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อิทธิพลของความสุกแก่ของผลกาแฟและอุณหภูมิในการอบแห้งต่อคุณภาพของเมล็ดกาแฟพันธุ์โรบัสต้า
Effect of cherry maturity and drying temperature on Robusta coffee bean quality

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Abstract

Maturity of coffee cherries and drying processes are among various factors that affect to coffee bean quality. The present study aims to search out suitable proportion of ripe and unripe Robusta coffee cherries maturity (by weight) and drying temperature to improve coffee bean quality. The results of experiments from laboratory scale showed that drying temperature at 50°C had given a good appearance characteristic of coffee beans than over 65°C. In the cup quality test by the expert tester indicated that coffee bean from 100% ripe cherries with drying at 50°C and 65°C as well as 75% ripe cherries with drying at 50°C showed equivalent good cup quality. However, to be obtained good quality of Robusta coffee beans with low amount of defect bean and good cup quality, the proportion of unripe cherries showed not over 25%. The main chemicals composition in coffee bean that would affect for their flavor and aroma were also determined in all experiments. The results showed that drying temperature at 50°C, the amount of trigonelline (an aroma precursor) in coffee bean was higher than the coffee beans from used drying temperature at 65°C and 80°C, whereas the amounts of protein and sucrose were quite similar. The pilot scale experiments were carried out in Chumphon community area. The coffee cherries consisting of unripe cherries not more than 25% were dried at 50°C and 65°C, the drying time need to reduce moisture below 13% were found at 57 and 33 hrs respectively. The good cup quality of coffee beans dried at 50°C and 65°C were appreciated as that found in the laboratory experiments.
Keywords: Robusta cherry maturity, Drying temperature, Coffee bean quality

บทคัดย่อ

หนึ่งในปัจจัยที่มีผลต่อคุณภาพของเมล็ดกาแฟได้แก่ ความสุกแก่ของผลกาแฟและกระบวนการทำให้เมล็ดกาแฟแห้ง ในการศึกษาครั้งนี้มีวัตถุประสงค์เพื่อพัฒนาคุณภาพของเมล็ดกาแฟ โดยหาอัตราส่วนการปนคละของผลกาแฟสุกและผลกาแฟดิบ (โดยปริมาตร) และอุณหภูมิการอบแห้งผลกาแฟที่เหมาะสม การทดลองระดับห้องปฏิบัติการแสดงให้เห็นว่า การอบแห้งผลกาแฟที่อุณหภูมิ 50°C ทำให้ได้เมล็ดกาแฟที่มีลักษณะปรากฏที่ดีมากกว่าการอบแห้งที่อุณหภูมิสูงกว่า 65°C โดยในการทดสอบคุณภาพเครื่องดื่มกาแฟด้วยการชิม ผู้เชี่ยวชาญระบุว่า เมล็ดกาแฟที่ได้จากผลกาแฟสุกร้อยละ 100 โดยน้ำหนักที่อบแห้งที่อุณหภูมิ 50°C และ 65°C มีคุณภาพดีเช่นเดียวกับเมล็ดกาแฟที่ได้จากผลกาแฟที่มีผลสุกร้อยละ 75 โดยน้ำหนัก ที่อบแห้งที่อุณหภูมิ 50°C อย่างไรก็ตามเพื่อที่จะได้เมล็ดกาแฟพันธุ์โรบัสต้าที่มีคุณภาพที่ดี มีเมล็ดกาแฟที่มีข้อบกพร่องในปริมาณต่ำและมีคุณภาพเครื่องดื่มกาแฟที่ดี ผลกาแฟควรมีผลกาแฟดิบปนอยู่ต้องไม่เกินร้อยละ 25 โดยน้ำหนัก เมื่อวิเคราะห์องค์ประกอบทางเคมีที่สำคัญที่มีผลต่อรสชาติและกลิ่นของกาแฟ พบว่า เมล็ดกาแฟที่อบแห้งที่อุณหภูมิ 50°C มีปริมาณไตรโกนิลลีนสูงกว่าเมล็ดกาแฟที่อบแห้งที่อุณหภูมิ 65°C และ 80°C โดยปริมาณโปรตีนและซูโครสต่างมีผลในลักษณะเช่นเดียวกัน การทดลองระดับโรงงานต้นแบบ ทำการทดลองที่จังหวัดชุมพร โดยใช้ผลกาแฟที่มีผลกาแฟดิบปนไม่เกินร้อยละ 25 โดยน้ำหนัก ทำการอบแห้งเพื่อให้ผลกาแฟมีความชื้นไม่เกินร้อยละ13 ในการอบแห้งผลกาแฟที่อุณหภูมิ 50°C และ 65°C ใช้ระยะเวลาอบแห้ง 57 และ 33 ชั่วโมง ตามลำดับ ซึ่งเมล็ดกาแฟที่ได้มีคุณภาพของเครื่องดื่มกาแฟที่ดีเป็นที่ยอมรับเช่นเดียวกับเมล็ดกาแฟที่ได้จากการทดลองในระดับห้องปฏิบัติการ
คำสำคัญ: ความสุกแก่ของผลกาแฟพันธุ์โรบัสต้า อุณหภูมิในการอบแห้ง คุณภาพของเมล็ดกาแฟ

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Introduction

Coffee is the worldwide well-known beverage due to the impressive aroma and the unique flavor that is acceptable. The importance commercialized species includes Coffee arabica, and C. canephora (commonly known Robusta). Arabica coffee has lower bitterness and better flavor. However, Robusta coffee has appropriate property on commercial side, such as lower production costs, higher productivity and greater cup yield when compared with Arabica coffee (Luciane et. al., 2001).

Beside the appropriate harvesting and post-harvesting process are two important factors effecting the quality another of coffee. The maturation of coffee cherries is also the factor that affects on coffee quality. Previous literatures cited that the immature and premature cherry are caused of lower quality (Menezes, 1994; Mazzafera, 1999). Most of Robusta coffee cherries usually harvested by “strip-harvested” (a method where coffee cherries are harvested without consideration of maturation). Hence, Robusta coffee generally includes a high percentage of immature beans potentially degrading cup coffee quality (Montavon and Bortlik, 2004).

The dry process is the simplest process for preparation of coffee bean from cherries. Although sun drying process is easy and less expenses, mechanical drying is present some advantage such as limitation of drying areas and associated with labor reduction. Moreover, it can reduce drying time and decrease undesirable fermentation during drying process in case the climatic interference. Then the coffee beans were obtained have good quality and not contamination of microorganism or toxic (Nai, 1997).

The purposes of this work were to study the effect of different proportions of ripe and unripe coffee cherries with drying temperature on Robusta coffee bean quality. The main chemical composition of coffee beans and cup quality profile were also investigated.

Materials and methods

Robusta coffee cherries samples were obtained from Chumphon community area, Thailand. Cherries were harvested by strip harvested when 60-70% of the cherries were at the maturation stage. After harvesting, the mature cherries were separated from the rest, immature and dried cherries by water flotation. To split partial cherries were as strip harvesting method cherries then the other cherries were manually sorted into ripe and unripe cherries according to color appearance, the orange yellow and red cherry indicate as ripe cherry, light green and yellowish green cherry indicate as unripe cherry (Montavon *et. al.*, 2003). Four treatments of ripe and unripe cherry were proportions by weight: 100% ripe cherries, 75% ripe cherries + 25% unripe cherries, 50% ripe cherries + 50% unripe cherries and strip harvesting cherries (control).

Drying process in laboratory scale, various proportions of coffee cherries and strip harvesting cherries were dried by hot air dryer at 50^{o}C, 65^{o}C and 80^{o}C. The well dried of parchment coffee had obtained of moisture content below 13%. In pilot plant scale, rotary dryer was used to dry coffee cherries of 350 kg. The appropriated proportions of ripe and unripe cherries with drying temperature were applied for pilot scale experiments.

Coffee beans were evaluated quality according to commercial standard, including the coffee beans should have moisture content below 13%, the amount of defective beans content not more than the standard. Moreover, coffee must have aroma and flavor of beverage which accepted from experts by cup quality testing. In this study, the coffee beans were evaluated by cup quality testing from the experts of the Coffee Quality Products Company Limited, Thailand. The moisture content of coffee cherries and coffee beans were determined according to A.O.A.C. (1995). The defective beans content were evaluated in three characteristics, which confirmed the influence on cup quality, including broken bean, black bean and brown bean. Five random samples of a 100 g were separated from each lot. The non-defective beans and defective beans were manually separated and weighted. Defective beans content were expressed as means of percentage by weigh of defects of each characteristic.

Chemical composition analysis: Protein, reducing sugar and sucrose content were determined in coffee solution. Preparation of the coffee sample solution, powdered coffee sample (10 g) was mixed with 100 ml hot water (80°C), cooled to room temperature, the extract was filtered through Whatman paper No 2. Protein content was determined according to Lowry *et. al.* (1951), reducing sugar content was determined according to Aurand *et. al.* (1987) and sucrose content was determined according to van Handel (1968).

Caffeine and trigonelline content were determined by HPLC. Extraction, cleanup method and HPLC analysis was achieved as described by Maeztu *et. al.* (2001). The method was validated obtaining a linear relationship between the concentration of both compounds and the UV absorbance (r = 0.9997 and r = 0.9999 for caffeine and trigonelline, respectively).

Results and Discussion

Coffee drying in laboratory scale

Four treatments of Robusta coffee cherries were carried out in hot air dryer at temperature 50°C, 65°C and 80°C. Drying curves of coffee cherries are shown in Figure 1. The initial moisture content was approximately 67.73%. In order to reach moisture standard at 13%, drying at high temperature reduced the drying time to about 18, 30, 51 hrs for 80°C, 65°C and 50°C respectively. The moisture content of coffee beans is one factor to indicate that the coffee beans reached commercial standard quality. Generally, the beans must have moisture content below 13%. Whole coffee beans sample have moisture content corresponded to the commercial standard; they were 9.56 – 10.94%. Although drying processes with high temperature (as 65°C and 80°C), can rapidly reduced drying time, but the broken bean found over commercial standard, except experiment of coffee beans from 100% ripe cherries. In process with 80°C, the amount of brown beans was higher than 50% (Table 1). Brown beans are the defective beans that make cub quality decrease. Under 50°C drying, coffee beans showed less broken beans and brown beans were absence. Study showed that the optimal drying temperature was 50°C.

Cherry maturity

Cherry maturity is the other factor effecting coffee quality. In drying process used cherries in various proportion of bean maturity. Results showed coffee beans from 50% ripe cherries and beans from strip method cherries contained black beans higher than 2% that were considered as the low quality beans according to commercial standard. The black beans occurred should be caused by unripe cherries, the black beans increased corresponding to increasing of unripe cherries. However, treatment of 100% and 75% ripe cherries present good characteristic with slightly broken beans and no brown beans at all (Table 1). Therefore, in order to obtain good quality coffee beans, the mature cherries should be used as raw material in coffee processing (Menezes, 1994; Mazzafera, 1999). In practice, pick-harvested for only ripe cherries represent the higher cost for labor of harvesting process, therefore most farmers harvested Robusta cherries by strip method. However, they should try to mix unripe cherries in a rather low content, in order to get high quality coffee bean better prize.

Cup quality

The cup quality was carried out by the expert tasters which indicated that coffee beans from 100% ripe cherries and dried at 50°C and 65°C as well as coffee beans from 75% ripe dried at 50°C showed good cup quality (Table 1). While the other coffee beans were unaccepted due to strong fermented taste. Then the proportion of maturation of Robusta coffee cherries and optimum drying temperature were the important factors to cup quality of coffee. Therefore, to obtain good quality of Robusta coffee beans with low defective bean and good cup quality, present study suggest unripe cherries below 25% with drying temperature of 50°C.

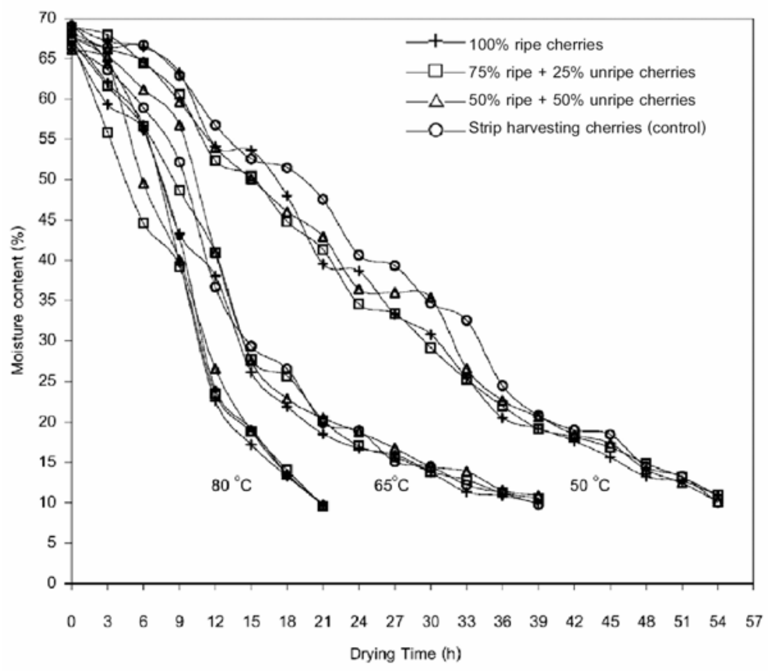

Figure 1 Drying curves of different proportion of coffee cherries in hot air dryer at various temperatures

Table 1 Defective beans content and cup quality

Coffee bean sample		Defective beans content (%w/w)			Cup quality
Proportion of maturation (by weight)	Drying temperature (°C)	Black bean	Broken bean	Brown bean	
100 % ripe	50	0.75	0.14	0	Good
	65	0.82	0.94	0	Good
	80	0.97	3.07	>50	Strong fermented
75% ripe	50	1.72	0.41	0	Good
	65	1.96	2.22	18	Strong fermented
	80	1.97	3.14	>50	Strong fermented
50% ripe	50	3.02	1.12	0	Strong fermented
	65	3.23	2.64	31	Strong fermented
	80	3.27	3.41	>50	Strong fermented
Strip harvesting cherries (control)	50	2.28	1.04	0	Strong fermented
	65	2.31	2.78	28	Strong fermented
	80	2.46	3.23	>50	Strong fermented

Chemical composition

The main chemical composition of coffee beans that would affect the flavor and aroma were also determined in all experiments. Results showed that coffee beans obtained from drying at 50°C, the amount of trigonelline (an aroma precursor) were 1.06%, 1.04%, 0.68% and 0.5% in treatment of 100%, 75%, 50% ripe cherries and strip harvesting cherries respectively. The treatment of 100% and 75% ripe cherries contained high content of trigonelline than the two high unripe cherries treatments. The trigonelline content in coffee beans dried at 80°C was lower than that dried at 50°C (Figure 2). However, the amount of protein and sucrose of all experiments were quite similar (Figure2). De Maria *et. al*. (1994, 1996) reported that protein and free amino acid in coffee beans were important roles together with monosaccharide in maillard reaction during roasting process.

Sucrose and trigonelline will act as aroma precursors, originating several substances (furans, pyrazines, pyrroles, pyridinines, etc.) that will affect both flavor and aroma in the beverage (De Maria *et al*., 1996; Ky et al., 2001; Stadler *et al*., 2002).

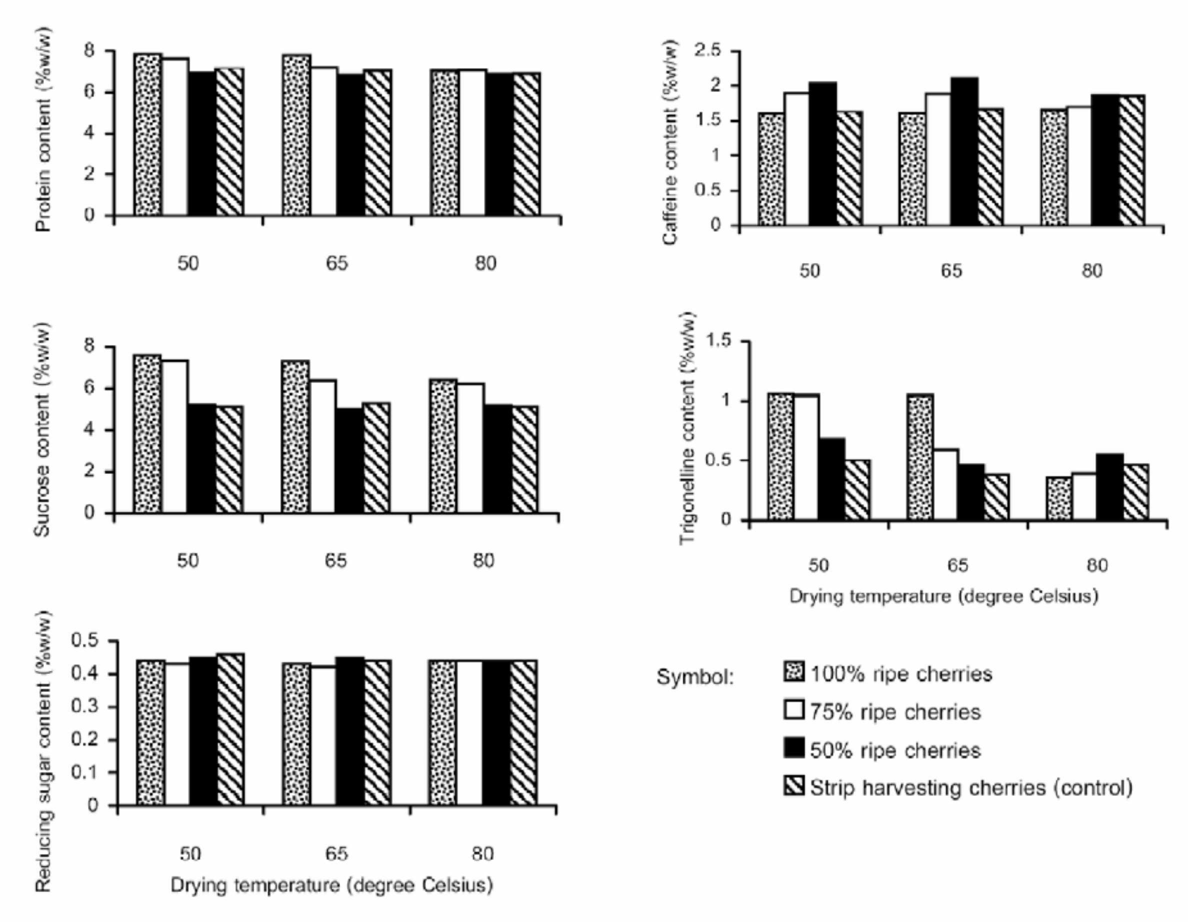

Figure 2 Chemical attributes of coffee beans

Coffee drying in pilot plant scale

The experiment in pilot plant scale were carried out with unripe cherries not more than 25% and dried at 50°C and 65°C in a rotary drier. The time need to dry coffee parchments with moisture content less than 13% at 50°C and 65°C were 57 and 33 hrs, respectively. The obtained coffee beans contained low defective bean which considered as the standard quality beans. Moreover, the result of cup quality testing showed coffee beans that used drying temperature at 50°C and 65°C as good cup quality as that of laboratory experiment. However, the expert tasters appreciate coffee beans that used drying temperature at 50°C more than at 65°C. Consequently, the resulted confirm that the maturity ratio of coffee cherries and the drying temperature are important factors to affect coffee beans quality.

Summary

In order to produce a commercial standard quality of Robusta coffee beans, the best quality one should used ripe cherries 75 – 100% and dried at 50°C – 65°C. The coffee beans would contain low amount of defective bean and present good cup quality. The trigonelline and sucrose content were two chemical components in question are aroma precursors that will affect both flavor and aroma in the beverage.

Acknowledgments

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Literature cited

A.O.A.C. 1995. Official Method of Analysis of the Association of Analytical Chemists.16th ed., Association of Analytical Chemist., USA.

Aurand, L.W., A.E. Woods and M.R Wells. 1987. Food composition and Analysis. Van Nostrand Reinnold, New York. 690p.

De Maria, C.A.B., L.C. Trugo, R.F.A. Moreira and C.C. Werneck. 1994. Composition of green coffee fractions and their contribution to the volatile profile formed during roasting. J. Food Chem. 50: 141–145.

De Maria, C.A.B., L.C. Trugo, F.R. Aquino Neto, R.F.A. Moreira and C.S. Alviano. 1996. Composition of green coffee water-soluble fraction and identification of volatiles formed during roasting. J. Food Chem. 55(3): 203–207.

Ky, C.L., J. Louarn, S. Dussert, B. Guyot, S. Hamon and M. Noirot. 2001. Caffeine, trigonelline, chlorogenic acids and sucrose diversity in wild Coffea arabica L. and C. canephora P. accessions. J. Food Chem. 75: 223–230.

Lowry, O.H., N.J. Rose, A.L. Farr and R.J. Randall. 1951. Protein measurement with the folin phenol reagent. J. Biol Chem. 193: 265–275.

Luciane C. M., H.C. de Menezes, M. Aparecida and A. P. da Silva. 2001. Optimization of the roasting of robusta coffee (*C. canephora* conillon) using acceptability tests and RSM. Food Quality and Preference. 12 (2): 153-162.

Maeztu, L., A. Susana, I. Carmen, M.P. de Pena, B. Jose and C. Concepcion. 2001. Multivariate Methods for Characterization and Classification of Espresso Coffees from Different Botanical Varieties and Types of Roast by Foam, Taste, and Mouthfeel. J. Agric Food Chem. 49: 4743–4747.

Mazzafera, P. 1999. Chemical composition of defective coffee beans. J. Food Chem. 64: 547–554.

Menezes, H.C. 1994. The relationship between the state of maturity of raw coffee beans and the isomers of caffeoylquiric acid. J. Food Chem. 50: 293–296.

Montavon, P. and Bortlik, K. 2004. Evolution of Robusta Green Coffee Redox Enzymatic Activities with Maturation. J. Agric. Food Chem. 52: 3590-3594.