milling with better head rice yield of a particular variety. In Orissa, *Padmini* variety of paddy is grown and popular among farmers and consumers. It is of fine quality which resulted in more breakage during milling in a huller. So there is a need to study the milling characteristics of this variety and its suitability for milling in a single pass rice mill. The study was conducted for milling characteristics of *Padmini* variety of paddy in laboratory model equipments and to compare the milling recovery in a huller and single pass rice mill.

Materials and Methods

Materials

Padmini variety of paddy was purchased from local market of Bhubaneswar. The samples were packed in polythene bags, sealed and stored for further experiment. The laboratory model milling equipments (Satake make) were used to study the milling characteristics. The single pass rice mill available at Implement Factory was used for milling paddy to analyze the milling recovery.

Milling characteristic study

The dimension i.e. length, breadth and thickness of paddy was measured taking 20

grains at a time and the average values were calculated. About 200g of paddy samples were cleaned, dehusked and polished in a laboratory cleaner, rubber roll sheller, polisher. The weight of the foreign matter, husk, brown rice, bran and milled rice was taken and recorded. The brokens were separated manually from 100g milled rice and weighed in a digital balance.

Calculation of different parameters of milling characteristics

Foreign matter

$$Foreign\ matter\ percentage = \frac{W_{FM}}{W_{WP}} \times 100$$

Where, W_{FM} is the weight of foreign matter present in the paddy (g) and W_{WP} is the total weight of uncleaned paddy (g).

Husk content

$$Husk\ percentage = \frac{W_{Hu}}{W_{WP}} \times 100$$

Where, W_{Hu} is the weight of husk (g) and W_{WP} is the total weight of paddy (g).

Bran content

$$Bran\ percentage = \frac{W_{br}}{W_{WP}} \times 100$$

Where, W_{br} is the weight of bran (g) and W_{WP} is the weight of paddy (g).

Head rice yield

Milled rice with length greater or equal to three quarters of the average length of the whole kernel is called head rice.

$$Head\ rice\ percentage = \frac{W_{HR}}{W_{MR}} \times 100$$

Where, W_{HR} is the weight of head rice (g) and W_{MR} is the weight of milled rice (g).

Broken rice

$$Broken\ rice\ percentage = \frac{W_{BR}}{W_{MR}} \times 100$$

Where, W_{BR} is the weight of broken rice (g) which may be obtained by subtracting the weight of head rice from weight of milled rice and W_{MR} is the weight of milled rice (g).

Milling recovery

Total milled rice obtained out of paddy, expressed as weight percentage of milled rice (including broken) obtained from a sample of paddy.

$$Milling\ Recovery\ (\%) = \frac{W_{TR}}{W_{WP}} \times 100$$

Where, W_{TR} is the weight of total rice (g) and W_{WP} is the total weight of paddy (g).

Hulling efficiency

Hulling efficiency is the measure of the ability of the machine to remove the hulls.

$$Coefficient\ of\ hulling = \frac{W_{BR}}{W_{WP}} \times 100$$

Where, W_{BR} is the weight of brown rice (g) and W_{WP} is the total weight of paddy (g).

Milling efficiency

$$Milling\ efficiency\ (\%) = \frac{Hulling\ efficiency\ (\%) \times Head\ rice\ yield\ (\%)}{100}$$

$$Degree\ of\ polishing\ (\%) = \frac{W_{br}}{W_{BR}}\ x\ 100$$

Where, W_{br} is the weight of bran (g) and W_{BR} is the weight of brown rice (g).

Milling of paddy in huller and single pass rice mill

The Padmini variety of paddy was milled in huller and single pass rice mill. The capacity and energy consumption of the machine was measured. The dehusking efficiency, total yield and head rice yield in the mills were determined and compared.

Determination of moisture content

Moisture content of the samples was determined using standard hot air oven drying method AOAC (2000) and expressed in percentage (dry basis). About 5 g sample weighed exactly using electronic balance (M/s Citizen Scale Inc., USA; least count 0.1 mg) was dried in hot air oven at 105±1°C for 17±1

h. All the moisture content samples were replicated thrice. Moisture content of samples was estimated using following equation.

$$M_d = \frac{W_1 - W_2}{W_2}\ x\ 100$$

Where, M_d is the percentage of the moisture content of sample in dry basis, W_1 is the mass of the sample prior to drying (g) and W_2 is the mass of the sample after drying (g).

Results and Discussion

The milling characteristics of paddy in laboratory equipments and commercial mills have been studied.

Physical properties of paddy

The physical properties like length, breadth and thickness of paddy are 7.9, 1.9, and 1.5, respectively (Table 1). The Slenderness ratio of paddy is 4.16. The paddy is at 13.3% moisture content.

Table.1 Data of physical properties of paddy

Parameter	Dimensions (mm)
Length	7.9
Breadth	1.9
Thickness	1.5
Slenderness ratio	4.16
Moisture content (% d. b.)	13.3

Table.2 Milling characteristics of paddy in laboratory equipments

Parameters	Content (%)
Foreign matter (%)	1.14
Husk (%)	18.0
Bran (%)	5.65
Brown rice (%)	81.4
Milled rice recovery (%)	75.1

Table.3 Comparison of milling characteristics of huller and single pass rice mill

Parameters	Huller	Single pass rice mill
Capacity, kg/h	190	480
Energy consumption, kWh	3.7	7.3
Dehusking efficiency (%)	99.2	98.5
Milling recovery (%)	62	68
Head rice yield (%)	86.7	97.1
Broken rice (%)	13.3	2.9
Milling efficiency	86.0	95.6

Milling characteristics of paddy in laboratory equipments

The different parameters of milling characteristics of *Padmini* variety of paddy like husk and bran content is 18 and 5.65%, respectively (Table 2). The total milling recovery is 75.1%.

Milling of paddy in huller and single pass rice mill

The capacity of huller and single pass rice mill is 190 and 480 kg/h with energy consumption of 3.7 and 7.3 kWh, respectively (Table 3). The milling recovery and head rice yield is higher in single pass rice mill having rubber roll sheller and horizontal abrasive polisher. The milling efficiency of single pass rice mill was 95.6% as compared to 86 % in huller.

In conclusion, the laboratory model milling equipments (Satake make) were used to study the milling characteristics. The huller and single pass rice mill available at Implement Factory were used for milling paddy to analyze the milling recovery. From the above study, it is concluded that the slenderness ratio of paddy is 4.16. The husk content and bran content of *Padmini* variety of paddy is 18 and 5.65 %, respectively. The total milling recovery is 75.1% in laboratory equipments. The capacity of huller and single pass rice

mill are 190 and 480 kg/h with energy consumption of 3.7 and 7.3 kWh, respectively. The milling recovery and head rice yield is higher in single pass rice mill having rubber roll sheller and horizontal abrasive polisher. The milling efficiency of single pass rice mill is 95.6% as compared to 86 % in huller.

References

Juliano B. O., Cagampang G. B., Cruz L. J. and Santiago R. G. (1964) Some Physiochemical properties of rice in Southeast Asia. *Journal series no. 20*, pp. 275-285.

Mohapatra D. and Bal S. (2007) Effect of degree of milling on specific energy consumption, optical measurements and cooking quality of rice, *Journal of Food Engineering*, 80 (1), pp. 119-125.

Roy P. and Ijiri T. (2008) Effect of processing conditions on overall energy consumption and quality of rice (*Oryza sativa* L.), *Journal of Food Engineering*, 89 (3), pp. 343-348.

Singh K. K. and Sahay K. M. (2015) Unit Operations of Agricultural processing, *Vikas Publishing House Pvt. Ltd.*

Yadav B. K. and Jindal V. K. (2008) Changes in head rice yield and whiteness during milling of rough rice (*Oryza sativa* L.), *Journal of Food Engineering*, 86 (1), pp. 113-121.