

Development on improved parboiling equipment for paddy rice in Benin

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Abstract

Rice is a staple food largely cultivated and consumed in Benin. During processing, it is important to parboil paddy rice. But the current traditional method of parboiling paddy does not enhance quality and yield of rice at husking. To improve quality and yield of rice, a parboiling equipment was developed and tested. Its performance was evaluated by measuring the time for parboiling operation and for sun drying the parboiled paddy. The rate of cracks and the yield of rice after husking were also determined and compared to those obtained when using the traditional method. Results from tests showed that the improved method gives better quality and yield of rice. This method contributes to significant reduction of the rate of cracks from approximately 24% for the traditional method (TM) to less than 15% for the improved method (IM). The rice husking out-turn also improves from 64% for the TM to about 70% for the IM. Rice parboiled using IM requires lesser sun drying time. The average time of parboiling operation (19 min) does not vary significantly for both IM and TM. But parboiling using the IM becomes faster at subsequent operations. The IM appears also more economical.

Keys words: Apparatus, *Oryzae sativa*, parboiling, *performance*

Introduction

Parboiling of rice is an operation that consists of pre-cooking paddy with vapour. It is an operation that enhances quality and yield of rice at husking (Diop, et al 1997). The yield of pre-cooked rice after husking was shown to be approximately 70% as against 55% for none pre-cooked paddy. Also, the nutritional values (riches in vitamin A and protein) and the appearance of pre-cooked rice are definitely much better (FAO, 1987). Works of HOUSSOU (2003) on rice parboiling in Benin showed that the traditional parboiling method is not adequate. An attempt at improving on this method led to the adoption of a new system of pre-cooking rice by steaming. During the process two half-barrels were superposed and used. Although, this new system contributed to the enhancement of quality and yield of rice, the material of construction of barrels offers low resistance to rust and heat and this consequently reduces their shelf life (not more than six months). The very short shelf life of the main component of the new system combined with the high cost (\$ 36 US) of its realisation make it unprofitable for farmers. To make parboiling technique more powerful from the improvement point of view of rice quality and good resistance to heat of the container material, a new equipment was developed. The present work presents the result from tests of performance of newly developed equipment compared to that used in traditional method of parboiling paddy.

Materials

One variety of paddy rice (DJ11365) was used for the tests. This variety is among those in extension phase in Benin. The characteristics of the chosen variety are shown in table 1.

The main components of improved parboiling equipment consisted of a moulded aluminium alloy pot and a parboiling vat. This vat was constructed at a metal workshop and it is made up galvanized iron sheet. To properly achieve steaming, the vat was perforated at the base and around $\frac{1}{4}$ of its body from the base. Plate 1 presents the sketch drawing of the vat that was used during construction After parboiling, a special platform was used to dry the parboiled paddy.

Study area

The test of performance was carried out in two (2) villages, Kpakpaza and Sowe around Glazoué in Zou Department area of Benin where rice is predominantly cultivated and parboiled. In those areas, two different groupings / associations of women namely Kachefetoga and Kamassou, with good experience in processing of rice were engaged for the trials. These groupings were supervised by the research team.

Table 1. Characteristics of the variety of paddy used for the tests.

Variety	Type of rice	Vegetative cycle (days)	Means dimensions (mm)		
			Length	breadth	thickness
DJ11365	Low land	110-120	9.49	2.56	2.05

Materials for the traditional method are pot, baskets and bags of jute.



One specificity of the improved method is that it prevents water from getting into the paddy. The steam generated passes through the perforated vat to the paddy grains.

Drying and husking:

After steaming, paddy rice was dried and husked. During paddy processing, data related to steaming and sun-drying times of paddy were recorded. The rate of cracks and the yield of rice after husking were also determined. These parameters were used to evaluate the efficiency of parboiling methods.

Type of analysis

The mean values of steaming time, drying time, rate of cracks and yield of rice were calculated using SPSS program and the analysis of variance (ANOVA) was performed to test for the significance difference between the improved and the traditional methods.

Experimental design

The work was done in two phases:

Phase 1

The steaming vat was constructed at a metal workshop, based on technical design by the project. Dimensions used for the vat were chosen based on the size of the moulded aluminium alloy pot bought from the local market.

Phase 2

The developed equipment was tested by steaming rice and comparing the results with those obtained with traditional method. Four replicates were applied for the traditional and improved technologies. For each replicate, 40 kg of paddy was used. The main stages of parboiling rice consist of:

Soaking

The pre-cleaned rice in water warmed to a temperature of 80°C and allowing the product to cool overnight.

Pre-cooking

Soaked paddy rice in the vat was inserted in the pot containing enough water. The water level was such that it does not reach the bottom of the vat for the improved method. But for the traditional method paddy was poured directly in the pot containing very little water and covered with jute bags in order to conserve vapour during steaming. The product was fully steamed when bursting of balls of some grains were observed.

Results

Design characteristics of improved parboiling equipment

The newly design parboiling equipment consists mainly of a parboiling vat and a big pot. The equipment can be constructed with locally available materials and skills. The production cost is within reach of an average income farmer. The equipment are quite durable and resist heat and rust. The main characteristics are summarised below.



Capacity of vat varying 50 kg (max.), Multiple purpose use, Good resistance to rust. Drying of steam paddy 2hrs (max), Rate of cracks < 15%, Yield 70% (approximately)

Plate 2: Equipment for the improve parboiling method

Table 2. Evaluation of two parboiling methods

Parboiling parameters	Traditional method (TM)	Improved method (IM)
Parboiling time (Min)	18,25	20,25
Sun drying time (min)	167,50 **	131,25**
Yield (%)	64,32**	70,23**
Rate of cracks (%)	24,05***	12,31***

Table 3: Record of data from the tests both for traditional and improved parboiling methods (for reference purpose)

Essays	Traditional method				Improved method			
	Parboiling time (Min)	Sun drying time (min)	Yield (%)	Rate of cracks (%)	Parboiling time (Min)	Sun drying time	Yield (%)	Rate of cracks (%)
1 st	18	170	65,04	2,7	31	120	70.01	13.30
2 nd	19	180	66,00	24,01	17	135	68.95	14.5
3 rd	18	160	62,00	25,60	16	130	72.02	11,74
4 th	18	160	63,35	23,90	17	140	69.95	10,15

Evaluation of traditional and improved parboiling methods

The improved method is significantly ($p < .05$) different from the traditional method when considering the time of main operations and the quality (rate of cracks) and yield of rice obtained (Tables 2).

The average time of steaming operation does not vary for both improved and traditional methods. However, when using the improved method the time of steaming is longer at the first replicate. These times decrease and become stable and lower with lesser fire wood consumption at subsequent replicates. Longer time is required to dry steamed paddy when using the traditional method. But for the improved method this time is reduced (Table 3).

The improved method gives better quality and yield of rice. Its use contributed to the reduction of cracked rice in the product. The average rates of cracks are 12 % and 25% when using the improved method and the traditional method respectively. Rice husking out-turn improves as well by increasing from approximately 64% for traditional method to about 70% for the improved method.

Discussion

The newly developed parboiling equipment consists of two major components, the vat and the pot. At the beginning of steaming some times are required for heat transfer between the two components (vat inserted into the pot). This explains the delay and the increase in steaming time at the beginning of parboiling operation using the improved method. Once

the required heat is established the time of steaming becomes shorter and stable.

The improved parboiling equipment prevents water from getting into the product. Steam generated passes through the perforated vat to paddy grains. At the end of the operation paddy grains are uniformly steamed. But during traditional steaming, paddy is poured directly into the pot. As such water either readily get into part of the grains especially those at the bottom of the pot or the product gets short of water and burns. At the end of steaming, moisture content in the product is higher and not uniform. Paddy steamed using the traditional method therefore requires longer time to be completely dried. During this drying process, some grains are over dried and these crack easily during husking. The rate of cracks is increased thereby causing low yield. When the product gets burnt during steaming there is presence of black burnt paddy in the product. The higher the presence of cracks or burnt paddy in rice the lower its quality. Therefore, the traditional method of parboiling paddy does not enhance good quality of rice. This confirms results found by Diop (1999), which indicated that if traditional parboiling is not properly conducted for one reason or the other the nutritional values of rice are reduced.

As regards fuel consumption, using the improved method is faster and consequently consumed less firewood when a great quantity of rice is to be treated. Therefore, the improved method appears more economical.

Conclusion

The newly developed parboiling equipment enhances quality and yield of rice produced. The improved method of parboiling is better than the traditional method. Its use appears more economical. Nevertheless, further financial and economic studies of the new parboiling equipment are necessary.

Acknowledgments

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