Performance evaluation of a rice cleaning and grading machine

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Abstract. *Rice (Oryza sativa L.), that are locally produced and processed in Nigeria is characterized with high percentage of broken grains and impurities which impairs its quality and attracts low market value. To overcome this predicament, an appropriate technology machine was designed.*

A three sieve cleaner-grader machine developed by the authors was tested for performance with a vibration speed of 240 r.p.m. Three rice varieties was used for testing the milling qualities such as milled rice yield, head rice yield and brokens at the moisture content of 12.2% ±1.4 An air blast of 4.8ms-1 was utilized to separate light materials while apertures diameter of 3, 5.5 and 7mm were selected for bottom, intermediate and top sieves to effect grading of whole kernels. Milled rice fed into the machine was tested at tilt angles of 2^{o}, 4o and 6o and at blower inclinations of 0o and 5o.

The brokens within 18.18 to 22.62% was reduced to 6.13 and 9.06%.with the utilization of the grading machine. Machine capacity ranges from 1000 – 1,200kg/hr. The incorporation of the grading machine after milling has upgraded locally processed rice quality from grade III to grade II

Keywords. Rice, tilt angle, sieves, cleaner - grader

Introduction

Rice is a major component of Nigerians diet and is a widely grown crop because of its economic importance. Rice consumption has increased steadily over the last decade as a result of population growth and rapid urbanization. Locally produced rice have been known to be highly nutritious, however, the quality of its milled rice are usually poor. They are characterized with high percentage of impurities like husk and stones as well as under size / broken grains which reduces it economic value and makes it difficult to compete favorably with imported ones. The low level technology input in rice production has contributed to high grain losses and poor quality of Nigerian rice, thereby limiting sustainable food chain. Milled rice obtained from the processors are usually winnowed by hand, separating grains from contaminants i.e. materials other than grains (MOG) This procedure is tedious and time-consuming and a lot of dockages, small stones and brokens remains mixed with the rice in the end. The rice has not been graded and they are not well cleaned. This explains why local rice available in the market is characterized with high percentage of breakages and impurities which attracts low price.

Ogunlowo and Adesuyi (1999) accomplished separation of stones and other contaminants with a combination of oscillating sieves and variable directional air stream at 160 r.p.m. Tabatabaeefar et al (2004) designed and developed a second sieving and grading machine for chick pea which attained an overall cleaning efficiency of 84% with a use of four sieves vibrated at 200 r.pm. Also Okunola and Igbeka (2009) improved on an appropriate technology cereal cleaner Igbeka (1984) and obtained a higher cleaning efficiency of 71% for paddy than 61% when vibration occurred at 240 r.p.m. instead of 250 r.p.m.

Materials and Method

Parboiling

All the samples of paddy were parboiled were done under similar conditions. Paddy was soaked in cold water for 48hours in a drum and then steamed for 30 minutes as suggested by Ibukun, (2008). The water was drained off and the wet paddy was dried by exposure to the sun for the duration of 10 hours. The dried rice samples were packed into woven sacks and stored in well ventilated room until it is milled with a No 1 rice huller

Cleaning and grading

The developed cleaner - grader was used for further separation of the milled rice This machine vibrates it's sieve assembly which contains three sieves of aperture sizes diameters of 3, 5.5 and 7mm at 240 r.p.m. The intermediate sieve tilt angle was varied at 2.4 and 6^0 to determine extent of cleaning during the experiment. Also blower inclination was varied at 0 and 5^0 to the horizontal. The top and bottom sieves were fixed at 2^0 and 15^0 respectively. All the sieves were fixed inside the sieve casing suspended by four hangers and receive oscillating motion by an eccentric drive of 25mm obtained via the fan shaft. Milled rice were fed into the hopper with a gate opening set at 6mm to allow for effective distribution and sufficient resident time over the sieves for through separation and grading. The milled rice was sorted into four categories, namely; light materials away from the top sieve, over tailings sliding over the lower ends of the

two upper sieves, brokens / undersized / small stones and whole kernels. Final separation of the various rejects and product obtained from the receptacles into various quality grades were done with a manually operated 2mm square sieve mesh. Grains with 3/4 or more length were regarded as whole kernel while those shorter were taken as brokens Sampang (2005). For purposes of evaluation, the following terms and nomenclature were adopted for the separation efficiency as used by Igbeka (1984). Method for separation processes is shown in equations 1, 2, 3 and 4.

1. Efficiency of separating whole grain - E_{GR}

$$E_{GR} = \frac{\text{mass of GP}}{\text{mass of GP in GR}} \quad 100 \qquad 1$$

2. Efficiency of separating materials other than grain (MOG) - E_{BC}

$$E_{BC} = \frac{\text{mass of BR}}{\text{mass of BR in BP}} \quad 100 \qquad 2$$

3. Cleaning Efficiency

$$E_T = \frac{E_{GR} E_{BC}}{100} \qquad 3$$

4. Efficiency of grading of whole grain in products

$$E_G = \frac{\text{mass of GP}}{\text{mass of GP in BP}} \quad 100 \qquad 4$$

Results and discussion.

The effect of variety on milled rice quality parameters is shown in Table 1 with the use of Duncan multiple range test for the separation of means. There were significant differences in the values of the MRY, HRY and brokens in these varieties.

Table 1. Quality characteristics of different variety of milled rice

Variety	*MC* (%)	*HRY* (%)	*MRY* (%)	Broken (%)
ITA 150	11.07c	49.01b	69.85a	20.83ab
FARO 44	13.57a	55.02a	67.83ab	12.80c
FARO 52	11.87b	45.57c	67.45b	21.89a

MC - Moisture content, HRY - Head rice yield, MRY - Milled rice yield
Mean with the same letter in each column are not significantly different at 5% level

Grading machine performances at 00 and 50 blower inclinations were shown in Tables 2 and 3. From Table 2. At 00 blower inclination, brokens were considerably reduced after grading in all the varieties and only FARO 52 retains grade III category while from Table 3. All the varieties had their grades enhanced to grade II.

Table 2.Grading machine performance at 00 blower inclination

Variety	Tilt (α^0)	Angle	*BM* (%)	Rice grade	*BG* (%)	Rice grade

ITA 150	2	19.79	III	8.20	II
	4	22.62	III	7.56	II
	6	22.42	III	9.06	II
FARO 44	2	15.51	II	6.27	II
	4	14.50	II	5.83	II
	6	13.00	II	7.78	II
FARO 52	2	25.34	III	17.40	III
	4	24.35	III	16.75	III
	6	24.78	III	19.53	III

BM - Broken at milling; BG - Broken after grading

Table 3 Grading machine performance at 00 blower inclination

Variety	Tilt angle (α0)	B.Md (%)	Rice grade	B.Ge (%)	Rice grade
ITA 150	2	18.18	III	6.13	II
	4	22.41	III	6.34	II
	6	19.66	III	7.57	II
FARO 44	2	12.06	II	5.24	II
	4	12.51	II	5.91	II
	6	11.37	II	5.58	II
FARO 52	2	20.06	III	14,12	II
	4	19.97	III	14.01	II
	6	18.85	III	13.81	II

BM - Broken at milling; BG - Broken after grading

Conclusion

Variety has significant effect on quality characteristics of milled rice. The cleaning / grading has improved physical quality of Nigerian milled rice and should be incorporated in rice processing at cottage industry.

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