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Controlling Rancidity of Purple Rice Bran by using Radio Frequency Heating Technique s

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Introduction

Rice bran provides a potential source of human food, especially landrace purple containing high amounts of natural antioxidants and increase immune system so called anthocyanin especially cyanidine-3-glucoside as well as rice bran oil containing gamma oryzanol (Xu *et al.*, 2007). Then, purple rice and their bran have been promoted to be food as medicine or nutraceutical. However, the crude bran is fast to deteriorate during storage because the oil composition is degradation by lypolysis and oxidative rancidity as well as the microorganisms contamination was also detected to be a factor affecting deterioration. Various thermal methods have been made to stabilize rice bran (Juliano, 1994; Prakash, 1996; Lakkakula *et al.*, 2004). The application of microwave and RF dielectric heating to agricultural products after post harvest management is a new technology and has attracted great interest following many researches (Wang et al., 2003). In this technology, the radiation energy is dissipated within the sample afterward a great rate of heating can be obtained rapidly. von Hörsten and Lücke (2001) compared five thermal processes for eradicating *Fusarium culmorum* from wheat seed. Hot-air treatment (65–68°C) of seed wrapped in a moisture barrier reduced treatment time under 2 h with no loss moisture content. Microwave-steam treatment at temperatures of 68–75°C was equally effective in less than 10 min. This study was to investigate the effect of radio frequency heat treatment on purple rice bran stabilization, extension of its storage life and the nutrients.

Material and Methods

A split-split plot in complete randomized design (CRD) with 3 replications was designed in this experiment. The main plot was four cultivars of Thai rice bran as followed:

- 2 white rice[cv. San Pa Tong1 (SPT1); cv. Kao Dok Mali105 (KDML105)]
- 2 landrace purple rice [cr. Kum Doil Saket (KDSK) and cv.Kum Nan (KN)]

Sub-plot was temperature of radio-frequency (RF) at 3 levels, and sub-sub-plot was 4 storage periods. The rice bran samples were exposed to RF at frequency of 27.12 MHz at temperatures of 70, 75 and 80ºC for 3 min. Then, the treated bran was packed in aluminum foil bag and vacuum sealed at a pressure of 80 kPa and stored at 25°C for 0, 2, 4 and 6 months.

In each storage time, the bran samples were determined by following:

1) Contamination of microorganisms (AOAC, 2005)
2) Moisture contents (mc) (ISTA, 2001)
3) Oil and Protein contents (AOAC, 2005)
4) Rancidity by thiobarbituric (TBA) acid number (AOAC, 2005)
5) Anthocyanin content (cyanidin-3-glucocide: C3G) (Ryu *et al*, 1998)

Results and Discussion

The results showed that RF heating technique significantly decreased ($p \leq 0.05$) the moisture content more than 1% (Table 1), but there was no significant difference between all treating temperatures. The interactions between temperature and cultivar also result oil content. Rice bran treated at 75 and 80ºC showed higher oil content than untreated especially in cv. San-pah-tawng 1, Khao Dawk Mali 105 and Kam Nan. The same evident also happened in protein content but the storage time had no effect in protein.

Table 1 Quality of rice bran 4 varieties before and after treating with various RF treatments

Rice bran variety	RF temperature (°C)	mc (%)	Oil content (%)	Protein content (%)	TBA number (mg-malonaldehyde Kg^{-1})
SPT1	Control	9.21	28.26	12.54	21.88
	70	8.10	27.51	12.87	20.21
	75	8.21	29.21	12.63	22.93
	80	8.49	26.51	12.83	21.22
KDML105	Control	10.20	26.81	12.00	23.24
	70	7.65	25.51	12.00	20.01
	75	6.91	26.52	12.33	21.84
	80	7.29	27.03	12.41	21.50
KDSK	Control	10.45	9.54	11.31	24.13
	70	8.82	10.33	11.07	19.87
	75	8.99	9.66	10.72	10.19
	80	8.89	9.73	11.23	11.08
KN	Control	9.46	18.47	14.30	23.69
	70	8.52	19.57	14.86	11.63
	75	8.3	19.80	14.43	12.04
	80	7.80	20.11	15.23	14.75
$LSD_{0.05}$variety (V)		0.31	0.22	0.22	3.14
$LSD_{0.05}$ Temperature (T)		0.18	ns**	ns	2.58
$LSD_{0.05}$ V x T		0.36	ns	ns	5.16

When the bran sample containing moisture content as 9.21-10.45% was subjected to magnetic field such RF application, the water molecule was rotate as movement back and forth rapidly as the frequency of the electromagnetic wave. In the case of movement in radio-frequency condition, ion motion takes approximately 3 to 300 million times per second, of which the speed of rotation action result on friction and cause to heat up rapidly within 2-3 seconds or about 1 minute after receiving electromagnetic waves. Subsequently, the heat has spread to other cool parts heating migration continuously occurred. Then, the bran's moisture content significantly decreased which cv. KDML decreased for 2.55 to 3.29% after treating under 75 º C while cv. Kam Nan decreased for 0.94, 1.16, 1.66% follow by increasing temperatures at 70, 75 and 80º C, respectively. However, the interactions between temperature and cultivar significantly affected rancidity of rice bran by the RF heat treatment at temperatures of 75 and 80º C showed the lowest average of TBA value in cv. San-pah-tawng 1. The technique also provided high anthocyanin content extracted from purple rice bran with significantly.

After 2 months storage, the mc of bran increased significantly due to moisture equilibration in their airtight containers (Figure 1). The RF at temperatures of 70 and 75ºC reduced microbial contamination significantly (Figure2). Champagne et al. (1992) detailed when rice bran layers were removed from the endosperm during the milling process, the individual cells was damaged and the rice bran lipids disperse into contact with highly reactive lipasees. Not only these enzymes containing in the bran but also origin from microorganisms of which initiate hydrolytic deterioration of kernel oil. The different treated temperature showed no effect on oil content and thiobarbituric acid number or TBA number of rice bran during storage. Storage for 2-6 months significantly resulted on decreasing number of oil content (Figure 3).

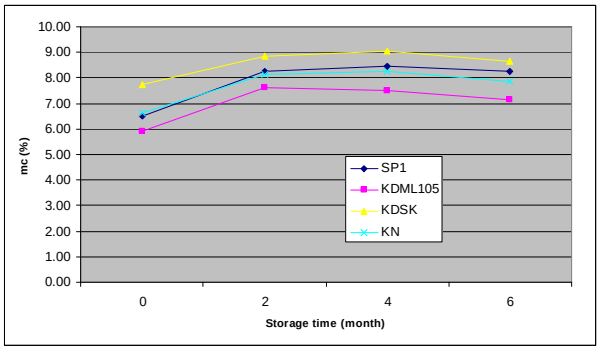

Figure 1 Moisture content of RF treated rice bran after storage for 6 months for 6 months

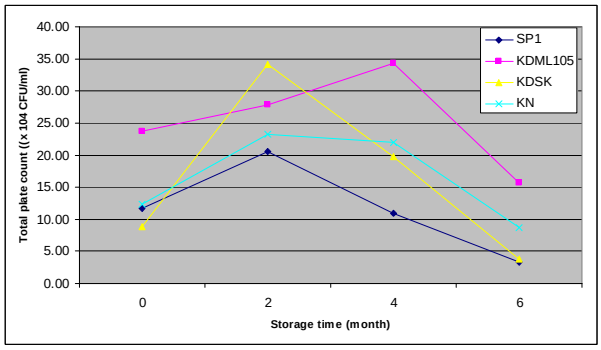

Figure 2 Disease contamination of RF treated rice bran after storage

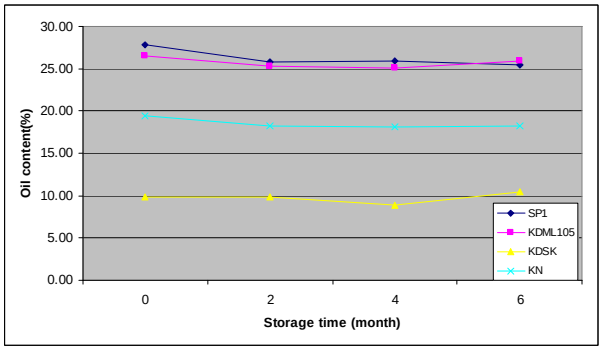

Figure 3. Oil content of RF treated rice bran 4 varieties after storage for 6 months

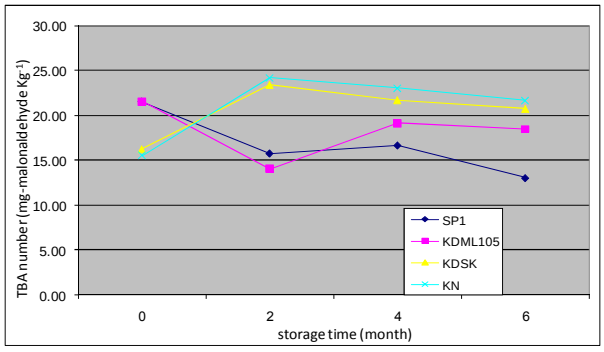

Figure 4. TBA acid number of RF treated rice bran 4 varieties after storage for 6 months

The interactions between temperature and cultivar also affected oil content. Storage of 2-6 months resulted in TBA value of treated purple rice bran which tended to decrease in 2 months after that increased during 4 months and decreased again in sixth month (Figure 4). The cause of rancidity form the decomposition of lipids (triacylglycerols) into free fatty acids is typical of the rapid development of hydrolytic rancidity in raw rice bran, of which the products unsuitable for human consumption. Ramezanzadeh *et al.* (1999) also studied the effect of microwave heating (850 Watt for 3 min), packaging and storage temperature on the production of free fatty acid in rice bran. The research found that free fatty acid of raw bran increase rapidly over the 16 weeks of storage when stored at 25ºC increased from 2.5% to 54.9% in vacuum bags while bran packed in zipper-top bags was 48.1%. The result also showed that hydrolytic rancidity of rice bran can be prevented by microwave heating and the recommendation for prolong shelf life of microwave rice bran was storage condition at 4-5ºC in closed tight bag.

Conclusions and Outlook

RF heat treatment is an alternative method for decrease moisture content and disease contamination of rice bran especially at the temperature of 75 and 80ºC, subsequently exhibited low rancidity by TBA number without adverse effect on chemical compositions (oil and protein), however storage condition and time showed significant effect on moisture equilibrium as well as auto-oxidation by transportation of oxygen.

References

AOAC. 2005. Association of Official Analytical Chemists. Official methods of analysis (18th ed.). Arlington V. A., USA.

Champagne, E. T., R. J. Sr. Horn and G. Abraham. 1992. Stabilizing brown rice to lipolytic hydrolysis by ethanol vapors. Cereal Chemistry. 69: 152-156

ISTA. 2006. International Rules for Seed Testing. Edition 2006. International Seed Testing Association, SwitzerlandJuliano, O. B. *In*: O.B. Juliano, Editor, Rice: Chemistry and Technology (2nd ed.), The American Association of Cereal chemists inc., St. Paul, EUA.

Juliano, O.B. 1994. *In*: O.B. Juliano, Editor, Rice: Chemistry and Technology (2nd ed.), The American Association of Cereal chemists inc., St. Paul, Lakkalula, N. R., M. Lima, T.

Prakash, J. 1996. Rice bran proteins: properties and food uses, Critical Review of Food Science Nutrition. 36(6): 537–552.

Ramezanzadeh, F.M., R.M. Rao, M. Windhauser, R.T. Prinyawiwatkul and W.E. Marshall. 1999. Prevention of hydrolytic rancidity in bran during storage, Journal of Agricultural and Food Chemistry. 47: 3050–3052.

Ryu, S.N., S.Z. Park, and C.-T. Ho. 1998. High performance liquid chromatographic determination of anthocyanin pigments in some varieties of black rice. Journal of Food Drug Analysis 6(4):729-736

von Hoersten, D. and W. Luecke. 2001. Thermal treatment of seeds comparison of different methods for eradicating seedborne fungi. *Annual International Meeting of the American Society of Agricultural Engineers*, 30 July – 1 Aug. 2001, Sacramento, Calif. ASAE Meet. Pap. No. 01-6165.

Walke. 2004. Rice bran stabilization and rice bran oil extraction using ohmic heating Bioresource Technology 92:157–161.

Xu, Z., N. Hua and J. S. Godber. 2007. Antioxidant activity of tocopherols, tocotrienols, and γ-oryzanol component from rice bran against cholesterol oxidation accelerated by 2, 2′-azobis (2-methyl propionamidine) hydrochororide. Journal of Agricultural and Food Chemistry 49:2077-2081.