International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(2): 505-507

Received: 22-01-2019
Accepted: 24-02-2019

Sanjana Pandey
Dept. of Post-Harvest Process & Food Engineering, CAE, JNKVV, Jabalpur, Madhya Pradesh, India

CM Abroal
Dept. of Post-Harvest Process & Food Engineering, CAE, JNKVV, Jabalpur, Madhya Pradesh, India

Correspondence
Sanjana Pandey
Dept. of Post-Harvest Process & Food Engineering, CAE, JNKVV, Jabalpur, Madhya Pradesh, India

Effect of microwave heating on moisture absorption during hot water soaking of paddy for parboiling

Sanjana Pandey and CM Abroal

Abstract
Rice (*Oryza sativa*) is the staple food of half of the world population. But it is necessary to reduce the losses in the post-harvest processing of rice for completing its demand. To reduce these losses, there is a very important process of parboiling which is done before the rice milling, parboiling of paddy is also known as pre milling treatment of paddy. The effect of microwave heating on hot soaking of paddy was studied. The cleaned paddy of moisture content 13.6 (% db) was weighed and 28 samples of 250 g each were prepared. To attain a moisture content up to 47 (% db), the paddy samples were soaked and heated in MW oven of 800 W at various power time combinations to give a total heat to each sample in range of 48-120 KJ. The moisture absorption by paddy increased with the increase in energy supply for heating at various power levels. At lower power levels of 320 W and time combination of 375 seconds the moisture absorption (47%) was better for supplying the same heat energy (120 KJ) as compared to other power levels.

Keywords: Microwave heating, moisture absorption

Introduction
Paddy (*Oryza sativa*) is the most important crop grown in Asia. India is one of the world's largest producers of rice, accounting for 20% of all world rice production and is also the fourth largest exporter of rice in the world. In the Kharif season of 2017-18 crop year (July-June), rice production is estimated to be 944.8 lakh tonnes against 963.9 lakh tonnes in the previous year (Indian Rice Market Update, 2018). Parboiling is a hydrothermal process in which paddy is deliberately allowed to absorb water and later steamed to gelatinize the starch in the endosperm before drying and milling. The process of parboiling seals internal fissures in the rice grain resulting in higher Head Rice Yield (HRY) during milling (Manful *et al*. 2009) [3]. This process consists of three major steps soaking, steaming and drying. The processes involve soaking the paddy in hot water usually between 10 to 24 hours in order to saturate the paddy with moisture. The soaked paddy is then steam heated till it is gelatinized followed by drying and milling.

Modern methods of parboiling are energy and capital intensive, and are not suitable for small-scale operation at the village level (Roy *et al.*, 2011) [4]. The use of the microwave (MW) heating allows to achieve the following effects in rice: to improve its physical and chemical characteristics; to optimize cooking conditions (save energy and clean up time); to keep its nutritional and sensory properties; to substitute steaming and conventional drying during rice parboiling process by microwave treatment; to optimize the processing of puffed rice products (Kaasova *et al.* 2001) [2]. The process of parboiling is a hydrothermal process which increases the strength of rice grain by its gelatinization. This process consists of four main unit operation namely soaking, draining, heating and drying. For all these unit operations a big setup is required for steaming and drying. There is a very large heat (energy) loss during this process. To reduce these losses of energy, MW oven can be used for heating action during parboiling because in MW oven heat application is very efficient, uniform and less time consuming Graham *et al.* (2015) [1] studied the effects of initial soaking temperatures (IST) (30–90 °C) and steaming times (STM) (5–20 min) during artisanal parboiling on the quality of parboiled rice and found that total milling yield and head rice yields increased as the IST increased. Water absorption of the rice kernels during parboiling increased as IST increased and correlated positively with head rice yield.

Taghinezhad *et al.* (2016) [6] studied and formulated a mathematical relationship correlating the degree of starch gelatinization (DSG) of rice to the paddy moisture-electrical conductivity (EC) of paddy water during the soaking portion of the parboiling process. Optimum soaking times for 60˚, 65˚, 70˚ and 75˚C were determined to be 240, 180, 120 and 80 min. respectively. Paddy moisture (22.43–34.93%, wet basis), EC of paddy water (1.63–2.71 mS/cm) and DSG of rice (5.38–36.90%) increased with increasing temperature and soaking time. Taghinezhad and Brenner (2017) [5] studied the effects of parboiling indicators (soaking temperature and steaming time) on the degree of starch gelatinization (DSG) and several rice quality properties [head rice yield (HRY), color value, lightness, and hardness] of parboiled rice were investigated. The DSG and hardness increased with increasing soaking temperature and steaming time, while the HRY and lightness showed a maximum at a steaming time of 6 min.

In order to study the effect of various treatment combinations for power and time of microwave in parboiling operation, the effect of microwave heating on moisture absorption during hot soaking of paddy for parboiling was studied.

Materials and methods

Semi-dwarf variety of paddy (IR-36) was procured from the Department of Plant Breeding, College of Agriculture, JNKVV, Jabalpur. Paddy sample collected was cleaned and preliminarily open sun dried till moisture content of 13.6 % (db) was achieved. Each of sample (250 g) was carefully weighed and stored in microwaveable container and later subjected to different power and time combinations. Four different power levels of microwave ranging from 320 W to 800 W were selected along with different time combinations. Microwave heat treatment of paddy was done by using Bajaj 2300 ET-B MW oven at four different Microwave power levels (320, 480, 640 and 800 W) seven energy levels were selected and thus to obtain these energy levels combinations of exposure time and power were made. The distinct levels of selected energy were 48, 60, 72, 84, 96,108 and 120 KJ.

Table 1: Selected parameters for the experimentation

Independent parameters	Levels	Dependent parameter
Energy level	7	Moisture absorption during hot soaking of paddy
Power level	4	
Treatment combinations	28	

Table 2: Selected levels of the variables for experimentation

Energy (KJ)/Power (W)	48	60	72	84	96	108	120
320	150	188	225	263	300	338	375
480	100	125	150	175	200	225	250
640	75	94	113	132	150	169	188
800	60	75	90	105	120	135	150
Time of MW heating (sec.)							

The initial moisture content of paddy (IR-36) was determined by hot air oven method. Temperature controller and hot air oven was used for gravimetric method of moisture content determination. The temperature and time combination of 130 degree Celsius and 16 hours was used to find the moisture content. The samples were weighted initially before placing in the hot air oven. Final weight was also recorded and moisture content was calculated using the below equations.

$$\text{Moisture content (w.b.)} = \frac{Initial\ weight - final\ weight}{initial\ weight} \times 100$$

$$\text{Moisture content (d.b.)} = \frac{Initial\ weight - final\ weight}{final\ weight} \times 100$$

500 ml water was then gradually sprayed over the sample (250 g) collected allowing sufficient time (60 s to 375 s) and temperature (70° C) for its soaking. The activity was performed in a microwavable container which could later be used for heating in the microwave. The sample was transferred to the microwave and the specified power and time level was set. The paddy samples were microwave heat treated at four MW power levels (320, 480, 640 and 800 W corresponding to 40%, 60%, 80% and 100% power levels and energy levels (48, 60, 72, 84, 96, 108, and 120 KJ). The exposure time was calculated using power and energy relationship. The excess water was drained from the microwavable container and the surface water from the paddy was removed with the help of blotting paper. Each sample was weighed and labeled. The prepared (soaked and drained) samples were weighed and 250 g batch of sample was collected. The power used for treatments were 320,480,640 and 800 W. The time of treatment was selected on the basic of the range of energy between 48 to 120 KJ on the basis of selection trial which give different time of treatment for various powers of treatment e.g. for 320 W power, time of treatment is between 150 to 375 sec while in case of 800 W power, time of treatment is between 60 to 150 sec.

After selecting all 28 power time combinations, 28 samples of 250 g each were weighed and put into the Microwave according to the selected power time combination of Microwave heating. The microwave treated samples contains lot of surface moisture along with free gravitational water which can be easily drained out by gravity. The MW treated samples are left free into a sieve for draining out free water with the effect of gravity. Then these drained samples are wrapped into blotting paper to remove the hygroscopic water from their surface. When only pore water is remained inside the grains, the MW treated sample is measured for its moisture content in the hot air oven.

Results and discussions

The moisture absorption by paddy increases with the increased in the duration of exposure time for heating at various power levels (Fig 1). It was observed that at lower power levels of 320 W the moisture absorption was less at same exposure time as compared to other power levels i.e. 480, 640 and 800 W at the same time. The higher power level at same exposure time, the moisture absorption was high as compare to other power levels. It was due to the reason that at higher power level the operating temperature was optimum for the moisture penetration to the paddy and then the rate of moisture absorption was higher.

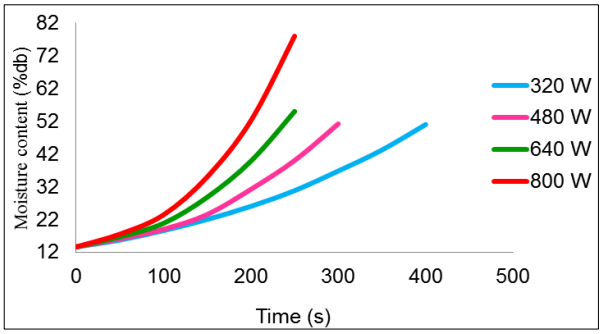

Fig 1: Effect of moisture content with time of microwave parboiling of paddy at different power levels

The moisture absorption by paddy increased with the increase in energy supplied for heating at various power levels (Fig. 2). It was observed that at lower power level of 320 W the moisture absorption was better for supplying the same heat energy as compared to other power levels.

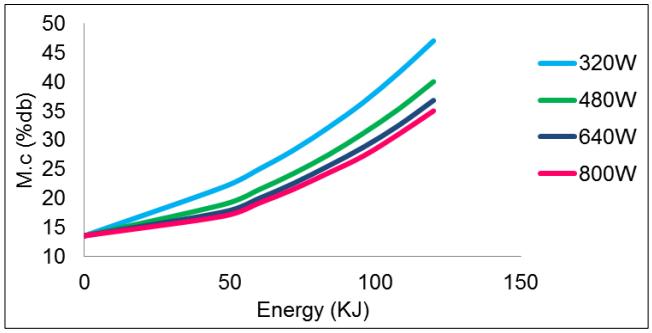

Fig 2: Effect of moisture content with energy of microwave parboiling of paddy at different power levels.

It was due to the reason that at lower power level the time required was higher to deliver the same energy content and thus gave more time for hot soaking of paddy.

Conclusion

The cleaned paddy of moisture content 13.6 (% db) was weighed and 28 samples of 250 g each were prepared. To attain a moisture content up to 47 (% db), the paddy samples were soaked and heated in MW oven of 800 W at various power time combinat ions to give a total heat to each sample in range of 48-120 KJ. After heating, these samples were left in ambient air for tempering. The samples were placed in the hot air tray dryer for drying up to moisture content of 13.6 (% db) after measuring their moisture content. The moisture absorption by paddy increased with the increase in energy supply for heating at various power levels. At lower power levels of 320 W the moisture absorption (47%) was better for supplying the same heat energy (120 KJ) as compared to other power levels. As the concept of parboiling of paddy in MW ovens is limited to the laboratory, it requires sincere efforts to optimize the process and conditions in order to produce parboiled rice from paddy in industry.

Acknowledgement

The authors acknowledge the laboratory facilities provided by CAE, JNKVV, Jabalpur, M.P and the staff of the department for their guidance and assistance during the experimentation.

References

1. Graham-Acquaah S, Manful JT, Ndindeng SA, Tchatcha DA. Effects of soaking and steaming regimes on the quality of artisanal parboiled rice. Journal of food processing and preservation. 2015; 39(6):286-2296.
2. Kaasova J, Kadlec P, Bubnik Z, Pour V. Microwave treatment of rice. Czech Journal of Food Sciences. 2001; 19(2):62-66.
3. Manful JT, Abbey LD, Coker RD. Effect of artisanal parboiling methods on milling yield and cooked rice textural characteristics. Journal of food quality. 2009; 32(6):725-734.
4. Roy P, Orikasa T, Okadome H, Nakamura N, Shiina T. Processing conditions, rice properties, health and environment. International Journal of Environmental Research and Public Health. 2011; 8(6):1957-1976.
5. Taghinezhad E, Brenner T. Mathematical modeling of starch gelatinization and some quality properties of parboiled rice based on parboiling indicators using RSM. Journal of Food Process Engineering. 2017; 40(3).
6. Taghinezhad E, Khoshtaghaza MH, Suzuki T, Minaei S, Brenner T. Quantifying the Relationship between Rice Starch Gelatinization and Moisture-Electrical Conductivity of Paddy during Soaking. Journal of Food Process Engineering. 2016; 39(5):442-452.