World Academy of Science, Engineering and Technology
International Journal of Nutrition and Food Engineering
Vol:6, No:3, 2012

Analysis and Study of Parboiling Method, and the following Impact on Waste Reduction and Yield Increase of Iranian Rice in Paddy Conversion Phase

F. E. Cherati, R. Babatabar and F. Nikzad

Abstract**—**An important goal of parboiling is a decrease of rice broken percentage and at the beginning Selected paddy of *variety* of rice *Tarom* and soaked at three different temperatures 45 Cº, 65 Cº and 80 Cº orderly for 5 hours, 4 hours and 1.5 hours to moisture of 40 % and then in steaming stage to operate these action two steaming methods are selected steaming under pressure condition and steaming in atmosphere pressure and In the first method after exerting air, the steam pressure is increase to 1 Kg/Cm^2 which is done in two different duration times of 2.5 and 5 minutes and in second method used of three times of 5,10 and 15 minutes and dry to 8% moisture and decreases of rice broken percentage at best condition in *variety* of *Tarom* of 37.2 % to 7.3 % and increases yield percentage at best condition in *variety* of *Tarom* of 69.4 % to 75.93 % and bran percentage decreased in *variety* of *Tarom* of 9.53 % to 2.2-3.2 % and this issue cause increases yield percentage in rice and use of This method is very significant for our country because broken percentage of rice in our country is 23-33 %.

Keywords**—**parboiling, Soaking temperature, broken rice, yield percent of rice, bran

I. Introduction

PARBOILING is a process developed for improving rice quality. It consists of soaking, steaming and drying of the rough rice. The major reasons for parboiling rice include higher milling yields, higher nutritional value and resistance to spoilage by insects and mold [4, 3]. The parboiling process is applied to rice with a preliminary objective of hardening the kernel in order to maximize head rice yield in milling. Besides milling yield, it was also the realization of the nutritional and health benefits of parboiled brown rice Bhattacharya [2] compared to raw brown rice that created the awareness and importance of parboiling among consumers and manufacturers. Several studies have reported on parboiling processes as reviewed [10]. Traditionally, parboiling consists of steeping rough rice in water at room temperature followed by steaming or boiling at 100 C° and sun-drying. Recently, more sophisticated procedures such as dry-heat parboiling and pressure parboiling have been applied [1].Parboiling with gelatinizing of rice starch, and elimination and filing rice seed chaps, results in improved resistance of seeds against exerted tensions, during paddy threshing operations.

Fazlollah Eskandari Cherati, Young Researchers Club, Islamic Azad University, Ayatollah Amoli Branch, Amol, Iran. (phone: +09809113002679; fax: +09801924822153; corresponding author e-mail:f.eskandaricherati@gmail.com)

Ramzan Babatabar,Young Researchers Club, Islamic Azad University, Ayatollah Amoli Branch, Amol , Iran.

Fariborz Nikzad, Young Researchers Club, Islamic Azad University, Ayatollah Amoli Branch, Amol , Iran.

Also, nick percentage is reduced significantly, yield percentage increases, and because of leakage and penetration of bran into the rice seed, bran percentage is reduced significantly and crust percentage is reduced slightly to, which justifies yield percentage improvement [8] .

Nearly 3000 years ago, parboiling method was settled in Indian subcontinent, in a very simple form for the first time, and has improved gradually until now that, it is used in most of southeast Asia countries like; Sri Lanka, Thailand, China, Bangladesh, Philippines, Japan ,And Nepal. According to the last report of IRRI, 60 % of the rice produced in India, is parboiled. Formal investigations were first done in 1928, by Subrahamany, in India. Also, after founding CFTRI in 1944(Central Technological Research Institute) Reference [3] shows that during some studies done in India based on determining the impact of parboiling on characteristics of rice, acknowledged that parboiled rice can own its desirable characteristics in terms of taste and color like raw rice to, and this highly depends on parboiling technique, soaking and steaming temperature, and PH of the used water.

Reference [5] shows at Egypt, specified two samples of long- grain rice (Arabi) and, short-grain rice (Nahada) in laboratory scale, to determine the impact of processing under pressure ,on quality of paddy threshing, which all characteristics of paddy threshing are promoted and improved ,during it, and this is especially true in variety of short-grain rice(Nahada), and with increasing the steam pressure to approximately (0-15 kg/cm^2) in steaming stage, the quality of threshing(recycling intact rice) is much more improved, too.

In paper [6] determined 60, 70, and 80 Cº degrees of a threshold ,above which, there would be an inverse relation between temperature and soaking time, and end of soaking time was when humidity of paddies reached near 43.5% db. Moreover, steaming process was used for gelatinization of rice starch in an under-pressure situation(196.14, 147.11, and 198.07 Kpa) and timings of (300,600,900, and 1200 s) , and drying rice seeds in 98 Cº degree up to final humidity of 13.64%, with 98.07 Kpa pressure and 600 s timing, results in brightest color of rice, without cracked ,broken and turgid seeds. In [14] presents during parboiling rice and after implementing texture testing with *instran* device, found out that the stiffness and resistance of rice seeds are increased during parboiling which is because of gelatinization of rice, and that is why the resistance of rice is increased during paddy threshing. Reference [15] shows that 70-90 Cº of soaking for 2-5 hours , and steaming in 120- 160 degree with 3.9 m/s intensity, which showed that by increasing the

steaming temperature from 120 to 140 Cº, more head rice will be resulted, totally.

In paper [16] used soaking temperatures of 75 Cº for 2.5 hours and 65 Cº for 4 hours, and cold water for 48 hours, for parboiling, and used under atmosphere pressure situation for 5 seconds, for steaming, and found out that by increasing the pressure during steaming to 1.25-6-25 Kpa, moisture content increases, and with soaking temperature enhancement, cracked rice percentage decreases. Reference [12] shows that soaking temperature of 65 Cº for 6 hours , and after soaking, final humidity reached 30-35%, a situation in which timing of soaking should be long enough for the final humidity to reach this degree, and used under atmosphere pressure steaming in 90-100 Cº for 5-60 minutes , and used solar drier with 26-28 Cº for 18-24 hours up to final humidity of 3-7.7% for drying, and after drying was done, the produced rice was packed in PE bags and it was clarified that , by increasing timing and steaming intensity , whiteness of rice seeds decreases, color value increases which is measured by hunter lab instrument, hardness which is measured in texture(tissue) testing increases, and milling yield is increases .

Therefore this study aimed to investigate the effect of soaking temperature on cooking quality physicals and cooking properties of parboiled rice.

II. Materials And Method

Needed paddy from *Tarom* variety, in 100 kg quantity, is supplied by national rice research institute- deputy of Mazandaran, and is fully winnowed and verified by the institute and weighed and coded in 1 kg scale.

A. Soaking

The purpose of this stage is to absorb water up to 40 %, and facilitate cooking and heat transferring during next steps. For this purpose, three degrees of 45 Cº for 5 hours, 65 for 4 hours which is bellow gelatinization temperature, and 80 for 1.5 hours which is above gelatinization temperature, are used. 100 kg weighing double-walled stainless steel cooking boiler, equipped with water circulation was used for soaking [12].

B. Cooking

The purpose of cooking stage is to complete parboiling operations and gelatinizing rice starch, which is done by two methods of cooking under pressure and cooking under atmosphere pressure, and vertical autoclave is used for this purpose. In first method, after air exits, we set the steam pressure on 1 Kg/cm^2 . For cooking under atmosphere pressure, we use cooking periods of 5, 10, and 15 minutes, and for cooking under pressure we use 1 kg/cm^2 for 2.30 and 5 minutes [11].

C. Drying

For this purpose, dryers was used with ambient temperature, during which, paddies were wide spread in a shelter, and after three days paddies are dried out, and final humidity reaches near 7 % [13]

D. Peeling paddies

For this purpose, Testing *hosker*, THU 35B model, peeler was used which is made in Japan. This phase of operations was done in azandaran Rice Research Institute.

E. Whitening paddies

The Whitener *Seteka TM 05* whitener with maximum capacity of one kg, 2.5 minutes timing and frictional method, which is made in USA, was used for whitening produced brown paddies. This phase of operation was done in Mazandaran Rice Research Institute, too.

F. Yield percentage of head rice

Is the amount of total output of head rice from whitener machine, and is represented, proportional to initial amount of paddy.

G. Fracture percentage

For this purpose, we take 40 gr of head rice, separate cracked seeds which are less than ¾ an intact seed, and calculate the percentage, according to initial paddy amount.

III. Results And Discussion

In fracture percentage test, we see that, except the existing interaction between variety treatments, soaking temperature, and steaming situation which only make sense in possibility level of 0.05 ,the impact of other treatments are only meaningful in possibility level of 0.001,and in yield percentage test, except interaction between soaking temperature treatments and steaming situations, and the interaction between variety treatments , soaking temperature ,and steaming situation which are meaningless ,the impact of other treatments are meaningful in possibility level of 0.001.

It has been observed in bran percentage test ,that except soaking temperature treatment, which makes sense in possibility level of 0.001, the impact of other treatments are meaningless on this test.

TABLE I
Analysis Of Variance Treatment

SOURE OF variation	Mean of Square		
	Fracture percentage	Percent yield	Percent bran
Variety	24.95^{***}	52.97^{***}	0.05^{ns}
Soaking temperature	6.04^{***}	67.84^{***}	6.71^{***}
Steam conditions	155.39^{***}	17.80^{***}	0.83^{ns}
Variety× Soaking temperature	127.78^{***}	11.01^{***}	1.26^{ns}
Variety× Steam conditions	51.22^{***}	13.57^{***}	0.70^{ns}
Soaking temperature× Steam conditions	2.89^{***}	2.42^{ns}	0.11^{ns}
Variety ×Soaking temperature× Steam conditions	1.89^{*}	1.62^{ns}	0.12^{ns}
Error	0.67	1.32	0.48

* significant at 5% of confidence level
** significant at 1% of confidence level
*** significant at 0.1% of confidence level
ns not significant

A. Simultaneous effect of testifier and treatments of number, soaking temperature and steaming situation:

In this part, different treatments are comprised by the testifier, and the impact of parboiling process on them, is studied. As it is demonstrated in Table II, in fracture percentage test, the difference between testifier average of both treatments, are meaningful with all treatments, and according Table II, in *Tarom* variety, we see least of fracture percentages in soaking temperature treatments of 65 Cº and atmospheric pressure for 15 minutes timing, and a 400 % decrease was observed in this variety. For yield percentage, the difference between testifier and all treatments are meaningful, and in *Tarom* variety, highest percentage of yield is in soaking temperature treatment of 45 Cº and steaming under atmospheric pressure for 10 minutes, during which, a 6.53 % increase in yield percentage in observable.

In the national scale, this yield percentage increase is significantly important, and could guide the rice production industry to self-sufficiency in our country.

TABLE II
COMPARATIVE TEST OF AVERAGE, USING DUNCAN METHOD FOR SIMULTANEOUS IMPACT OF TESTIFIER

	Mean of Square		
Treatments	Fracture percentage	Percent yield	Percent bran
T45×ATM×M5	20.32 ^{c}	72.03 ^{hi}	3.43 ^{cde}
T45× ATM ×M10	15.70 ^{d}	76.18 ^{b}	2.57 ^{e}
T45× ATM ×M15	6.26 ^{kl}	74.26 ^{bcdefg}	2.87 ^{de}
T45×PR1×M2.5	10.71 ^{fgh}	72.23 ^{ghi}	3.35 ^{cde}
T45× PR1×M5	12.78 ^{e}	75.47 ^{bc}	2.78 ^{e}
T65× ATM ×M5	14.57 ^{d}	71.31 ^{i}	3.69 ^{cde}
T65× ATM ×M10	10.68 ^{fgh}	75.77 ^{bc}	2.72 ^{e}
T65× ATM ×M15	4.39 ^{mn}	73.84 ^{cdefgh}	3.45 ^{cde}
T65× PR1× M2.5	7.65 ^{jk}	72.01hi	3.65 ^{cde}
T65× PR1× M5	8.78 ^{ij}	74.83 ^{bcde}	3.26 ^{cde}
T80× ATM × M5	15.31 ^{d}	71.16 ^{i}	3.73 ^{cde}
T80× ATM × M10	10.79 ^{fgh}	72.50 ^{fghi}	3.22 ^{cde}
T80× ATM × M15	5.53 ^{lm}	71.51 ^{i}	3.67 ^{cde}
T80× PR1× M2.5	8.64 ^{ij}	70.91 ^{i}	3.80 ^{cde}
T80× PR1× M5	9.78 ^{ghi}	71.65 ^{i}	3.29 ^{cde}
witness	36.20 ^{a}	68.67 ^{k}	9.65 ^{b}

T45,T65 and T80= parboiling rice soaked at temperatures 45,65 and 80 ,respectively
M2.5,M5,M10 and M15= time for cooking to minute 2.5, 5, 10 and 15 ,respectively
ATM= atmospheric pressure
PR1= steam pressure 1 Kg/Cm^2

According to Table II, we see that in bran percentage test, the difference between different treatments average and testifier average is meaningful in both variety, and the difference between those treatments themselves, does not make much sense. In *Tarom* variety, bran percentage is decreased from 9.53 to 3.2-3.6 %, which is a significant difference, and is triggered, by leakage and penetration of bran into rice seeds, during parboiling stages, and it also justifies the increase of yield percentage. Because bran holds highest nutritional value in rice, these processes have a very desirable impact on nutritional value of rice.According to the last statics, annual paddy production in our country is 3.3 million tons [7], and according to the data extracted from *Tarom* rice, we can see a 37.2 % and 69.4% of fracture percentage and yield percentage, respectively**,** by which, total head rice production is 2266110 tons, and including 37.2 % fracture it is 842992.92 tons, and total intact head rice is 1423117.08 tons.At best, yield percentage during parboiling reaches 75.93%. This produces a total amount of 2513940 tons. In this situation, including 7.3 % fracture percentage we will have 212717.62 tons of fractured rice, and 2301222.38 tons of intact rice.

IV. CONCLUSIONS

Soaking temperature is one of the most important processes of rice parboiling. Our present findings have demonstrated that significant differences were found in cooking properties of parboiled, Also In the national scale, the parboiling method is important, and could guide the rice production industry to self-sufficiency in our country.

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