MILLING QUALITY OF PADDY RICE PROCESSED USING TRADITIONAL AND MODIFIED PARBOILING DRUMS TO ENHENCE JOB CREATION FOR NATIONAL DEVELOPMENT.

BY

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Abstract

Milling quality of paddy rice was determined by comparing products from improved rice parboiling drum with false bottom, fabricated from stainless steel, with the traditional drum. Quality parameters of three rice varieties, FARO 44, FARO 52 and SIPI, parboiled using the two drums were evaluated using the standard evaluation system (SES) for rice. The results showed significant difference ($p \leq 0.05$) in the milling characteristics of the paddy between the improved and traditional parboilers. Such as the percentage broken rice was 24% in traditional drum as against 1.55% in the modified drum However, milling characteristics did not vary significantly ($p \geq 0.05$) in some cases between the rice varieties as in the degree of milling. Whereas the total milling recovery of the paddy rice for the improved parboiler ranged from 59.63-73.33% that of the traditional ranged from 56.00 – 72.27%. Similar trends were observed for other milling attributes. The modified drum showed better milling quality characteristics when compared to local drums.

Introduction

Rice is staple food consumed by more than half of the world population. Rice is consumed by over 4.8 billion people in 176 countries and is the most important food crop for over 2.89 billion people in Asia, over 40 million people in Africa and over 150.3 million people in America (Daramola, 2005). In Africa there is a growing deficit between production and consumption, with the continent importing over 10 million tons of rice annually (John, 2010). In addition, rice produced in many African Countries is unable to compete with imported rice and locally produced rice is increasingly leading market share to imports.

Rice production occurs in all agro-ecological zones in Nigeria with middle belt enjoying a comparative advantage in production over other part of the country (Tarwase, 2011). Although, Nigeria is endowed with abundant natural resources suitable for rice production to domestically produce more than enough rice and even export surplus, yet the demand outstrips domestic supply. Nigeria‘s growing rice demand simultaneously presents a food security challenge and an economic opportunity for the country. Currently, a two-third (2 million metric tonnes) of Nigeria‘s rice demand is being met by importation, due to low adoption rate, low yield and inefficient production systems as well as sub-standard methods of processing. Nigeria has been a major consumer and importer of rice in Africa. A former Minister of Agriculture and Rural Development revealed that the country spends over N356 billion on yearly importation of rice, out of which about N1 billion is used per day (Adesina, 2012). This appalling situation has compelled the Federal Government of Nigeria, as part of its Agricultural Transformation Agenda (ATA), to set a goal to achieve complete self-sufficiency in rice production in the next 3 to 4 years. This is to bridge the existing gap between demand and supply of rice and thus reduce significantly the quantum of about 2 million metric tonnes of rice currently being imported. The quality characteristics and general acceptability of rice is largely related to the series of unit operations followed during rice milling. Parboiled paddy provides higher milling yield and reduces nutrient loss during milling and cooking (Parnsakhorn and Noomhorm, 2008). From commercial and consumer point of views, the main quality criteria of parboiled rice are: Optimum milling yield, maximum head rice, minimum broken grains, uniform grain size, desirable colour and aroma. Based on these criteria rice experts have identified parboiling as one of the major constraints in the rice commodity chain (Ayamdoo, Demuyakor, Dogbe, and Owusu, 2013).

Rice parboiling in Nigeria is mainly done by women in the villages surrounding rice milling clusters as an alternative source of income. Traditional parboiling methods have been identified as important source of quality problem in rice (Tinsley, 2011). The traditional method of parboiling paddy rice in large pots and barrels have a number of draw-backs, which results in poor quality of rice and also pose health risk because the work is done around open fires and involves emptying boiling water from large pots or drums (M&A's Greenery, 2007). The quality of parboiled rice is dependent on the rice varieties; the efficiency of the equipment and the processing technique used. It therefore becomes pertinent for food engineers to develop improved parboiler for better and enhanced milling attributes of paddy to ensure that rice milled locally competes favorably with imported rice. Gladly, a lot of research work has been done in the area of improving the parboiling drum and many models have been developed with false bottom as an attempt to reduce burning of the paddy at the bottom of traditional parboiling drum (M&A's Greenery 2007: Training manual 2012, USAID 2008, USAID 2009). However no single model pays attention to even steam distribution in the parboiler during the heating process. The dwarf of information on the milling qualities of paddy rice processed using the two drums necessitates this research work.

Statement of the Problem

Locally produced rice in Nigeria is characterized by the presence of stones/sand, due to poor method of harvesting and processing. Because of these, the quality of most processed rice is low and this has led to poor patronage by consumers in preference to imported (foreign) rice. Due to unscientific and faulty parboiling process, the rice obtained may be of darker colour and bad odour after milling (Sulaiman, 2008). Therefore, lower the price of local product.

Objective of the Study

The objective of this research focus on comparing the milling characteristics and of rice parboiled with the improved drum and that with the traditional drum.

Materials and Methods

Materials

The material used during this research comprised a weighing scale, a measuring tape, digital thermometer, stop watch, stainless steel, corrugated iron, Digital camera, kirya firewood, rice paddy from North bank market in Makurdi, Paddy rice from National cereal research institute (NCRI) Badeggi.

Parboiling Process These involves Steaming, Drying and Milling

Husk percentage

The husking index of paddy was calculated based on the method suggested by Rachel, Wan-Nadiah, and Rajeev (2013)

Husk percentage was calculated using equation: $H = 100(1-W_2/W_1)\ (W_3/W_1-W_2-W_4)$.(1) Where; H= Husking index (%); W_1 = mass of sample before husking, gm. W_3 = mass of brown rice in the final product, (gm) W_4= mass of husk in the final product (gm).

Broken grain percentage

Using the grain grader, the broken grains were separated from the whole grains. The % of the broken grain was calculated using the following equation % broken =

$$\frac{\text{wt of broken grain}}{\text{wt of paddy sample}} \times 100 \quad (2)$$

Shelling breakage percentage

From the broken rice percentage the shelling performance was determined by calculating the ratio of the weight of the shelled kernels to the total of the rice sample (Parnsakhorn and Noomhorm, 2008).

Head rice yield percentage

Using the grain grader the broken grains were separated from the whole grains. The percentage of the head rice was calculated using the following equation (Parnsakhorn and Noomhorm, 2008).

% head rice yield =

$$\frac{\text{wt of whole grains}}{\text{wt of paddy sample}} \times 100 \quad (3)$$

Cooking Properties

Cooking properties of the rice samples were determined based on the available standard procedures (Singh *et al.*, 2003, 2005).

Minimum cooking time

Rice samples (2 g) were individually taken and cooked around 90°C in distilled water (20 ml) in a boiling water bath. The minimum time required for cooking was estimated by pressing the cooked rice samples between two glass slides (till no white core was left) by removing a few cooked kernels at regular time intervals (Parnsakhorn and Noomhorm, 2008).

Elongation ratio and length–breadth ratio

To determine elongation ratio, randomly selected cooked rice samples were measured for length and were divided by length of uncooked raw samples. Results were reported as elongation ratio. The length-breadth ratio was determined by dividing the cumulative length by the breadth of cooked kernels. A mean of 10 replicates were taken for measurement (Parnsakhorn and Noomhorm, 2008).

$$\text{Elongation ratio} = \frac{\text{Length of cooked rice}}{\text{Length raw rice}} \quad (4)$$

Water uptake ratio

Two grams of rice samples were cooked in 20 ml of distilled water for a minimum cooking time in a boiling water bath. After this, the contents were drained and the adhering superficial water present on cooked rice was removed by pressing the samples between filter papers. Cooked rice s1amples were weighed and the water uptake ratio was calculated (determined as increase in weight of rice samples after cooking) (Parnsakhorn and Noomhorm, 2008). Water uptake (%)

$$= \frac{\text{Weight of cooked rice}}{\text{Weight of raw rice}} \quad (5)$$

Result

Table 1: Effect of Steaming Level on the Milling Characteristics of Rice during Improved and Traditional Parboiling

Treatments	Total Milling i Recovery	Total Milling t Recovery	Head Rice i (%)	Head Rice t (%)	Broken Rice i (%)	Broken Rice t (%)	Degree Milling i (%)	Degree Milling (%)	Hull i (%)	Hull t (%)	Unfilled Grain i (%)	Unfilled Grain t (%)
Top												
Ton 2	73.30	98.33	1.67	11.50	0.47	16.70	56.00	73.33	26.33	13.07	31.18	4.23
FARO 52	59.63	90.00	10.00	18.57	2.33	24.63	70.77	97.00	3.00	9.33	21.28	0.60
FARO 44	69.00	93.00	7.00	9.23	1.13	22.83	72.27	89.67	10.33	8.17	20.73	0.53
Middle												
Ton 2	68.50	96.67	3.33		0.93	31.40	55.40	59.00	41.00	16.90	29.33	3.93
FARO 52	62.77	91.67	8.33	13.53	2.73	24.60	67.57	96.00	4.00	12.83	21.63	0.37
FARO 44	67.03	95.67	4.33	9.17	2.00	23.97	72.70	85.00	15.00	7.53	20.60	0.70
Bottom												
Ton 2	62.07	98.67	1.33	20.43	0.33	21.57	46.07	47.00	53.00	15.8	54.00	7.33
FARO 52	65.20	97.00	3.00	12.60	2.13	23.03	68.30	94.00	6.00	9.73	22.17	0.27
FARO 44	68.67	97.33	2.67	9.30	1.50	22.32	71.37	87.00	13.00	6.83	22.03	0.93
Control												
TON 2	70.30	68.77	1.80	8.40	0.37	20.30	70.30	68.77	1.80	8.40	20.30	0.37
FARO 52	63.53	61.40	2.73	18.53	0.40	19.43	63.53	61.40	2.73	18.53	19.43	0.40
FARO 44	69.23	66.97	2.97	11.13	0.17	20.83	69.23	66.97	2.97	11.13	20.83	0.17
Mean	68.01	76.97	15.34	12.31	1.55	24.25	68.01	76.97	15.34	11.45	24.25	1.55
LSD (5%)	4.96	5.89	5.67	2.24	0.47	9.27	4.96	5.89	5.67	2.24	9.27	0.47
CV (%)	4.50	4.40	22.7	7.4	18.80	23.50	4.50	4.40	22.70	7.40	23.50	18.80

CV=Coefficient of variation, LSD=Least significant difference, FARO=Federal Agricultural Research Oryza. Any two mean within the row having difference greater than LSD are significantly different at 5% level of probability. i = improved parboiler; t = Traditional parboiler. Ton 2 = local rice variety.

Discussion

Milling Characteristics

Table 1. Shows the results of milling characteristic including total milling recovery, percentage head rice, percentage broken rice, degree of milling, hull and unfilled grain of the paddy rice processed using improved and traditional parboiling methods. There was significance variation ($p \leq 0.05$) in the milling characteristics of the rice between improved and traditional technique as well as among the different varieties.

The milling recovery of the three rice varieties ranged from 69.63 - 73.30% for the top of the improved drum which was higher than values recorded for the traditional (56.00 -72.27%) at top position of the traditional parboiling technique. At the bottom the ranges were 62.07 – 68.67 and 46.07 – 71.37 respectively. At both the top and the bottom of the drum, the improved parboiler gave higher milling recoveries than the traditional. However, on the basis of varieties, the two equipment performed generally at the same level. Ton 2 recorded higher milling recovery at the top of 73.30% for the improved parboiler and the traditional was 56.00%. At the bottom it was 62.07% with the improved parboiler and 46.07 for the traditional. The milling recovery in the control sample was 69.23%.

In terms of the varieties Faro 52 recorded the lowest milling recovery while Ton 2 had the highest. The degree of milling or percent brown removal as bran influences consumer acceptance. In the improved parboiling method, the milling degree for TON 2 was 11.50% at the top, 6.20%at the middle and 20.43% at the bottom respectively. Whereas the milling degree obtained in the traditional method for the same variety was13.07%, 15.80% and 16.90% at the top bottom and middle. The control has milling degree of 8.40%.

In the improved parboiling method, the milling degree for FARO52 was 12.60%, 13.57% and 18.57% at the bottom, middle and top. Whereas the degree of milling obtained in the traditional parboiler method for the same variety was 3.00%, 4.00% and 6.00% at the top, middle and bottom. The degree of milling in the control sample was 18.53%.Well-milled rice has 10% of rice removed during whitening (Danbaba *et al*., 2012). These results therefore, revealed that the TON 2 and FARO 52 were extra milled for both improved and traditional method except the samples at the middle of the drum with milling degree of 6.20%.

The percentages of husk removed from the samples are presented in Table 2. In the improved parboiling method, the percentage of husk for Ton2was 16.70%, 21.57% and 31.40% at the top, bottom and middle. Whereas that for the traditional method was higher for the same variety, being 29.33%, 31.18% and 54.00% at the middle, top and bottom respectively. The control has value of 20.30% husk.

There was no significant difference ($p \geq 0.05$), in the unfilled grains of two varieties (FARO 52 and FARO 44) between the top and the bottom of the improved parbolier. This indicates the veracity of the improved parboiler in processing the FARO varieties to achieve uniformity of product. There were however significant difference ($p \leq 0.05$) in the parameter in the traditional parboiler, indicating that rice from it will have lower quality due to variations in this property in the traditional parboiler.

Conclusion and Recommendation

Conclusion

Modification of traditional parboiling drum to enhance steam distribution during parboiling was successfully carried out.

The modified parboiling drum improved milling and cooking qualities of rice. The length of parboiled rice at the top of the drum for the improved vessel was generally higher 5.50 – 6.10 mm than the traditional vessel 5.40 - 5.90 mm. The milling recovery of the three rice varieties ranged from 69.63 - 73.30% for the top of the improved drum which was higher than values recorded for the traditional 56.00 - 72.27% at top position of the traditional parboiling technique. The improved drum also retained higher temperature during steaming, making it more economical to use.

The findings showed that the quality (dimensions, milling and cooking attributes) of rice from the modified parboiler were better as compared to the use of traditional drum. The improved drum could be used to replace the traditional parboiler for rice processing (soaking, steaming) prior to drying and milling as it has shown more prospects for maintaining uniformity of product after parboiling.

Recommendations

The following recommendations are made based on the results of the research:

1. The use of the improved parboiler should be encouraged in rice processing clusters.
2. The use of Stainless steel in the fabrication of the drum could be introduced in order to enhance even distribution of heat during

parboiling and reduce intermittent leakage from the drum.

3. Steam jets should be incorporated into the parboiling drums so as to enhance effective steam distribution.

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