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Aging Milled Rice by Radio Frequency Heat Treatment

Suchada Vearasilp[a], Kultida Chaisathidvanich[a], Sa-nguansak Thanapornpoonpong[b],Dieter von Hörsten[c] and Wolfgang Lücke[c]

a Chiang Mai University, Postharvest Technology Institute / Postharvest Technology Innovation Center, Commission on Higher Education, Thailand
b Chiang Mai University, Faculty of Agriculture, Department of Plant Science and Natural Resources, Thailand
c Georg-August-University ät Göttingen, Institute of Agricultural Engineering, Germany

proposed outline

This investigation was aimed to evaluate the radio frequency (RF) heat treatments as alternative aging technique for 6 months milled rice storage. The experiment was conducted at Postharvest Research Institute, Chiang Mai University, Thailand. Milled rice cultivar KDML 105 with initial 11.6 percent moisture content was used. The samples were exposed to RF heat treatments at the operating frequency of 27.12 MHz with the treatment temperatures of 70 and 85 °C. The treatment durations were 5, 10 and 15 minutes. Their cooking qualities were evaluated using the elongation ratio of kernel, the gel consistency, the texture, and the viscosity. The RF heat treatment at 85°C for 5 minutes provided the best results; the moisture content was decreased to 11.2 percent which was the least moisture loss treatment compare to the control, the ratio of kernel elongation increased from 1.345 to 1.367 and the gel consistency was significantly decreased from 9.87 to 9.70 cm. whereas their textures as hardness and stickiness were significantly increased 17.62 %, 21.25% respectively. In addition, the viscosity profiles which are the values of breakdown (from 538 to 599 RVU), the final viscosity (from 4197 to 4233.33 RVU), and the pasting temperature (from 71.23 to 78.63 °C) were increased while value of setback (from 1604.3 to 1425.8 RVU) was decreased. It was concluded that the physical properties of milled rice after treated with the RF treatment at 85 °C for 5 minutes were equivalent to those from 6 month storage. Therefore, it can be suggested as alternative aging rice technique.

Keywords: Aging, cooking qualities, milled rice, radio frequency

Introduction

In Thailand, interestingly rice consumer like the cooking quality of aged rice for some months. They prefer the grain to remain separate and firm after cooking. Generally processing products from rice prefer to use aged rice as well. Rice sits for 4-6 months in the warehouse, its cooked texture get progressively firmer and less sticker. Nevertheless, aged rice need storage facilities which increased the production cost (Chinsuwan and Wannacharee, 2002). Induced aging of new harvested rice is becoming interesting issue for researcher. The storage temperature plays the main influence on the quality changes, milled rice was affected faster than paddy rice. The high

amylase containing variety apparently aged quicker than those from the low amylase containing variety while subjected to high temperature treatment (Chinsuwan and Wannacharee, 2002). They used high temperature hot air oven with various levels of moist paddy rice samples, their milling and their cooking qualities, chemical components were changed. Long duration of continuous high temperature heat treatment resulted in increased in gelatinization and rice aging (Taweerattanapanish *et al.,* 1999). Using the new method of heat treatment from the radio frequency generator to the agricultural commodities has been reported (Wang et al., 2003). The electromagnetic energy from the radio frequency was induced rapidly inside the product. The effectiveness of heat treatment with short timing has been used for many purpose and reported in many publication (Tang *et al*., 2000). The rice aging by RF heat treatment in this experiment therefore was aimed to age the rice to reach the marketing need with less time and cost.

Material and Methods

The experiment was conducted at the postharvest research institute Chiang Mai University. Chiang Mai grown rice variety KDML 105 was harvested, threshed, milled and dried to 11.6% moisture content. The mill rice then was subjected to heat treatment by radio frequency at 70 and 85 ^{O}C for durations of 5, 10 and 15 minutes. The 6 month old storage milled rice was used as control treatment. There were 3 replications. Thereafter, the milled rice was evaluated for their qualities: moisture content by hot air oven (AOAC, 2005), elongation ratio of kernel (Juliano and Pezer, 1984), gel consistency (Cagampang *et al.,* 1973), texture of cooked rice (Champagne *et al.,* 1998) and viscosity according to RACI (1995) by Rapid Visco Analyser.

Results and Discussion

The RF heat-treatment, resulting in a decrease of KDML105 rice moisture content. However, there was a significant difference in moist reduction among six months old rice and the heat treated samples. The heat treated rice samples from all treatments resulted about 1% higer than those aged for six months old. Table 1, presented the percentage of amylose content of rice grain. The control treatment had an average percentage of amylose of 17.49 percent, after the heat treatments, it was found that the amylase percentage of RF heated rice was increased.

Table 1 Moisture content, amylose, elongation ratio and gel consistency

Treatment	Moisture content (%)	Amylose (%)	Elongation ratio	Gel Consistency (mm)
70◦C 5min	11.21 bc	18.08 a	1.320 abc	9.89 ab
70◦C 10min	11.12 c	18.39 a	1.275 c	8.28 d
70◦C 15min	11.61 a	18.17 a	1.311 bc	8.89 cd
85◦C 5min	11.21 bc	18.08 a	1.367 a	9.70 ab
85◦C 10min	11.03 c	17.84 ab	1.299 bc	8.99 c
85◦C 15min	11.41 ab	17.95 ab	1.277 c	9.21 bc
Control	11.60 a	17.49 b	1.345 ab	9.87 ab
6 month	10.61 d	17.96 ab	1.334 ab	10.00 a
$LSD_{0.05}$	0.221	0.557	0.053	0.684
CV (%)	1.14	3.29	9.22	9.02

The cooking qualities after RF heat treating were determined. Elongation rate of rice seeds was recorded. After RF heating at 85 ° C for a period of five minutes the elongation of rice increased from 1.345 to 1.367, which was similar to six months aged seed (1.334). The expansion of the grain resulted in lighter texture, less compact and fluffy. The treatment using temperature 85 degrees Celsius for a period of five minutes, the gel consistency is increased and a similar to the six months aged rice, the gel consistency was correrated with the amount of amylose. Whenever the temperature increased the amount of amylose increased. The results of amylose content affected by heat was also similar to Varavinit *et al.* (2002).

The analysis of the changes in viscosity was shown in Table 2,the breakdown value was significantly differ with heated and unheated rice (from 538 to 783 RVU). The high temperature 85 degree Celsius and with duration 15 minute used, resulted the breakdown value with no significantly difference from control. The final viscosity varied from 4197 to 4233.33 RVU and pasting temperature were increased from 71.23 to 78.63 degree Celcius while setback values were decreased varied from 1604.3 to 1425.8 RVU . The results of viscosity analysis from the experiments were similar to the reports of Indudhara Swamy *et al.* (1978)

Table 2 The result of rapid viscosity analysis (cP) after treated by various RF Heat Treatment.

Treatment	Break-down	Final viscosity	Peak	Setback	Trough	Time	Temp
70◦C 5min	783.33 a	4246.8 b	3084.7 a	1162.1 f	2301.3 a	5.8456 de	78.122 a
70◦C 10min	727.67 b	4224.6 bcd	2978.9 b	1245.7 e	2251.2 ab	5.8600 de	76.511 a
70◦C 15min	745.33 ab	4144.3 d	2957.7 b	1186.7 ef	2212.3 b	5.8233 e	76.733 a
85◦C 5min	599.00 c	4233.3 b	2807.6 c	1425.8 d	2208.6 b	5.9322 bc	78.639 a
85◦C 10min	622.78 c	4325.4 a	2892.1 bd	1433.3 d	2269.3 ab	5.9422 ab	80.911 a
85◦C 15min	535.44 d	4157.4 cd	2656.1 d	1501.3 c	2120.7 c	5.9344 bc	79.600 a
Control	538.00 d	4197.0 d	2592.7 d	1604.3 b	2054.7 d	5.8900 cd	71.233 b
6 month	415.89 e	3919.9 e	2137.2 e	1782.7 a	1721.3 e	5.9922 a	78.672 a
$LSD_{0.05}$	44.48	69.75	90.57	64.51	63.07	4.81	0.05
CV (%)	7.61	1.77	3.48	4.83	3.13	0.91	6.59

Table 3 presented the texture of cooked rice after the RFheat treatment. The hardness and the stickiness were increased. Inprasit and Noomhorm (2001) noted that the high temperature drying of rice, the ratio among hard and stickiness of cooked rice was decreased while the hardness of cooked rice was increased. Gujral and Kumar (2003) provided also heat to accelerate aging rice and measured the hardness and texture, the brittleness and friability of rice after cooking and found that they were increased, but the adhesiveness was decreased.

Table 3 Texture properties of KDML 105 cooked rice after treated with RF at different conditions

Treatment	Texture Profile analysis (N)			
	Hardness	**Stickiness**	**Adhesiveness**	**Cohesiveness**
70◦C 5min	188.13 e	157.88 e	-1.3006 d	98.38 d
70◦C 10min	202.02 cd	174.51 cd	-0.9541 c	111.15 c
70◦C 15min	198.15 d	168.38 d	-1.4536 d	107.86 c
85◦C 5min	207.03 bc	181.06 bc	-0.5397 b	115.85 bc
85◦C 10min	218.34 a	192.83 a	-0.3700 a	135.35 a
85◦C 15min	208.39 bc	180.79 bc	-0.5408 b	120.74 b
Control	176.01 f	149.33 f	-0.3134 a	84.59 e
6 month	212.66 ab	188.13 ab	-1.1457 cd	119.65 b
$LSD_{0.05}$	7.05	8.28	0.09	8.28
CV (%)	5.22	7.07	9.66	10.87

Conclusions and Outlook

Using the RF heat treatment at 85 degrees Celsius for a period of five minutes to age KDML 105 rice resulted the rice qualities which are similar to the aged six months old rice.

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References

AOAC. 2005. *Officail Methods of Analysis of AOAC INTERNATIONAL.* 18th ed. AOAC INTERNATIONAL. Gaithersburg, MD, USA. : Chapter 32: pp. 14-38.

Cagampang, G.B., C.M. Perez and B.O. Juliano. 1973. A gel consistency test for eating quality of rice. *Journal of the Science of Food and Agriculture* 24: 1589-1594.

Champagne, E.T., B.G. Lyon, B.K. Min, B.T. Vinyard, K.L. Bett, F.E. Bartonll, B.D. Webb, A.M. McClung, K.A. Moldenhauer, S. Linscombe, K.S. McKenzie and D.E. Kohlwey. 1998. Effects of postharvest processing on texture profile analysis of cooked rice. *Cereal Chemistr*y 75(2): 181-186.

Chinsuwan, W. and P. Wannacharee. 2002. Accelerated aging of Hommali paddy by drying in sealed container. *KKU Engineering Journal* 29: 131-146.

Gujral, H. S. and V. Kumar. 2003. Effect of accelerated aging on the physicochemical and textural properties of brown and milled rice. *Journal Food Engineering* 59: 117-121.

Indudhara Swamy, Y.M., C.M. Sowbhagya and K.R. Bhattacharya. 1978. Changes in the physicochemical properties of rice with aging. *Journal of the Science of Food and Agriculture* 29: 627-639.

Inprasit, C. and A. Noomhorm. 2001. Effect of drying air temperature and grain temperature of different types of dryer and operation on rice quality. *Drying technology* 19(2): 389-404.

Juliano, B.O. and G.M. Perez. 1984. Results of a collaborative test on the measurement of grain elongation of milled rice during cooking. *Journal of Cereal Science* 2: 281-292.

RACI. 1995. Determination of the Pasting Properties of Rice with the Rapid Visco Analyser. Official Method 06-05. Royal Australian Chemical Institute, Australian. 110 pp.

Tang, J., J.N. Ikediala, S. Wang, J.D. Hansen and R.P. Cavalieri. 2000. High-temperature-short-time thermal quarantine methods. *Postharvest Biology and Technology* 21: 129-145.

Taweerattanapanish, A., S. Soponronnarit, S. Wetchacama, N. Kongseree and S. Wongpiyachon. 1999. Paddy drying by fluidization technique for increasing head rice yield. *Kasetsart Journal (Nat. Sci.)* 33: 134-145.

Varavinit, S., S. Shobsngob, W. Varanganond, P. Chinachoti and O. Naivikul. 2002. Freezing and thawing conditions affect the gel stability of different varieties of rice flour. *Starch/ Starke* 54: 31-36.

Wang, S., J. Tang, J. Cavalieri, R.P. Davis. D. 2003. Differential heating of insects in dried nuts and fruits associated with radio frequency and microwave treatment. *Transaction of the ASAE* 46: 1175-1182.