Journal of Dry Zone Agriculture, 2016, 31: 31 - 35

ISSN 2012 − 8673

Determination of Quality of Parboiled Rice by Adapting Different Processing Practices in Jaffna Peninsula

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Abstract: Parboiling is a hydrothermal treatment applied before milling in order to increase milling recovery by minimizing broken rice percentage in the end product. Parboiling has three stages namely soaking, steaming and drying. Soaking and steaming play a key role to harden paddy grains by changing physical properties. Therefore, quality determination of end product is important. Effect of soaking and steaming duration on rice quality was investigated with respect to parboiling process. One kilogram of paddy was taken as sample. There were five treatments assigned with three replicates such as un-soaking and un-steaming, soaking and un-steaming, soaking and steaming an hour, soaking and steaming 2 hours soaking and steaming 3 hours. Soaking duration 12 hours at 30 ^{o}C was kept constant for all treatments. Machines were used on husking, milling and polishing of rice for analytical grade to evaluate the percentages of de-husked yield, head rice yield and broken rice yield, respectively. Lab scale detectors were used to count the quality attributes of white belly, heat damaged grains and whiteness value, which reflected the appearance of final processed product in local markets. Among the treatments, higher yield of de-husking rice, milling rice recovery and less percentage of broken rice were 78.4 %, 65.18 % and 11.9 %, respectively and obtained from the treatment of soaking 12 hours at 30 ^{o}C and steaming 2 hours of duration. The results revealed that steamed with two hours duration had given very less white belly, whereas un-soaked steamed rice kernel had highest percentage of white belly. The percentage of damaged grains by heat increased with the increasing the duration of steaming. There was significant difference on degree of de-husking, milling and broken percentage at 5% alpha level among treatments in un-soaked, un-steamed, soaked-un-steamed and soaked-steamed. Sample of Un-soaked with un-steamed had highest whiteness value while soaked with steamed samples yielded lowest whiteness values From these results, it can be concluded that the parboiling process has to be designed with soaking and steaming strategies to minimize the percentage of broken rice at the end product.

Keywords: Brown Rice Parboiling, Bulk soaking, Cottage milling and Traditional steaming

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1. Introduction

Rice parboiling is a hydrothermal process applied as a treatment prior to the normal milling stage. Paddy parboiling is certainly the most ancient process, which has been applied to thresh paddy. It was probably invented to facilitate the easy removal of husk by pounding in the pestle and motor practical advantages are edible rice contain less broken and good taste, flavor and hardness for cooked product to suit the consumer, and that can be stored for longer time without being sticky and rancid. The parboiling process is to produce physical, chemical and organoleptic modification in the rice with economic and nutritional advantages. Whatever may be the method of parboiling some of the main advantages are, the milled rice yield and head rice yield are higher than raw paddy milling and keeps longer and more resistance to insect attack (Pillaiyar, 1988).

There are three important steps involved in paddy parboiling soaking, steaming and drying. The main objective of soaking is to achieve quick and uniform water absorption. The lower the water temperature is the slower the soaking process (Athapool, 2000). Paddy soaked in water at ambient temperature (20-30 ^{0}C) takes 36 to 48 hours to reached 30 % moisture content, where as in hot water (60 to 65 ^{0}C), it takes only 2 to 4 hours. Generally saturated steam at a pressure of 1 to 5 kg/cm^2 is used for steaming, steaming duration depends on the steaming arrangement, and steam temperature at atmospheric pressure it is always higher than that at which needed for gelatinization. The purpose of steaming is to increase the milling yield and to improve storage characteristics and eating quality. It improves the firmness after cooking and achieves better vitamin and salt retention in the milled rice. During steaming process the moisture content of the paddy rice increases because of the extra water formed by condensation. Water soluble substances spread inside the paddy grain, the granular texture of the endosperm become pasty during to gelatinization of starch. The cracks in the caryopsis become sealed and the texture of the endosperm becomes more compact. Paddy should be dried to 14 % moisture for safe storage or milling. If drying is done too fast, internal stress develops in the grain and causes breakage during milling. After drying is completed, the paddy should be allowed to stand for at least several hours preferably 1 or 2 days, before it is milled, to permit internal moisture difference and stresses to equalize. This study aims to determine the quality standards of parboiled rice through the degree of soaking and steaming.

2. Materials and Methods

2.1 Materials

Raw paddy (Moddai Karuppan – Jaffna Traditional Variety), Soaking water bath, Electric steam cooker, Hot air circulatory Oven , Lab scale electric Huller, Lab scale electric polisher, Lab scale electric grader, and Whiteness tester (Reflection meter) were used.

2.2 Methods

Sample Preparation: The paddy sample (10 kg) was cleaned before soaking. Paddy was soaked in a hot water bath for 12 hours at

30 °C. After soaking the excess water was drained-off then soaked paddy sample was steamed in an auto-clave at the pressure of 1.0 kg/cm^2 for 1hr, 2 hours and 3 hours durations. Triplicate was made for each treatment groups. Finally drying was done at two stages; first paddy sample was tempered under sun drying for a day and then aged at atmospheric temperature (25 °C) until the paddy sample reached a moisture content of 14 %. The quality parameters obtained from milling test of three different steaming duration of parboiled (1 hour, 2 hours and 3 hours) and two control (un-soaked & un-steam and soaked & un-steamed) paddy.

Milling and Polishing: Before milling, the moisture content of sample was measured by conventional oven at 30 °C. Then 500 g of each sample was milled by Satake huller and polished for 2 min by using Satake Polisher. The weight of milled rice was recorded. The following parameters for evaluating the quality of parboiled rice were determined which analyzed by statistically using standard statistical packages verson 2000.

- Milled yield refers to the amount of rice obtained after the milling process. This was expressed as percentage (%)
- Head yield refers to the head rice obtained after milling (> ¾). This expressed as percentage (%)
- Broken refers to the pieces of rice kernel (< ¾) that are less than the size of the head rice (%).
- White belly grains refer to the un-gelatinized starch indicated by a white opaque spot at the centre of the kernel (%).
- Heat damage grains refer to the discolored rice kernel (%).
- Whiteness refers to the degree of whiteness of the sample surface with reference to the standards.

3. Results and Discussions

Results of the different parboiled treatments on rice quality parameters are shown in Table 1. It was found that there were no significant differences found between un-soaked and soaked un-steam. But milling yield was significantly increased in the treatment of soaked with steaming and was higher while increasing steaming time because of splitting of husk during steaming Therefore, parboiled rice was easily de-husked and yield more milling rice.

Head rice yield was increased with increasing in steaming time and was more at 2 hours steaming. More treatment (3 hours) could conclude the optimum steaming time. During steaming, parboiled rice kernel gelatinized and sealed the cracks inside, therefore kernel become compact and harder, therefore, less rice was broken and increased head rice yield during milling. Broken rice yield was inversely proportional to head rice yield and was found more with the paddy without steaming.

Parboiled rice is translucent because any chalkiness inside rice kernel disappears during steaming. Therefore no light scattered and diffracted during detector process (Hall, 1980).

Table 1: Quality parameters obtained from milling test of parboiled rice

Parameter	Rep.	Sam.	DH. (%)	MD. (%)	HR (%)	BR (%)	WB (%)	HD (%)	WV (%)
Un soaked	R1	500 g	72.51	52.33	32.17	20.16	8.6	0.66	51.90
Un steam	R2	500 g	73.77	52.99	33.29	19.70	8.51	2.00	50.00
paddy	R3	500 g	75.46	51.90	32.46	19.43	9.2	2.00	49.70
Soaked	R1	500 g	76.66	44.77	26.89	17.88	45	0.85	44.50
Un steamed	R2	500 g	77.59	44.91	25.72	19.19	31.2	0.80	43.80
	R3	500 g	77.54	44.19	26.93	17.26	27.2	0.90	45.50
Soaked	R1	500 g	78.76	48.18	36.17	12.02	26.5	1.00	36.00
Steamed	R2	500 g	78.77	49.70	37.05	12.66	29.5	1.50	36.40
1 hour	R3	500 g	78.75	47.87	34.61	13.26	27.5	1.20	36.20
Soaked	R1	500 g	81.60	64.21	52.31	11.90	2.00	4.50	21.50
Steamed	R2	500 g	76.41	65.18	53.05	12.13	1.00	6.00	20.60
2 hours	R3	500 g	77.22	66.10	54.27	11.83	1.00	5.30	21.10
Soaked	R1	500 g	78.76	56.46	43.42	13.04	16.5	3.30	33.50
Steamed	R2	500 g	78.34	58.57	44.33	14.24	15.0	2.60	35.00
3 hours	R3	500 g	78.85	57.16	45.78	11.38	18.5	2.20	33.50

Note: Rep: replicates; Sam: samples; DH: Dehushed; MD: Milled; HR: Head rice; BR: Broken rice, WB: white belly; HD: heat damage; WV: Whiteness value

The result reveals that steaming with 2 hours duration had almost very less white belly and un-soaked steamed rice kernel had highest white belly. The heat damaged grains were increased with the increase of steaming time was found to be more in 2 hours of steaming. There was significant difference on quality parameters of milled rice yield and head rice yield are higher than raw paddy milling among treatments in un-soaked un-steamed, soaked un-steamed and soaked steamed. Highest whiteness value was obtained from Un-soaked un-steamed sample while lowest whiteness values was obtained from soaking and steaming. This may be due to get rid off of many water soluble pigments from the kernel surface and make parboiled rice less white during soaking and steaming get them out (Pillaiyar, 1998).

4. Conclusions

Parboiling process (soaking and steaming) could improve milling characters of paddy, it resulted in more milling yield, more head rice yield, lesser broken rice and lower white belly percentage. From this study, steaming with two hours was found to be best for this selected variety. Result from this study reveals that soaked but un-steamed paddy showed no significant difference with un-soaked un-steamed paddy regarding white belly and whiteness and a significant difference was obtained in terms of milling yield and head rice yield and this might be due to the soaking and subsequent drying resulted in swelling and shrinking of cells which made cracking of grains. Though most parameters showed that parboiled rice was better than un-parboiled rice, the only one drawback was whiteness.

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Annexure 1: Result of ANOVA, Two-Factor with replication

Summary	Count	Sum	Average	Variance
Row 1	7	238.91	34.13	679.56
Row 2	7	246.43	35.20	582.41
Row 3	7	241.02	34.43	635.61
Row 4	7	235.07	33.58	991.02
Row 5	7	246.48	35.21	731.35
Column 1	5	387.00	77.40	4.15
Column 2	5	268.17	53.63	63.82
Column 3	5	192.97	38.59	109.07
Column 4	5	75.36	15.07	12.91
Column 5	5	87.74	17.55	194.45
Column 6	5	10.94	2.19	3.34
Column 7	5	185.73	37.15	121.68

Annexure 2: Result of the ANOVA Table

Source of Variation	SS	df	MS	F	P-value	F crit
Rows –Replicates	13.90	4	3.47	0.04	1.00	2.78
Columns - Treatments	19695.98	6	3282.66	38.93	0.00	2.51
Error	2023.77	24	84.32			
Total	21733.64	34				