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อิทธิพลของการอบแห้งด้วยอากาศที่มีความชื้นสัมพัทธ์ต่ำต่อการใช้พลังงานในการอบแห้งและ คุณภาพทางกายภาพของข้าวเคลือบกระเจี๊ยบแดง

Influence of Low Relative Humidity Air Drying on Energy Consumption and Physical Quality of Roselle Coated Rice

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Abstract

Herbal coated milled rice is a value added product and has been gaining popularity in the health conscious market. The purpose of this study was to investigate the effect of low relative humidity air drying on energy consumption and physical qualities of roselle coated rice. The drying conditions were; the drying air relative humidity 23-25%, velocity of 0.3 m/s and temperatures of 40, 60 and 80 °C. Result attained from this study showed that low relative humidity air drying at 40 °C gave the least changes in rice color and had lowest energy consumption on drying in roselle coated rice. When compare with ambient air drying at 40 °C, the drying air with low relative humidity reduced drying time by 40-50% with little change in color of roselle coated rice.

Keywords: Drying energy consumption, low relative humidity air drying, roselle coated rice

บทคัดย่อ

ข้าวเคลือบสมุนไพรเป็นผลิตภัณฑ์ที่เพิ่มคุณค่าให้กับข้าวสารและกำลังเป็นที่นิยมของตลาดในกลุ่มผู้รักสุขภาพ วัตถุประสงค์ในการวิจัยในครั้งนี้เพื่อศึกษาผลของการอบแห้งข้าวเคลือบกระเจี๊ยบแดงโดยใช้อากาศที่มีความชื้นสัมพัทธ์ต่ำต่อคุณภาพทางด้านกายภาพและการใช้พลังงานในการอบแห้ง โดยสภาวะของอากาศที่ใช้ในการอบแห้งประกอบไปด้วย ความชื้นสัมพัทธ์ของอากาศอยู่ในช่วง 23 - 25% ความเร็วของอากาศอบแห้งที่ใช้คือ 0.3 m/s และอุณหภูมิที่ใช้ในการอบแห้งคือ 40 60 และ 80 °C จากการศึกษา พบว่า อากาศอบแห้งที่ความชื้นสัมพัทธ์ต่ำมีอุณหภูมิ 40 °C ทำให้สีของเมล็ดข้าวเคลือบกระเจี๊ยบแดงมีการเปลี่ยนแปลงน้อยและใช้พลังงานรวมในการอบแห้งน้อยที่สุด เมื่อเปรียบเทียบกับการอบแห้งข้าวเคลือบกระเจี๊ยบแดงด้วยอากาศร้อนทั่วไปที่ 40 °C พบว่า การอบแห้งด้วยอากาศที่มีความชื้นสัมพัทธ์ต่ำใช้เวลาในการอบแห้งลดลงประมาณ 40 - 50%และสีของเมล็ดข้าวเคลือบกระเจี๊ยบแดงมีการเปลี่ยนแปลงน้อยกว่า

คำสำคัญ: การใช้พลังงานในการอบแห้ง การอบแห้งด้วยอากาศความชื้นสัมพัทธ์ต่ำ ข้าวเคลือบกระเจี๊ยบแดง

Introduction

Herbal coated rice is a value added product and has been gaining more popularity in the market. In the present work, rosell coated rice is subject to drying process for producing the herbal coated rice. Roselle has been widely used as herbal for rice coated production because of its accessibility and high content of anthocyanin, an active phytochemical. However anthocyanin is sensitive to the thermal process therefore it is a need to seek for an appropriate method for producing roselle coated rice. The initial moisture content of rosell coated rice was 14 – 16% d.b. and dried to 6 – 12 % d.b.

Hot air drying is the most common method used for drying herbal coated rice. The quality of herbal is rather sensitive to the drying temperature. The herbal subjected to high temperature drying leads to degradation of food qualities, such as color, shrinkage, nutritional substances, rehydration capability and microstructure. (Aguilera, 2005 ; Attanasio et al., 2004 ; Bello et al., 2006 ; Thipayarat and Leelayuthsoontorn, 2006). The important qualities of rosell coated rice are color and rehydration capability. In practical viewpoint, the consumers

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require the product characteristics, which have red color and fast rehydration rate. These properties can be maintained if drying is performed at low temperature and relative humidity.

The objective of this research was therefore to the effect study of low relative humidity air drying on energy consumption and physical properties of roselle coated rice.

Materials and Methods

Khaw Dok Mali 105 (KDML105) containing medium amylose content was purchased from local supermarket. The rice samples were coated with the ratio of 100 g: 2 ml (milled rice: aqueous roselle extract).The initial moisture content of roselle coated rice was in the range of 15 – 16% d.b. The coated rice was dried on tray dryer at temperatures of 40, 60 and 80 ^{o}C, relative humidities of 23 - 25% and air velocity at 0.3 m/s, respectively. The drying experiments were performed until the moisture content of roselle coated rice reached the desire moisture contents of 11 % d.b. The surface color of dried roselle coated rice was measured by a Minolta CR-300 Chroma Meter (Minolta, Japan). Before each measurement, the instrument was calibrated against a white standard. The color of dried roselle coated rice was expressed as L-value, a-value and b-value where ''L'' represents lightness, ''a'' represents redness (+) or greenness (-), and ''b'' represents yellowness (+) or blueness (-). Ten replicate measurements were performed and results were averaged. In addition, color intensity (chroma), total color difference (ΔE) and hue angle were calculated using the following Esq. (1)–(3), where L_o, a_o and b_o are the control values for roselle coated rice (Sigge et al., 2001).

$$\text{Chroma} = (a^2+b^2)^{0.5} \quad (1)$$

$$\Delta E = [(L-L_o)^2+(a-a_o)^2+(b-b_o)^2]^{0.5} \quad (2)$$

$$\text{Hue angle} = \text{arctangent } (b/a) \quad (3)$$

The energy consumptions were calculated using the following Esq. (4) – (5), respectively.

$$\text{Specific energy consumption (SEC)} = \frac{\text{Total heat consumption (kJ)}}{\text{Weigh of water evaporation (kg)}} \quad (4)$$

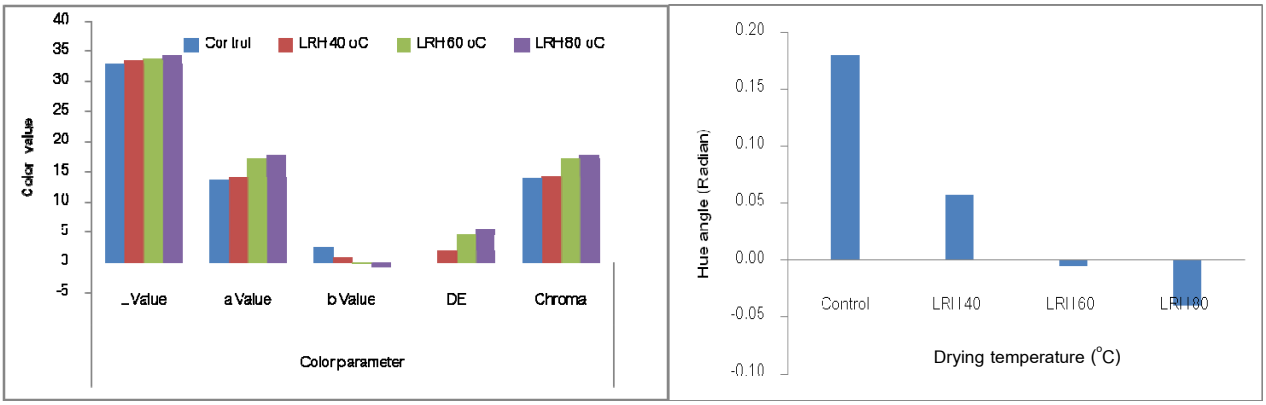
$$\text{Specific electrical consumption} = \frac{\text{Total electric consumption (kW.h)}}{\text{Weigh of water evaporation (kg)}} \quad (5)$$

Water activity (A_w) of roselle coated rice was measured with a water activity meter

Results

The effect of drying temperature on physical quality

The color parameter change of roselle coated rice at air velocity drying of 0.3 m/s and temperatures of 40, 60 and 80^{o}C, as shown in Figure 1. It was observed that roselle coated rice drying with low humidity air and low temperatures (40^{o}C) at air velocity of 0.3 m/s had no significantly different in color parameters when compared with the control. However the value of b and hue angle seem to decrease with increase in air temperature while L, a, ΔE, and chroma increased with increase in air temperature. The effect of drying temperature, roselle coated rice after drying had no different on water activity. (Table 1)



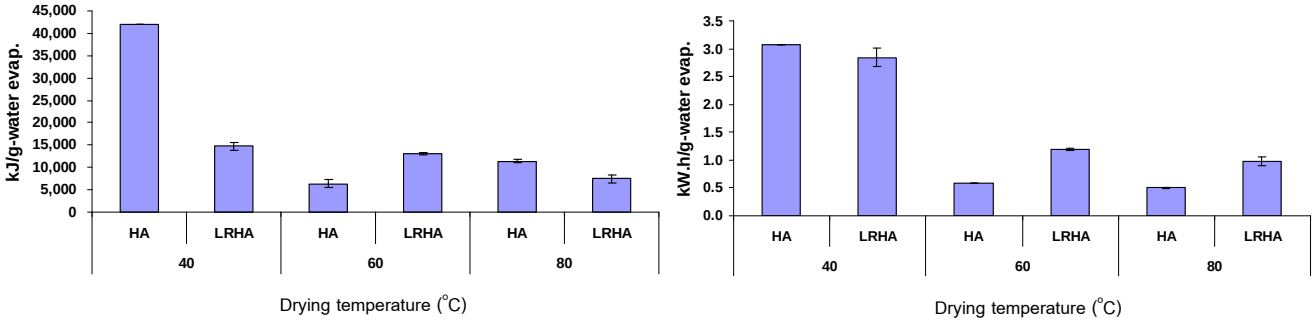
(a) (b)

Figure 1 Effect of air temperatures at air velocity at 0.3 m/s: (a) color parameter (b) hue angle

Table 1 Effect of temperatures at air velocity at 0.3 m/s on water activities and drying time

Condition		Water activity	Drying time (min)
control		0.60±0.04[a]	0.00±0.00[d]
Temperature	40 °C	0.46±0.05[b]	42.00±3.61[a]
	60 °C	0.47±0.01[b]	17±4.04[b]
	80 °C	0.49±0.04[b]	11.00±1.00[c]

*Different superscripts in the same column mean that the values are significantly different ($p<0.05$)



(a) (b)

Figure 2 Effect of air temperatures at air velocity 0.3 m/s: (a) Specific energy consumption (b) Specific electrical energy consumption

* HA = Hot ambient air

* LRHA = Low humidity hot air

The effect of drying on energy consumption

The effect of drying on energy consumption of drying air at air of 0.3 m/s and temperatures of 40, 60 and 80°C, are as shown in Figure 2. It was observed that roselle coated rice drying with low humidity air at high temperatures (80°C) had the least energy consumption, the specific energy consumption for drying and Specific electrical energy consumption decreased with increased drying in temperature

Discussion

The drying of roselle coated rice by low relative humidity air drying at low temperature (40 °C) and velocity of 0.3 m/s resulted in less color parameter changes than the higher temperature drying. Because high temperature drying may cause the degradation of food qualities, such as color, shrinkage, nutritional substances, rehydration capability and microstructure (Aguilera, 2005; Thipayarat and Leelayuthsoontorn, 2006).

Summary

This work has shown the importance of drying and post drying practices on the color parameter changes of roselle coated rice at final moistures contents of 11% dry basis. Using low relative humidity air for roselle coated rice drying temperature at 40 °C and drying velocity at 0.3 m/s could preserve the color of product while the higher drying temperature resulted in greater changes of color parameters. In addition, the low relative humidity air drying at low temperature (40 °C) had the least energy consumption than the hot ambient air which reduced time drying was approximately 45 %.

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