Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.7554

ISSN: 2582 – 2845

Ind. J. Pure App. Biosci. (2019) *7*(4), 225-230

Indian Journal of Pure & Applied Biosciences

Research Article

Effect of Infrared Pretreatment on the Cooking Characteristics of Traditional Rice Varieties

Aarati Pushparaj and Venkatachalapathy N.*

Department of Food Engineering, Indian Institute of Food Processing Technology, Pudukkottai Road, Thanjavur – 613005, Tamil Nadu, India

*Corresponding Author E-mail: venkat@iifpt.edu.in

Received: 7.06.2019 | Revised: 13.07.2019 | Accepted: 18.07.2019

ABSTRACT

Rice is the staple food of people in several parts of the world and is also second most extensively used up cereal in the world after wheat. As the key dietary source of carbohydrates, it plays a vital role in fulfilling energy requirements and nutrient intakes. The cooking quality of rice is one of the significant factors affecting the consumer acceptability. Freshly harvested rice becomes a sticky mass during the cooking process and only slight swelling is obtained. A good quantity of solids is lost into the cooking water resulting in a thick gruel and there are chances of splitting of rice kernels on sides. Therefore, some pretreatments can be done to improve the cooking quality of rice. In the present study, rice samples were exposed to infrared pretreatment with different power levels and exposure time. Cooking characteristics such as cooking time, grain elongation, water uptake, gruel loss, swelling index, alkali digestion score was analyzed after the treatment. The hardness of cooked rice was also measured. After the treatment it was observed that the rice samples showed higher cooking time and more elongation of grains when exposed to maximum power. Other characteristics namely swelling index, water uptake and gruel loss were also improved after the treatment. Hardness of rice also increased indicating that infrared pretreatment can be used effectively in enhancing the cooking characteristics of rice.

Keywords: *Infrared, Pretreatment, Cooking time, Swelling index, Hardness.*

INTRODUCTION

Rice (*Oryza sativa* L.) constitutes the basic food, sustaining two-thirds of the world population and numerous efforts are being done in order to maintain the grain quality of this crop in its different processing operations[4]. Rice is consumed largely as cooked whole kernel produced after dehulling and milling processes (Chukwuemeka et al., 2015). Milling process is a combination of various unit operations to convert paddy into well-milled silky-white rice having superior cooking quality attributes (Verma et al., 2015). Cooking time is significant as it determines stickiness and texture of cooked rice to a great extent (Chukwuemeka et al., 2015). Texture is defined as "the sensory indication of the structure of food and the way in which the structure responds to applied force".

Cite this article: Pushparaj, A., & Venkatachalapathy, N. (2019). Effect of Infrared Pretreatment on the Cooking Characteristics of Traditional Rice Varieties, *Int. J. Pure App. Biosci.* *7*(4), 225-230. doi: http://dx.doi.org/10.18782/2320-7051.7554

Texture of rice is affected by several factors such as rice variety, amylose content, gelatinization temperature and processing conditions (González et al., 2004). The physicochemical characteristics comprises of grain length, breadth, L/B ratio, hulling and milling percentage. The cooking qualities include amylose content, alkali spreading value, water uptake, volume expansion ratio and kernel elongation ratio (Verma et al., 2015). Optimum cooking degree of rice is usually assessed by the end cooking point where it absorbs maximum amount of water while the core of the cooked rice kernels gets gelatinized (Chukwuemeka et al., 2015). Cooked rice is complex food consist of diverse biopolymers, together with starch and proteins accompanied by moisture as a plasticizer. The gel consistency, amylose content and gelatinization temperature are the major parameters that are directly related to cooking and eating quality. Amylopectin structure, amylose content and composition of protein describes the difference in cooking quality of rice. Gelatinization temperature is accountable for cooking time, water absorption and the temperature at which starch permanently loses its crystalline order during cooking. The consistency of gel is responsible for softness and the amylose content for texture of cooked rice (Verma et al., 2015). Infrared heating has great potential to be used as a workable, environment friendly technology for attaining synchronized high drying rate, good milling and sensory quality, disinfestation, and disinfection of freshly harvested rough rice. It can also be used as an active method to improve the storage stability of rough and brown rice (Faruq et al., 2003). However, no data was reported regarding the effect of infrared heating on the physicochemical properties of rice during storage. Thus, this research aims to determine the impact of Infrared heating on the cooking characteristics of traditional rice varieties.

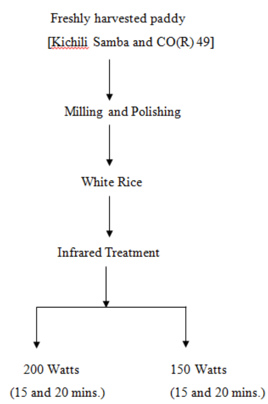
MATERIALS AND METHODS

2.1 Procurement of Samples

Freshly harvested paddy varieties namely, Kichili Samba and CO(R) 49 were selected for the present study and were procured from Sree Pannai Farms, Kumbakonam. These paddy samples were milled and polished to produce white rice, which were then used as the raw material for the analysis. A laboratory model rubber roll sheller (THU35B, Satake Ltd, Tokyo, Japan) with a capacity of 50 kg/h was used for shelling the rice grains. A laboratory model polisher (Model TMO5C, Satake Ltd., Tokyo, Japan) was used for polishing the brown rice. 120g of brown rice was taken and fed to the abrasive type polisher. The brown rice was polished for 1 min. to obtain a 6% degree of polish (Venkatachalapathy, & Udhayakumar, 2013).

2.2 Infrared Treatment

The milled rice samples were subjected to infrared heating at power levels of 150 and 200 Watts for time intervals being 10 and 15 minutes. The distance from infrared light to the sample was 0.19 cm. The rice sample was spread as a single layer on the sample tray covering an area of 17.64 m^2.



2.3 Cooking Time

Cooking time was determined by following the method given in (Chukwuemeka et al., 2015) with slight modification. Rice sample (30 grains) was taken into a test tube containing 30ml distilled water. The test tube was placed into the boiling water bath. After cooking for 10 min, the samples were taken at every 2 min intervals for testing until the end of the cooking cycle. Ten grains were randomly taken and pressed between two clean glass plates. Optimum cooking time was recorded when at least 90% of the grains no longer had opaque core or uncooked centers.

2.4 Grain Elongation

It was analyzed by the procedure given in (Verma et al., 2015) with slight modification. Ten number of rice grains were taken and the initial length (L_1) was measured using vernier caliper. These grains were then taken into a test tube with 10ml of distilled water and cooked for the optimum time by placing it in boiling water bath followed by the measurement of the final length (L_2). Elongation during cooking was calculated as $L_2 – L_1$.

Where, L_2 = Final length of grains after cooking (cm)

L_1 = Initial length of grains before cooking (cm)

2.5 Water Uptake

Water uptake was determined by the method given in (Verma et al., 2015) with some modification. Rice sample (30 grains) were initially weighed (W_1) and then taken in a test tube containing 30 ml water. The test tubes were immersed separately in water bath maintained at 100°C. The grains were allowed to cook for the optimum cooking time. Excess water was drained and weight of cooked kernels was determined (W_2). Increase in weight per g of sample was expressed as water uptake.

Water Uptake (g) = $W_2 - W_1$

Where, W_2 = Weight of cooked kernels

W_1 = Weight of uncooked kernels

2.6 Swelling Index

It was determined by the method given in (Sood et al., 2006) with modification. 30 rice kernels were boiled in 30 ml of distilled water in water bath. The weight was measured after the cooking of rice kernels. The swelling index (by weight) was expressed as the ratio of difference of final and initial weight to the initial weight of the sample.

$$\text{Swelling Index} = \frac{W_2 - W_1}{W_1}$$

Where, W_2 = Weight of cooked kernels

W_1 = Weight of uncooked kernels

2.7 Gruel Loss

Gruel loss in cooked rice was determined using the method given in (Faruq et al., 2003) with modification. The head rice (30 grains) was taken into a test tube containing 30ml distilled water. The rice was cooked for optimum time in a boiling water bath. The cooking water was collected and transferred into a reweighed petri dish and dried at 105°C in hot air oven for 24 h to remove moisture. The petri dish was cooled in a desiccator and weighed to determine the increase in weight of the dish.

$$\text{Gruel loss (\%)} = \frac{\text{Increase in weight of dish}}{\text{Weight of sample}} \times 100$$

2.8 Alkali Degradation Score

This method was used to score alkali spreading value and was measured using the procedure of (Verma et al., 2015) with modification. Seven whole milled grains of rice were placed in small glass petri-dish containing 10 ml of 1.7% potassium hydroxide (KOH) solution. The kernels were arranged in such a way to provide space between kernels for spreading. The petri-dishes were left undisturbed for 23hrs incubated at ambient room temperature. The extent of disintegration of kernel due to alkali was rated visually based on a 7-point numerical spreading scale.

2.9 Texture Profile Analysis

The texture of cooked rice was determined using Exponent Connect Software the TA-XT2i, Texture Analyzer from Stable Microsystems (Surrey, England) and was calibrated with a 50 kg load cell (Faruq et al., 2003). The cooked grains were arranged in a single layer on the base plate and a cylindrical probe of 35 mm radius (P/35) was used. The force was measured in terms of compression (g). The compression cycle was repeated twice with a test speed of 1 mm/s and the probe was allowed to compress 0.5 mm into the sample. Hardness of the samples were measured in grams.

RESULTS AND DISCUSSION

The observed values of cooking characteristics before and after the treatment are mentioned in Table 1 and Table 2.

3.1 Cooking Time

The cooking time before the treatment was found to be 17.50±0.56 for kichili samba variety and 18.30±0.45 for CO (R) 49. After the infrared treatment, the cooking time of the samples were ranging between 16 to 18 mins. The sample which was exposed to maximum power (200W) showed highest cooking time value in case of kichili samba variety. The variation in the cooking time might be due to its gelatinization temperature as it determines the cooking time of rice. It has been stated that the cooking time is directly proportional to gelatinization temperature. The cooking time may also differ due to varietal difference and it has been reported both high protein content and high gelatinization temperature can lead to higher cooking time (Chukwuemeka et al., 2015).

3.2 Grain Elongation

The grain elongation values of the rice samples were in the range of 0.13 to 0.18 cm. The highest value of grain elongation was showed by kichili samba rice variety when exposed to 200 W. Elongation of grains during cooking is affected by over cooking and it may cause the curling and disintegration of the cooked rice grain. Normally, grains with higher elongation are preferred by the consumers (Chukwuemeka et al., 2015).

3.3 Water Uptake

The water uptake or water absorbed is the amount of theof water absorbed during cooking. The water uptake of rice samples after the infrared treatment were higher than the samples without any treatment. An increase in water uptake might be due to the gelatinization of starch which led to the strengthening of the cell walls thus maintaining the hexagonal shape and providing higher water absorption. The higher water uptake shows more expansion and larger size of cooked rice. It was reported that higher water uptake is an index of good cooking quality of rice (Soponronnarit et al., 2008).

3.4 Swelling Index

It was noted the swelling index values of the rice samples increased after the infrared treatment. The values varied from 2.62 to 3.71. The increase in swelling index might be due to the starch gelatinization after the treatment which provides higher water absorption. The variation in swelling index between the two varieties was might be due to their amylose content (Sood et al., 2006). The highest value of swelling index was shown by the C0 (R) 49 variety which was exposed to power of 150 W for 10 mins.

3.5 Gruel Loss

It was observed that the gruel loss of rice samples decreased after the infrared treatment for both rice varieties. The values ranged between 3.81 to 4.80. The less amount of gruel loss after heating might be because of the strengthening of cell walls of rice grain during cooking. The complex formation between amylose and free fatty acids may also result in low amount of water-solubility starch (Soponronnarit et al., 2008).

3.6 Alkali Digestion Score

It was reported thet all the rice samples both before and after treatment had low alkali digestion score thus indicating that all the rice grains remained intact during the immersion of the grains in KOH solution. The alkali digestion value is quantitative index of gelatinization temperature (Verma et al., 2015). Therefore, it can be concluded that both Kichili Samba and CO (R) 49 have high gelatinization temperature.

Table 1: Cooking characteristics of rice varieties before the infrared treatment

S. No.	Sample	Cooking Time (Mins.)	Grain Elongation (cm)	Water Uptake (g)	Swelling Index	Gruel Loss (%)	Alkali Digestion Score
1	Kichili Samba	17.50±0.56	0.18±0.02	1.16±0.08	3.16±0.08	4.90±0.08	Low
2	CO(R) 49	18.30±0.45	0.16±0.02	0.84±0.08	2.37±0.12	4.25±0.05	Low

Table 2: Changes in cooking characteristics after the infrared treatment

S. No.	Sample	Cooking Time (Mins.)	Grain Elongation (cm)	Water Uptake (g)	Swelling Index	Gruel Loss (%)	Alkali Digestion Score
1	Ki, 200W, 15 mins.	18.40±0.36	0.17±0.02	1.19±0.06	3.40±0.03	4.08±0.03	Low
2	Ki, 200W, 10 mins.	17.90±0.40	0.18±0.01	0.93±0.01	3.12±0.10	4.80±0.03	Low
3	Ki, 150W, 15 mins.	17.30±0.41	0.17±0.01	0.86±0.08	2.62±0.08	4.87±0.05	Low
4	Ki, 150W, 10 mins.	17.30±0.35	0.18±0.01	1.40±0.07	3.85±0.04	4.07±0.08	Low
5	CO, 200W, 15 mins.	17.90±0.30	0.16±0.01	1.33±0.07	3.37±0.07	4.50±0.07	Low
6	CO, 200W, 10 mins.	15.80±0.76	0.14±0.01	1.21±0.06	3.52±0.15	4.03±0.25	Low
7	CO, 150W, 15 mins.	17.20±0.47	0.13±0.01	0.90±0.05	2.67±0.09	4.80±0.03	Low
8	CO,150W,10 mins	16.30±0.30	0.17±0.01	1.31±0.03	3.71±0.07	3.81±0.03	Low

3.7 Texture Profile Analysis

Texture is an important sensory property that reflects the physical attributes of cooked rice. The hardness values of the samples are given in Figure 1. It was observed that the hardness of the rice slightly increased after the infrared treatment. Both Kichili Samba and CO(R) 49 showed increased hardness when exposed to 150W for 15 mins. The hardness of cooked rice might be more linked to amylose/amylopectin ratio and insoluble amylose, not amylose alone in cooking, and also can be more strongly affected by cultivar and storage. During the storage time, the structure of rice cell wall changes and became weak. Thus, the starch granules and protein networks positioned in the adjacent cells may connect and result in a condensed structure. This strong network and more accumulated structure could enhance the ability of water uptake and volume expansion of the starch granules (Ding et al., 2016).

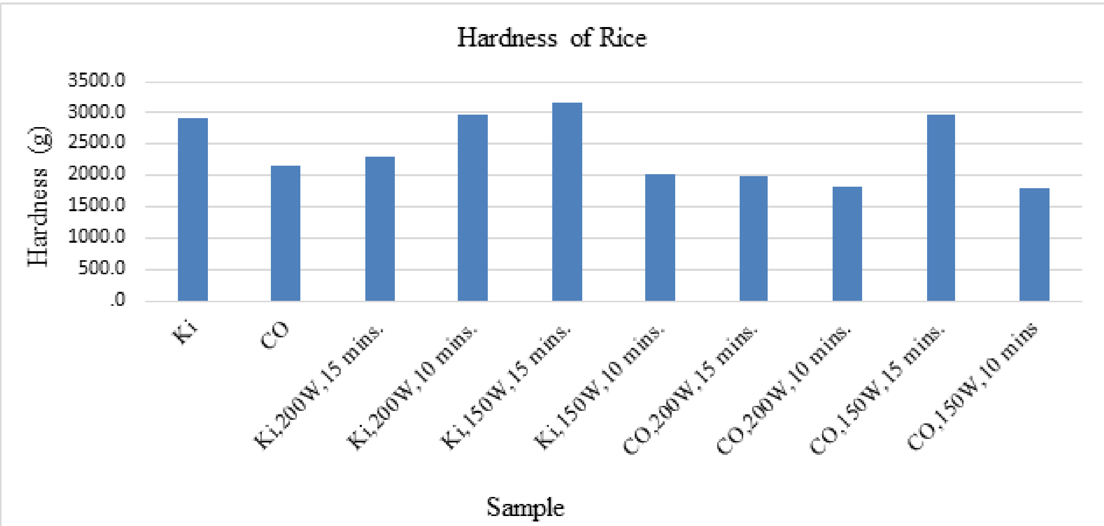


Fig. 1: Change in texture of rice samples

CONCLUSION

From this study it can be concluded that infrared pretreatment can be used for enhancing the cooking characteristics of rice. The rice samples which were exposed to 200W power showed higher cooking time, better grain elongation. Swelling index and water uptake increased while gruel loss was found to be less after the treatment which is the index for good cooking quality. Alkali digestion score was low for all the samples as the rice kernels were intact and maintained their shape without any disintegration. The hardness of rice was found to be increasing when exposed to 150W power for 15 mins.

REFERENCES

Chukwuemeka, A. I., Kelechi, A. J., & Bernard, A. (2015). Cooking and physicochemical properties of five rice varieties produced in Ohaukwu local government area. *European Journal of Food Science and Technology*, *3*(1), 1-10.

Corrêa, P. C., Da Silva, F. S., Jaren, C., Júnior, P. A., & Arana, I. (2006). Physical and mechanical properties in rice processing. *Journal of Food Engineering*, *79*, 137-142.

Ding, C., Khir, R., Pan, Z., Wood, D. F., Tu, K., & El-Mashad, H. (2016). Improvement in Storage Stability of Infrared-Dried Rough Rice. *Food Process Technology*, *9*(6), 1010-1020

Ding, C., Khir, R., Pan, Z., Zhang, J., Tu, K., & El-Mashad, H. (2015). Effect of Infrared and Conventional Drying Methods on Physicochemical Characteristics of Stored White Rice. *Cereal Chemistry*, *92*(5), 441-448.

Faruq, G. O. L. A. M., Hadjim, M. O., & Meisner, C. A. (2003). Kernel ageing An analysis in four Malaysian rice varieties. *International Journal of Agriculture and Biology*, *5*(3), 230-232.

González, R. J., Livore, A., & Pons, B. (2004). Physico-Chemical and Cooking Characteristics of Some Rice Varieties. *Brazilian Archives of Biology and Technology*, *47*(1), 71-76.

Sood, D. R., Singh, A. P., & Silpa, (2006). Changes in cooking behaviour of Basmati and non- Basmati rice genotypes during storage. *Journal of Dairying, Foods & H.S.*, *25*(2), 92-96.

Soponronnarit, S., Chiawwet, M., Prachayawarakorn, S., Tungtrakul, P., & Taechapairoj, C. (2008). Comparative study of physicochemical properties of accelerated and naturally aged rice. *Journal of Food Engineering*, *85*, 268–276.

Venkatachalapathy, N., & Udhayakumar, R. (2013). Effects of continuous steaming on milling characteristics of two indica rice varieties. *Rice Science*, *20*(4), 309-312.

Verma, D. K., Mohan, M., Prabhakar, P. K., & Srivastav, P. P. (2015). Physico-chemical and cooking characteristics of Azad basmati. *International Food Research Journal*, *22*(4), 1380-13.