

ผลของเวลาคั่วและอุณหภูมิต่อคุณภาพของกาแฟพันธุ์ Arabica และ Robusta ของประเทศลาว
Effect of Roasting Time and Temperature on the quality of Arabica and Robusta Coffee Bean in Lao PDR

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Abstract

The effect of roasting temperature and time was conducted using factorial 3x3 in CRD for each cultivar (Arabica and Robusta). The results showed that increasing of roasting time and temperature caused the L* value decreasing to dark brown. The range of roasted Arabica and Robusta color ranged from 17.63 to 30.32, 4.94 to 12.10, and 4.04 to 22.81, respectively. The difference of cultivar, temperature and roasting time contribute to different protein content, moisture and pH. The result showed that protein content, moisture and pH lost when the time and temperature was increased. In this experiment, the protein of Arabica decreased from 2.38 to 2.06% and dropt from 2.27 to 2.00% for Robusta. The moisture of Arabica had valued between 1.16 – 2.91 % and 1.36 – 3.27 % for Robusta. In contrast, pH of Arabica coffee increased from 5.19 to 5.64, and pH of Robusta increased from 5.15 to 5.70 as temperature and roasting time increasing. Sensory evaluation showed that Arabica was more favorable than that of Robusta and the optimum of roasting time and temperature was determined at 180°C for 8 minute.

Key word: Coffee bean, roasted time and temperature

บทคัดย่อ

ศึกษาผลของอุณหภูมิและเวลาในการคั่วเมล็ดกาแฟ (อาราบิก้า และโรบัสต้า) โดยวางแผนการทดลองแบบสุ่มตลอด (CRD) และจัดสิ่งทดลองแบบแฟคทอเรียล 3x3 พบว่า การเพิ่มขึ้นของอุณหภูมิ และเวลาทำให้เมล็ดกาแฟมีสีน้ำตาลเข้มมากขึ้น ค่าความสว่าง L* ลดลง และมีค่าสี L* a* และ b* อยู่ในช่วง 17.63 - 30.32, 4.94 - 12.10 และ 4.04 - 22.81 ตามลำดับ ความแตกต่างของพันธุ์ อุณหภูมิ และเวลา ทำให้ปริมาณโปรตีน ความชื้น และค่าความเป็นกรดต่างในเมล็ดกาแฟคั่วแตกต่างกัน โดยเมื่อเพิ่มอุณหภูมิและเวลาในการคั่วจะทำให้ปริมาณโปรตีน และความชื้นลดลง เมล็ดกาแฟพันธุ์อาราบิก้า มีปริมาณโปรตีน ลดลงจากร้อยละ 2.38 ไปเป็น 2.06 และความชื้นอยู่ในช่วงร้อยละ 1.16 – 2.91 ในขณะที่พันธุ์โรบัสต้า มีปริมาณโปรตีน ลดลงจากร้อยละ 2.27 ไปเป็น 2.00 และความชื้นอยู่ระหว่างร้อยละ 1.36 – 3.27 แต่ในทางตรงกันข้ามกลับทำให้ปริมาณความเป็นกรดต่างของเมล็ดกาแฟเพิ่มมากขึ้น สำหรับพันธุ์อาราบิก้า ความเป็นกรดต่างเพิ่มจาก 5.19 ไปเป็น 5.64 และ 5.15 ไปเป็น 5.70 สำหรับพันธุ์โรบัสต้า เมื่อนำไปทดสอบความชอบกับผู้บริโภค พบว่า กาแฟพันธุ์อาราบิก้าได้รับคะแนนความชอบโดยรวมมากกว่าพันธุ์โรบัสต้า ระยะเวลาที่เหมาะสมสำหรับการคั่วกาแฟ คือ 8 นาที ที่อุณหภูมิ 180 องศาเซลเซียส

Introduction

Coffee bean is an important agricultural product for both domestic and exportation which contribute to national economy about 400,000 million baht annually (Lao Coffee Council, 2006). There are many types of coffee each type has different characteristic in duding leaf sharp, stem height, product capability, taste and smell quality. The variety of coffee that cultivate for trade is Arabica (Phithaks, 2529; Highland coffee Research and development center, 2542) which is important for national agricultural income. The most of Lao coffee originally planted in the southern, especially in Champassak province. Most of farmers prefer to produce dry coffee by less than 13 -15% of moisture content. The problems of coffee bean quality have non unities and lower standard. This is because of the coffee with moisture over 13% caused fermentation effecting on sour taste and bad smell.

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Currently, there are two different methods to make good coffee which using dry and wet method. Hence the aim of this study was to present the methodology for the optimization of the roasting process.

Materials and Methods

Raw material: There are two types of coffee: Arabica and Robusta coffee bean which had similar size; 9.94-9.79 cm length, 8.89 – 8.68 cm width, 4.92-4.86 cm thickness and 14-15 percentage dry basis of moisture content, from three company; the Ago Lao Company Cooperative of Ago Lao Company, Sinook coffee shop and company Lao PDR. The coffee beans then were kept in cold storage at 10-20°C 60 RH.

The study of commercial roasted coffee quality: The commercial roasted coffee from three companies were determined with various temperatures and times from 200 to 230 °C for 15-20 minute as part of physical and chemical qualities such as size, color, moisture, protein content, ash content and water activity.

The study of the effect of roasting process on coffee qualities: The effect of temperature and roasting time of each type of coffee bean was investigated by using 3x3 factorials in CRD with three levels of temperatures (160,170 and 180°C) and times (8, 10 and 12 min). Then, the roasted coffee beans were determined; moisture content, water activity and ash content (A.O.A.C, 2000), color value ($L^* a^* b^*$ in CIE system) and pH (Bench pH/MV/Temperature Meter). Finally, the roasted coffee was prepared by mixing with hot water 100 ml and then tested by using 9–point hedonic scale with 30 untrained panels who is over 18 years old.

Result and discussion

The results (Table1) showed that the physical qualities of commercial Arabica and Robusta were slightly difference. However, the obvious difference was observed in the moisture and ash contents. Because there are different chemical properties depending on coffee variety, the moisture and ash contents of Robusta bean were usually higher than Arabica.

Table 1 Properties of commercial coating.

Properties		Arabica	Robusta
Physical	Coffee bean size (mm)		
	- Width	8.89 ± 0.65	8.68 ± 0.65
	- Length	9.94 ± 0.65	9.79 ± 0.65
	- Thickness	4.92 ± 0.06	4.86 ± 0.65
	Color		
	- L^*	23.68 ± 0.15	24.12 ± 0.12
Chemical	- a^*	8.98 ± 0.07	9.10 ± 0.03
	- b^*	11.28 ± 0.21	11.50 ± 0.03
	Moisture	4.26 ± 0.5	5.65 ± 0.5
	Protein (%)	2.11 ± 0.20	2.14 ± 0.1
	Ash (%)	4.53 ± 0.08	5.58 ± 0.13
	pH	5.80 ± 0.11	5.49 ± 0.12
	a_w	0.159 ± 0.01	0.154 ± 0.05

The color values of roasted Arabica and Robusta coffee were significant ($p \leq 0.05$) at different temperatures and roasting times (Table 2). The color values (L^* , a^* , b^*) tended to decrease to darker brown than the original one because of browning reaction from sucrose which effects on the coffee flavor and consumer acceptance (Ky et al., 2000). The red-browning color of coffee also called brown silverskin or stinker bean (Vicent, 1989). The water activity of both coffees (Figure 1a) was significant ($p \leq 0.05$), which was tended to decrease when temperature and roasting time were increased. However, in the same condition, Arabica and Robusta had similar range of water activity.

The ash quality of roasted coffee with different temperatures and roasting times were significant at ($p \leq 0.05$) (Figure 1b). The result showed that increasing of temperature and roasting time caused Arabica ash

reduced while ash content of Robusta only affected by roasting time. The ash content of Robusta roasting at 160 °C for 8 minute and the ash content of roasted Arabica roasting at 170 °C for 10 minute showed the highest value.

Table 2 Effect of temperature and time on roasted coffee color

Treatment	Temperature (°c)	Time (min)	Arabica			Robusta		
			L*	a*	b*	L*	a*	b*
1	160	8	44.53 a	11.90 a	28.61 a	30.32 bcd	12.10 a	19.24 bc
2	160	10	29.69 bcde	9.00 e	15.32 cd	26.74 cdef	10.84 bc	14.44 cd
3	160	12	20.60 ghi	7.09 fg	7.21 ef	23.90 efgh	9.04 e	11.39 de
4	170	8	32.66 bc	12.84 a	21.78 b	35.09 b	12.35 a	22.81 b
5	170	10	25.23 defg	10.93 bc	14.63 cd	23.19 fghi	9.50 de	11.74 de
6	170	12	19.57 ghi	6.73 g	6.44 ef	27.51 cdef	10.50 cd	15.53 cd
7	180	8	26.92 cdef	10.50 cd	15.20 cd	18.03 hi	7.86 f	8.94
8	180	10	23.62 fghi	9.05 e	11.57 de	17.63 i	4.94 h	4.04 f
9	180	12	19.76 ghi	6.25 g	6.42 ef	19.12 hi	6.08 g	5.59 f

a-h difference letter of each column, showed the significant difference at p≤0.05

Temperature and roasting time significantly affected on protein quantity (Figure 1c). Arabica protein tended to decrease when temperature and roasting time was increased. However, at 160°C 12 min the protein content increased to the half of protein at 8 min and it was higher than Robusta roasted at all conditions. The range of Arabica protein was 2.06-2.38% and Robusta was 2.00 - 2.27% with different temperatures and roasting times.

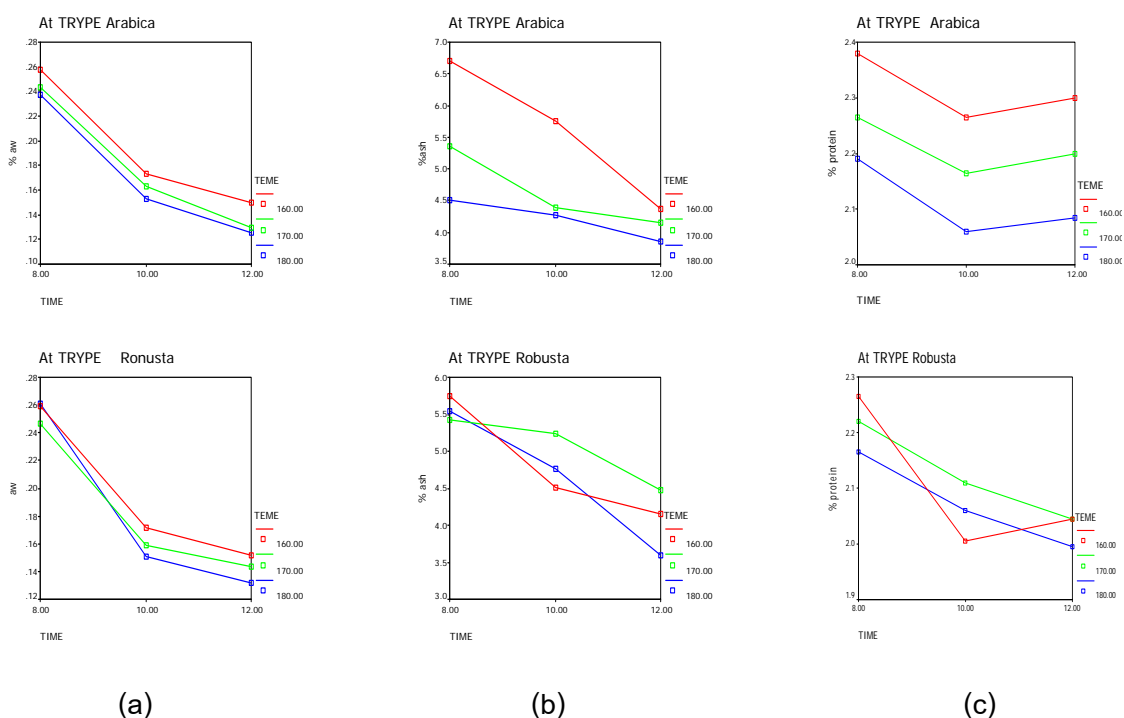


Figure 1 Properties of coffee bean

- (a) Water activity at different temperatures and roasting times
- (b) Ash content at different temperatures and roasting times
- (c) Protein content at different temperatures and roasting times

The Moisture content and pH of both coffees with using different temperature and time were significant at (p≤0.05) (Table3). The result showed the moisture content reduced when temperature and time were increased and it tended to higher than the moisture content of Arabica when comparing with the same condition. This is because the initial moisture of Robusta was usually higher than Arabica as shown in Table 1. It is reasonable that after roasting process the moisture content of Robusta tended to higher than that of Arabica.

Table 3 Effect of temperature and time on moisture content and ph of roasting coffee

Treatment	Temperature (°c)	Time (min)	Moisture content (%)		pH	
			Arabica	Robusta	Arabica	Robusta
1	160	8	2.91 a	3.27 a	5.19 f	5.15 f
2	160	10	1.86 cde	2.48 b	5.37 cd	5.44 bcd
3	160	12	1.34 fg	1.39 fg	5.46 bcd	5.62 a
4	170	8	2.37 b	3.26 a	5.15 f	5.20 f
5	170	10	1.78 def	2.28 bc	5.34 de	5.66 a
6	170	12	1.23 g	1.36 fg	5.18 f	5.25 ef
7	180	8	2.18 bcd	3.03 a	5.43 bcd	5.70 a
8	180	10	1.61 efg	2.20 bcd	5.51 b	5.43 bcd
9	180	12	1.16 g	1.39 fg	5.64 a	5.45 bcd

a-f difference letter of each column, showed the significant difference at $p \leq 0.05$

The pH values of both coffees were increased when temperature and time were increased due to pyrolysis reaction (Dutra et al, 2001). The increasing of pH value affects on consumer acceptance (sour taste of coffee) getting lower score than usual. However, both of Arabica and Robusta had the same range of pH value.

Table 4 Preference score of roasted coffee Attribute at 180°C

Attributes	Arabica			Robusta		
	8 min	10 min	12 min	8 min	10 min	12 min
Color	5.53 bc	6.73 a	7.10 a	4.73 c	5.80 b	5.47 bc
Odor	6.03 b	6.93 a	6.83 a	5.27 c	5.83 bc	5.57 bc
Bitter	5.13 c	5.97 ab	6.20 a	5.07 c	5.57 bc	5.27 bc
Sour	5.97 a	5.50 a	5.23 ab	5.17 ab	5.13 ab	4.57 b
Astringency	5.80 a	5.53 a	5.40 ab	5.27 ab	4.73 bc	4.37 c
Overall	5.77 ab	5.93 a	5.83 a	5.20 bc	4.87 c	4.97 c

a-c different letter of each column, showed the significant difference at $p \leq 0.05$

The roasting time affects on most of the sensory attributes ($p \leq 0.05$). The score of liking tended to decrease when roasting time was increased due to sour taste of coffee occurring. The result showed the preference score of Arabica coffee are higher than Robusta coffee. The optimum process for roasted coffee that gets the highest score of acceptance is the coffee roasted at 180°C for 8 minute (Table 4).

Conclusion

The roasted coffee quality depends on raw material properties and roasting process. The result shows Arabica coffee is more preferable than that of Robusta and the optimal roasting process is the roasting at 180°C and 8 minutes.

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