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การดัดแปลงคุณภาพการหุงต้มของข้าวขาวดอกมะลิ 105
Modifying Cooking Quality of Khao Dawk Mali 105 Rice

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Abstract

Cooking quality preference for rice consumers in various countries is so diverse. This study was aimed to modify cooking quality of Khao Dawk Mali 105 milled rice in order to supply rice to different desired demands. The rice samples were exposed to different temperature-pressures and durations namely 100 °C (60, 90, and 120 min.), 110 °C (30 and 45 min.), and 120 °C (15 and 30 min.). Textural properties, viscosity, and 2-acetyl-1-pyrroline retention of the heated rice were then examined in comparison with those of freshly harvested rice. Texture profile analysis of cooked rice revealed the more increases in hardness cohesiveness springiness and chewiness, and more decrease in adhesiveness when the milled rice were exposed to higher temperature and longer exposure durations. The changes in texture profile analysis attributes were associated with the changes in RVA viscogram parameters seen in naturally aged rice. 2-acetyl-1-pyrroline quantity was not change in rice exposed to 120 °C for 15 min. but gradually decrease when exposed to longer periods. Although there were reduction in the amount of 2-acetyl-1-pyrroline but the retention percentage were still high (>80%) in rice exposure to moderate duration or lower temperature. Therefore cooking quality of Khao Dawk Mali 105 freshly harvested rice can be modified by this uncomplicated technique.

Key words: cooking quality, texture profile analysis, 2-acetyl-1-pyrroline

บทคัดย่อ

ความชอบของผู้บริโภคต่อคุณภาพการหุงต้มของข้าวในแต่ละประเทศมีความหลากหลาย การศึกษาครั้งนี้มีวัตถุประสงค์เพื่อดัดแปลงสมบัติการหุงต้มของข้าวขาวดอกมะลิ 105 ให้ตรงกับความต้องการที่แตกต่างกันของผู้บริโภค โดยอบข้าวสารด้วยอุณหภูมิ-ความดันและระยะเวลาที่แตกต่างกัน คือ 100 องศาเซลเซียส (60 90 และ 120 นาที) 110 องศาเซลเซียส (30 และ 45 นาที) และ 120 องศาเซลเซียส (15 และ 30 นาที) จากนั้นตรวจสอบสมบัติทางเนื้อสัมผัส ความหนืดข้น และการคงอยู่ของสารให้ความหอม 2-อะเซติล-1-พิรโรลลีน เปรียบเทียบกับข้าวใหม่ปกติ การวิเคราะห์ลักษณะแบบจำเพาะของเนื้อสัมผัสข้าวสุกพบว่า เมื่อเพิ่มความร้อนและระยะเวลาการอบแก่ข้าวสาร ค่าความแข็ง การคงสภาพของเมล็ด การยืดหยุ่นสู่สภาพเดิม และ ค่าของแรงที่ใช้บดเคี้ยว เพิ่มขึ้นขณะที่ลักษณะความเหนียวติดของข้าวสุกลดลง การเปลี่ยนแปลงของลักษณะแบบจำเพาะของเนื้อสัมผัสข้าวสุกมีความสัมพันธ์กับการเปลี่ยนแปลงของค่าพารามิเตอร์ที่ได้จากกราฟความหนืดข้นของเครื่องอาร์วีเอ ที่พบตามปกติในข้าวเก่า ปริมาณสารให้ความหอม 2-อะเซติล-1-พิรโรลลีน ในข้าวสารที่อบด้วยอุณหภูมิ 120 องศาเซลเซียส นาน15 นาที ไม่เปลี่ยนแปลงจากข้าวใหม่ปกติ แต่เริ่มลดลงเมื่อเวลาการอบนานขึ้น อย่างไรก็ตามถึงแม้มีการลดลงของปริมาณสารให้ความหอม 2-อะเซติล-1-พิรโรลลีน แต่เปอร์เซ็นต์การคงอยู่ยังคงสูง (>80%) ในข้าวที่อบด้วยอุณหภูมิต่ำหรือข้าวที่ใช้เวลาการอบไม่นานเกินไป ดังนั้นคุณภาพการหุงต้มของข้าวขาวดอกมะลิ 105 ที่เพิ่งเก็บเกี่ยวใหม่สามารถถูกดัดแปลงด้วยเทคนิคที่ไม่ซับซ้อนนี้

คำสำคัญ: คุณภาพการหุงต้ม การวิเคราะห์ลักษณะแบบจำเพาะของเนื้อสัมผัส สารให้ความหอม 2-อะเซติล-1-พิรโรลลีน

Introduction

World rice trade is now becoming more highly competition and rice quality is a major determinant for consumers. Base on Juliano (1985) the majority of Asian populations have a preference for stored rice which has

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harder and fluffier texture when cooked. This means that KDML 105 rice sales in Asian market have to be stored for a certain period to allow time for the formation of its quality. During storage however, aroma quality of the rice as measured by the amount of 2-acetyl-1-pyrroline compound decreased (Widjaja *et al*., 1996a; Wongpornchai *et al*., 2004). Moreover, storage takes longer period of time and costly, and since rice must be supplied continually to market through out the year from the time of harvest. To solve this problem and to supply rice with good texture and aroma quality, a rice processing technique using heat treatment may be employed. The objective of this study was to determine textural properties, viscosity, and 2-acetyl-1-pyrroline retention of freshly harvested KDML 105 milled rice after heating with different temperatures and exposure durations.

Materials and Methods

Khao Dawk Mali 105 (KDML 105) freshly harvested was dehulled and milled for 30 second. Three replicates 370 g of fresh head milled rice samples were placed in aluminum containers and sealed. The containers were exposed to three different temperature-pressures and durations namely 100 °C (60, 90, and 120 min), 110 °C (30 and 45 min), and 120 °C (15 and 30 min) in an automatic autoclave. After exposure, the rice samples were left covered in the aluminum containers and cooled for about two hours at 21 °C. The rice samples were then poured onto screen and stored in zip-locked plastic bags at 4 °C until the time of measurements. Pasting characteristics of heated rice samples were investigated employing Rapid Visco Analyser (RVA) (model 4D, Newport Scientific, Warriewood, NSW, Australia). The measurement was performed using the profile outlined by Approved Method 61-02 (AACC, 2000). The pasting temperature, peak viscosity, trough (viscosity at 95 °C after holding), final viscosity (viscosity at 50 °C), breakdown and setback were recorded and analyzed. Color of the rice samples were measured in *L*a*b** scale using a color meter (Hunterlab, Inc., VA, USA). Solid loss during cooking was investigated by boiling 5.00 g milled rice in a test tube containing 30 ml distilled water for 15 min and the cooked rice water was oven dried and weighed to determine the solid. Cooked rice textural properties were measured and investigated using texture profile analysis as described by Champagne *et al*. (1998) with modification employing a bench-top TA-XT*plus* Texture Analyzer (Texture Technologies Corp., Scarsdale, NY). The texture profile analysis attributes to be recorded were hardness, adhesiveness, cohesiveness, springiness, and chewiness. Analysis of 2-acetyl-1-pyrroline in the rice sample headspace were performed using a gas chromatograph–flame ionization detector (GC-FID) equipped with a headspace auto-sampler (Agilent Technologies, Palo Alto, CA) and a fused silica capillary column, HP-5, with 5% phenyl 95% dimethylpolysiloxane, with dimension of 30 m in length x 0.53 mm internal diameter and 1.5 µm film thickness. To quantify the amount of 2-acetyl-1-pyrroline in the rice samples, 2-acetyl-1-pyrroline standard was synthesized as outlined by Buttery *et al*. (1983). Amount of 2-acetyl-1-pyrroline retained in treated rice samples was computed and expressed in percent retention.

Results and Discussion

Fresh and heated milled rice samples were ground and the resulting flour were analyzed for its pasting characteristic. The results showed that heat treatments altered pasting behavior of the fresh rice flour (Table 1). Temperature and durations increased pasting temperature and final viscosity with the effect was more pronounced in higher temperature and longer exposure treatments. Heating milled rice with lower temperature and shorter time lifted the peak viscosity which were then decrease after receiving higher temperature and longer exposure durations. The rise in peak viscosity was responsible for the lower setback of the viscogram of flours from milled rice given with lower temperature and shorter durations. Increase in peak viscosity followed by a decrease during aging of rice have reported (Perdon et al., 1997 ; Sowbhagya and Bhattacharya, 2001) and the increase had attributed to the decline in **α**-amylase activity of milled rice grain (Dhaliwal et al., 1991). Peak viscosity decreased in higher temperature and longer duration treatments were probably related to changes in protein and starch. The changes seen in the RVA curve was associated to changes in cooked rice texture. Cooked rice from milled rice receiving higher temperature or longer exposure duration (120 °C for 30 min or 100

°C for 90 and 120 min) had more hardness springiness chewiness and less adhesiveness than fresh rice and rice from the lower temperature and shorter duration treatments (Table 2). For cohesiveness, only rice heating at 120 °C for 30 min had significant higher value. Correlation between adhesiveness, hardness, springiness, chewiness, and pasting temperature, final viscosity, and setback were moderate to high (r = 0.67-0.87)

Table 1. RVA viscosity parameters of rice flour of fresh milled rice and rice heating with different temperatures (°C) and exposure durations (min)

	Viscosity (centipoises, cP)					
Treatment	peak	trough	final	breakdown	setback	pasting temp.
Fresh rice	3335 d	2308	3433 f	1027 d	98.0 c	80.7 d
100-60	3802 bc	2400	3670 de	1402 abc	-131.5 d	83.8 c
100-90	4045 a	2540	4021 bc	1505 a	-24.5 cd	85.4 b
100-120	3616 c	2647	4342 a	969 d	726.0 b	88.2 a
110-30	3714 bc	2431	3709 de	1283 bc	-5.2 cd	84.6 bc
110-45	3821 b	2390	3821 cd	1431 ab	0.3 cd	85.5 b
120-15	3619 bc	2361	3689 ef	1258 c	-29.5 cd	83.9 c
120-30	3101 e	2511	4175 ab	589 e	1074.5 a	88.9 a

Means followed by the same letters in a column are not significantly different (Duncan's)

Table 2. Texture profile analysis attributes of cooked rice from fresh and milled rice heating with different temperatures (°C) and exposure durations (min)

	Texture profile analysis attributes				
Treatment	hardness (g)	adhesiveness (g)	springiness	cohesiveness	chewiness
Fresh rice	14982 c	-576.1 c	0.1958 bc	0.5669 b	1669.8 c
100-60	15346 c	-521.8 bc	0.1960 bc	0.5692 b	1714.4 c
100-90	15506 bc	-427.1 b	0.1923 c	0.5651 b	1688.9 c
100-120	16138 ab	-308.1 a	0.2089 b	0.5715 b	1928.9 b
110-30	14908 c	-501.0 bc	0.1901 c	0.5717 b	1619.6 c
110-45	15470 c	-446.3 b	0.1979 bc	0.5674 b	1740.4 c
120-15	15308 c	-532.1 bc	0.1888 c	0.5707 b	1650.9 c
120-30	16237 a	-306.3 a	0.2258 a	0.5843 a	2145.5 a

Means followed by the same letters in a column are not significantly different (Duncan's)

The less adhesiveness of the higher and longer heating rice may be attributed to the lower solid loss (Table 3). The negative relation between cooked rice stickiness and soluble solid has been reported by Cameron and Wang (2005). In the current study, significant relation between adhesiveness and solid loss was observed, even though correlation was moderate (r = -0.68, *P-Value* = 0.0003). Heat treatment did not differ L* and a* value of the treated rice. Yellowing of the heated rice as expressed in b* value was found only when rice were treated with longer duration and higher temperature (Table 3). 2-Acetyl-1-pyrroline, the aroma impact compound of KDML 105 rice was quantified to assess the effect of heat treatments on the amount of the compound escape from or retain in rice grain samples. An average amount of 2-acetyl-1-pyrroline of the rice heated at 120 °C for 15 min was 5.42 ppm which was not difference from the amount of 2-acetyl-1-pyrroline analyzed from fresh rice (Table 3). Significant loss of 2-acetyl-1-pyrroline from rice grain was observed when the exposure duration was prolonged from 15 to 30 min in 120 °C treatment and from 60 to 90 and 120 min in 100 °C treatment. Rice heating at 110 °C for 30 and 45 min were not difference in 2-acetyl-1-pyrroline concentration. Retention percentages of the compound in rice grain samples were high for rice exposure to moderate duration or lower temperature. Interestingly, there was no significant different in the amount of 2-acetyl-1-pyrroline and its retention percentage between rice heating at 100 °C for 90 and 120 min. This indicated the majority of the compound might form a complex with other rice constituents and required higher temperature or much longer duration to liberate the compound from rice grain. Yoshihashi et al. (2005) has suggested that 2-acetyl-1-pyrroline in aromatic rice may

present in two forms, with the starch bound form require higher extraction temperature comparing to that of its free form. In the light of this fact, modifying cooking quality of KDML 105 rice by heat treatment while maintaining its aroma quality could be possible.

Table 3. Solid loss, color (*L* a* b**), and 2-acetyl-1-pyrroline (2AP) quantity and 2AP retention percentage of fresh milled rice and rice heating with different temperatures (°C) and exposure durations (min)

Treatment	Solid loss (%)	*L**	*a**	*b**	2AP (ppm)	2AP retention (%)
Fresh rice	6.2 a	51.1	-0.91	7.01 f	5.57 a	100.0 a
100-60	5.6 ab	53.0	-1.04	7.72 cde	4.63 b	83.8 b
100-90	4.8 abc	53.8	-1.02	8.15 bc	3.71 c	67.7 cd
100-120	3.3 c	52.9	-0.98	8.62 ab	3.91 c	71.3 c
110-30	6.1 a	51.8	-1.01	7.53 def	4.54 b	82.2 b
110-45	5.8 ab	53.0	-1.01	8.05 bcd	4.40 b	79.7 b
120-15	6.7 a	51.8	-1.00	7.22 ef	5.42 a	97.4 a
120-30	3.9 bc	53.2	-0.97	9.10 a	3.38 d	62.0 d

Means followed by the same letters in a column are not significantly different (Duncan's)

Summary

This study revealed that cooking quality of KDML 105 freshly harvested milled rice could be modified to the character identical to aged rice using heat treatment. The magnitude of changes in textural properties, viscosity, solid loss, color, and 2-acetyl-1-pyrroline concentration and 2-acetyl-1-pyrroline retention were depend on temperature levels and exposure durations.

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