Discourse Journal of Agriculture and Food Sciences
www.resjournals.org/JAFS
ISSN: 2346-7002
Vol. 2(2): 70-75, March, 2014

Processing Method, Variety and Roasting Effect on Cup Quality of Arabica Coffee (*Coffea arabica* L.)

Abrar Sualeh*, Solomon Endris and Ali Mohammed

Jimma Agricultural Research Center, P. O. box 192, Jimma, Ethiopia.

***** E-mail for Correspondence: Mabrarsualeh@yahoo.com

Abstract

Coffee is cornerstone in the Ethiopian economy. Coffee quality is affected by pre and post harvest practices. Among these practices, processing method and roasting duration are the main ones. This experiment was conducted to evaluate impact of processing method and roast duration on cup quality of Arabica coffee during 2011/12 cropping. Ten years old coffee berry disease resistant three varieties (744, 7440 and 74110) were used. The highest aromatic intensity (3.89) was achieved from dry processed coffee roasted for six minutes. Moderately pointed (3.86) acidity was registered from washed coffee roasted for eight minutes. Medium to moderately full (3.47) body was recorded for variety 74110 roasted for eight minutes. Flavor was significantly affected by the interaction of processing method with variety and processing method with roasting duration. Maximum value (3.75) was recorded for washed coffee roasted for eight minutes. The interaction between processing method and roasting duration was highly significant (P< 0.01) on overall quality where washed coffee roasted for eight minutes had the highest (3.64). Hence, cup quality of coffee affected by processing method, variety and roast duration. At fixed temperature (200^{o}C) and moisture content (11%) roasting dry and wet processing coffee for six and eight minutes respectively and six to eight minutes for semi washed coffee is advisable.

Key words: Processing method, variety, roasting duration, cup quality

INTRODUCTION

Coffee is the most important agricultural commodity and beverage enjoyed throughout the world. It belongs to the family Rubiacea (Illy and Viani, 2005) and consist more than one hundred species. *Coffea arabica* L. and *Coffea canephora* P are the two common species of coffee (Rick and Graham, 2004). *Coffea arabica L*., is more economical and it represent three quarters of the world coffee productions while *Coffea canephora* P. makes the rest one quarter of world coffee production (Kristina, 2011). These species vary in terms of chemical composition (Clifford, 1985). Arabica beans have good acid balance and chocolaty to flowery aroma while Robusta coffee beans are more bitter taste and woody to earthy aroma (Kristina, 2011).

Arabica coffee is originated in Ethiopia (Anthony *et al*., 2001). It is cornerstone in the Ethiopian export economy and supports directly or indirectly the livelihood of about 5% of the populations (EEA, 2001). Coffee production context and prices of the coffee market, improvement and valorization of coffee quality could provide the coffee chain with a new impetus (Leroy *et al*., 2006). As its volume of sales depends on coffee quality, much attention should pay to quality improvement and maintenance.

Coffee can be processed as sun-dried (natural), wet (washed) and semi-washed. Primary and secondary coffee processing determines 60% of coffee quality (Richard M., *et al.,* 2007). This indicates that the importance of primary and secondary processing to maintain the inherent quality and subsequent value of coffee. Coffee quality can be defined in terms of organoleptic cup-quality, physical appearances and inherent chemical constituents such as sugars, caffeine, volatile and non volatile phenolic contents of a green bean produced.

Coffee quality is considerably affected by many factors. *Inter ali*as, inappropriate post harvest practices are major problems of Ethiopian coffee, since numerous factors are affecting coffee quality. Improper coffee roasting temperature and duration may be factor for quality difference even if similar post harvest practices applied for the same coffee variety. Thus post harvest processing techniques largely contribute to the decline in coffee quality. Hence, this experiment was conducted to evaluate the impact of processing method and roasting duration on cup quality of selected Arabica coffee varieties.

Materials and methods

Sampling and processing method: Fully matured red cherry from uniformly grown ten years old coffee berry disease resistant varieties (744, 7440 and 74110) was harvested during main harvesting season of year 2011/2012 for each variety. Immature coffee berries and foreign matters were sorted out. Each variety was sub divided in to three and processed in dry, wet and semi washed methods as follows.

Dry processing: Red cherries were sun dried on raised compartmented mesh wire drying table 0.8 m above the ground. Samples regularly turned to maintain uniform drying to moisture level of 11%. During drying the moisture content of the bean was measured using Electronic Rapid Moisture Tester (HE 50, Germany) to maintain the moisture level of all samples at similar level. Finally dried coffee cherries were collected and hulled using manual hulling machine.

Wet processing: Red coffee samples were pulped using single disc motorized pulper. Wet parchment coffees were put in fermentation tank for 40 hours to facilitate breakdown of mucilage. After complete fermentation the parchment coffee properly washed and under gone further 24 hours of soaking (Woelore, 1993) and washed. Then, wet parchment coffee was sun dried on mesh wire raised bed. Moisture content of the samples was uniformly maintained at 11%. Then samples were hulled and hand polished to remove the parchment and silver skins.

Semi washed processing: Similar to wet processing method fully ripe red coffee cherries from each variety was pulped using single disc motorized pulper. Without fermentation, samples were washed using clean water to remove the mucilage and, then, dried to 11% moisture content. The dried parchment was hulled using manual huller and subsequent cleaning was followed.

Roasting: A six cylinder roaster machine (Probat BRZ6, Welke, Von Gimborn Gmbhan Co. KG) was first heated to 200^0C and then 100g green coffee beans per sample were put into the roasting cylinder. Samples were roasted for six, eight, ten and twelve minutes. During roasting the roaster temperature were controlled at 200^0C by adjusting the gas source for the heater.

Grinding: The coffee samples were ground to medium size using electrical grinder (MahlKonig, German) adjusted to 1.5 size and the grinder was cleaned well after each sample.

Brew preparation: Eight gram of coffee powder was put into each cup which has 180 ml of capacity (5 cups per sample unit). Fresh boiled water was poured on to the ground coffee up to about half size of the cup, followed by stirring the content to ensure the homogeneity of the mixture. Then, the cups were filled to the full size and left to settle. After three minutes, the floater was skimmed and ready for cup tasting.

Cup Tasting: Assessment of cup quality attributes was carried out by a team (three cuppers) of experienced and internationally certified Q grader professional panelists of JARC. Each panelist gave his/her independent judgment for each sample unit of the treatment. Finally, the average results of all panelists were used for data analysis.

Aromatic intensity, acidity and body were given magnitude of aroma, acidity and body. It is evaluated by the panelist on the basis of scale 0 to 5. Where: - 0 = nil, 1 = very light, 2 = light, 3 = medium, 4 = strong and 5 = very strong.

Aromatic quality, flavor and overall quality were determined by perception of the panelist or character of the coffee in the mouth. Using scale ranges from 0 to 5 where, 0 = unacceptable, 1 = bad, 2 = regular, 3 = good, 4 = very good and 5 = excellent.

Analysis of variance was computed for each quality parameter in order to identify the variability among the coffee processing method, varieties and roasting duration based on the procedures described by Gomez and Gomez (1984).

Table 1. Effect of processing method and roasting duration on aromatic intensity, aromatic quality and acidity

Method of Processing	Roasting duration (minute)	Aromatic intensity	Aromatic quality	Acidity
Dry	Six	3.89[a]	3.17[bc]	3.42[b]
	Eight	3.11[b]	3.11[bc]	3.03[c]
	Ten	2.64[c]	2.11[e]	2.58[e]
	Twelve	1.22[d]	1.28[g]	1.50[h]
Semi-washed	Six	3.83[a]	3.22[b]	3.36[b]
	Eight	3.19[b]	3.06[bc]	3.47[b]
	Ten	2.50[c]	2.33[de]	2.78[de]
	Twelve	1.44[d]	1.28[g]	1.78[g]
Washed	Six	3.22[b]	2.94[c]	3.39[b]
	Eight	3.83[a]	3.50[a]	3.86[a]
	Ten	2.75[c]	2.56[d]	2.94[cd]
	Twelve	1.44[d]	1.56[f]	2.19[f]
CV (%)		10.51	10.41	8.46
LSD (5%)		0.27	0.25	0.20

Mean values with similar letter(s) in the column are not significantly different at P<0.05

Table 2. Effect of variety and roasting duration on aromatic intensity, aromatic quality, acidity and body

Variety	Roasting duration (minute)	Aromatic intensity	Aromatic quality	Acidity	Body
744	Six	3.67[ab]	3.11[b]	3.28[b]	3.08[bc]
	Eight	3.36[c]	3.14[b]	3.39[ab]	3.42[a]
	Ten	2.75[e]	2.61[c]	2.61[d]	2.92[c]
	Twelve	1.44[g]	1.61[e]	1.89[e]	2.17[e]
7440	Six	3.50[bc]	3.06[b]	3.44[ab]	2.50[d]
	Eight	3.03[d]	3.08[b]	3.39[ab]	3.28[ab]
	Ten	2.22[f]	2.00[d]	2.83[cd]	3.00[c]
	Twelve	1.38[g]	1.28[f]	1.58[f]	2.03[ef]
74110	Six	3.78[a]	3.17[b]	3.44[ab]	2.89[c]
	Eight	3.75[a]	3.44[a]	3.58[a]	3.47[a]
	Ten	2.92[de]	2.39[c]	2.86[c]	2.86[c]
	Twelve	1.28[g]	1.22[f]	2.00[e]	1.89[f]
CV (%)		10.51	10.41	8.46	9.52
LSD (5%)		0.27	0.25	0.23	0.25

Mean values with similar letter(s) in the column are not significantly different at P<0.05

statistical software Version 9.2 (SAS, 2008) was employed for analysis of variance, in completely randomized design with three replications. Significant differences of the treatments were compared using Fisher's Least Significance Difference (LSD) at P < 5 % probability levels.

RESULT and DISCUSSION

Aromatic intensity was significantly (P<0.01) affected by the interaction between processing method and roasting duration. Strong aromatic intensity was recorded for dry (3.89) and semi washed (3.83) when the coffee is roasted for six minutes. However, strong aromatic intensity was recorded for wet processed coffee (3.83) when the coffee roasted for eight minutes (Table 1). Light aromatic intensity was recorded for all processed method coffee roasted for 12 minutes

A decline in aromatic intensity with increasing roasting duration was observed for dry and semi washed processed coffee. Roasting process has the greatest impact on coffee quality (Arya and Rao, 2007).

Interaction of variety and roasting duration was highly significant (P<0.01) for aromatic intensity. Medium to strong aromatic intensity for variety 74110 (3.78) and variety 744 (3.67) were recorded for six minutes of roasting duration (Table 2). Reduction in aromatic intensity was observed for all varieties as roasting duration increased from six to twelve minutes. According to Moura et al. (2007) linear increase of coffee roast duration presents significant negative effects on coffee aromatic quality as well as intensity.

Aromatic quality was significantly (P<0.01) affected by the interaction between processing method and roasting duration. Good aromatic quality (3.50) was recorded with eight minutes roasting duration for wet processed coffee and the lowest value was (1.28) observed under dry and semi washed processed coffee roasted for 12 minutes (Table 1). To achieve best aromatic quality, increasing roasting duration up to eight minutes would be advisable for washed coffee. But, for coffee processed under dry and semi washed methods, roasting to six minutes was found to be appropriate.

The interaction of variety and roasting duration was highly significant (P<0.01). Variety 74110 showed the highest value of aromatic quality (3.44) with eight 8 minutes roasting, whereas the least aromatic quality (1.22) recorded for variety roasted for 12 minutes (Table 2). Variety 744 and 7440 roasted for 8 minutes scored 3.14 and 3.08, respectively. Aromatic quality increased with roasting duration up to 8 minutes, and then highly declined to the lowest level at roasting duration of 12 minutes. According to Moura *et al.* (2007), the linear increase of roasting duration has significant negative effects on aroma that is due to loss of volatile compound.

Acidity was highly significant (P<0.01) due to interaction effect of processing method and roasting duration. Both coffees processed under washed and semi washed have shown the highest mean value of acidity (3.86 and 3.47, respectively) with roasting duration for 8 minutes (Table 1). Coffee processed by dry method had the highest mean value (3.42) at roasting duration for 6 minutes. Wet processed Arabica coffee gives good acidity even when roasted for 8 minutes duration. Dry processed coffee cannot resist heat as compared to washed coffee. The acidity of dry processed coffee decreased as roasting duration increased beyond six minutes. Clarke (1987) has reported that the use of fermentation instead of dry processing enhances acidity. Jackelers and Jackels (2005) have reported that fermentation in wet processed coffee increases the acidity of the coffee.

Interaction of coffee variety by roasting duration was significant (P<0.05). The highest mean value (3.58) was recorded for variety 74110 with roasting duration for 8 minutes (Table 2). Variety 7440 showed gradually decline of acidity as roasting duration increased from 6 minutes (3.44) to 12 minutes (1.58). The present finding indicates that roasting duration should be adjusted based on coffee type to get good acidity of coffee brew. Medium roast coffee usually has a sweet balanced cup with good acidity and overall quality (Mwithiga and Jindal, 2007; Garcia, *et al.,* 2008).

Body was highly and significantly (P<0.01) affected by the interaction effect of coffee variety by roasting duration. The highest score (3.47) for variety 74110 and 3.42 for variety 744 with roasting duration for 8 minutes were recorded roasted with 8 minutes while the smallest value (1.89) was for the variety 74110 roasted for 12 minutes (Table 2). As roasting duration increased from six to eight minutes quality attribute of body increases. ITC (2002) announced dark roast enhanced body of coffee brew which was in agreement of the present result.

Highly significant variation (P< 0.01) was observed for the interaction effect of processing method by variety. The highest value of body (3.42) was recorded for variety 744 and 74110 processed by the dry method. Variety 7440 processed by the dry method also showed the next best result (3.10). Variety 74110 under washed processing method had the list mean value (2.21). In general, the data shows that dry processed coffee has better body than either semi washed or fully washed coffee (Table 3). It has been reported that dry processed Arabica is less aromatic and less acidity, but with greater body (Clifford, 1985).

Flavor was highly and significantly (P<0.01) affected by the interaction of processing method and roasting duration. Maximum value was (3.75) recorded for washed coffee roasted for eight minutes followed by semi-washed coffee roasted for the same duration of time (3.39), while the lowest value was(1.44) dry and semi washed coffees roasted for 12 minutes (Table 4). The best value (3.08) for dry processed coffee was achieved of six minutes roasting. This shows that coffee processed under different processing methods must be roasted for different durations to achieve good flavour.

In addition the interaction between processing method and variety was highly significant (P< 0.01) for flavour. The maximum value (2.79) was recorded for variety 74110 processed under washed method followed by 2.69 for 744 and 2.67 for 7440 processed by the same processing method (Table 3). As to processing methods, washed coffee had the highest value, while the lowest value of flavour was recorded for the dry method of processing. That is due to discharging of some chemical compounds (poly phenols, tannins etc.) during soaking of washed coffee (Velmourougane, 2011).

Overall quality of a coffee was evaluated based on the value of different quality attributes used to determine and evaluate the quality potential of the coffee. Results of the research showed highly significant (P< 0.01) variations in overall quality for interaction of processing method by roasting duration. The highest mean value (3.64) was registered

Table 3. Effect of processing method and variety on body and flavour

Processing method	Variety	Body	Flavour
Dry	744	3.42[a]	2.04[d]
	7440	3.10[b]	2.44[c]
	74110	3.42[a]	2.58[abc]
Semi-washed	744	2.63[c]	2.56[bc]
	7440	2.60[cd]	2.50[bc]
	74110	2.71[c]	2.60[abc]
Washed	744	2.65[c]	2.69[ab]
	7440	2.40[d]	2.67[ab]
	74110	2.21[d]	2.79[a]
CV (%)		9.52	11.04
LSD (5%)		0.22	0.22

Mean values followed by the same letter are not significantly different at P<0.01

Table 4. Effect of processing method and roasting duration on flavor and overall quality

Processing method	Roasting duration (minute)	Flavour	Overall quality
Dry	Six	3.08[c]	3.33[b]
	Eight	2.78[d]	3.08[bc]
	Ten	2.11[gh]	2.42[de]
	Twelve	1.44[i]	1.28[f]
Semi-washed	Six	3.06[c]	3.17[bc]
	Eight	3.39[b]	3.31[b]
	Ten	2.33[fg]	2.22[e]
	Twelve	1.44[i]	1.22[f]
Washed	Six	2.50[ef]	2.92[c]
	Eight	3.75[a]	3.64[a]
	Ten	2.75[de]	2.56[d]
	Twelve	1.86[h]	1.28[f]
CV (%)		11.04	10.48
LSD (5%)		0.26	0.25

Mean values followed by the same letter(s) in the column are not significantly different at P<0.05

for washed coffee roasted for 8 minutes, followed by dry processed coffee roasted for six minutes (3.33). The lowest values were recorded at 12 minute roasting duration for all processing methods (Table 4). Hence, in order to achieve good result in overall quality of coffee there should be different roasting durations for different processing methods. However, the wet processed coffee showed superior overall quality as compared to the other methods for 8 minutes of roasting. In the case of dry processing, six minutes of roasting gave the best overall quality. Based on the overall quality result, variations were detected among coffees processed under different methods and roasted different times. Moreover, cup quality is a complex characteristic, which depends on various factors such as pre and post harvest processing (Barel and Jacquet, 2006).

CONCLUSION

The interaction effect arises from processing method and roasting duration as well as processing method and variety or variety and roasting duration were found to be significant for most quality traits, demonstrating the need to consider time of roasting and method of coffee processing to get best quality brew. In general, it can be concluded that coffee roasting

duration and processing method may account for specific quality attributes. The results also showed that dry processing method resulted in high value for most quality attributes with 6 minutes roasting while good acidity and other quality attributes were associated with 8 minutes roasting for wet processing method. This is because of washed coffee resist more heat than dry processed coffee. Coffee cup quality can be affected by processing method, varieties and roast duration. In order to get good result in overall quality of coffee there must be different time of roasting for each processing method. Thus, the selection of coffee roasting duration can made depending on respective variety and processing type. At fixed temperature (200^{o}C) and moisture content (11%) roasting dry and wet processing coffee for 6 and 8 minutes respectively and 6 to 8 minutes for semi washed coffee is recommended.

Acknowledgements

The authors thank Jimma Agricultural Research Center and Jimma University College of Agriculture and Veterinary Medicine for supporting the research activity. The contribution of certified professional cuppers at Jimma Agricultural Research Centre is highly acknowledged.

REFERENCES

Anthony F, Bertrand B, Quiros O, Lashermes P, Berthaud J and Charrier A. (2001). Genetic diversity of wild coffee (*Coffea arabica* L.) using molecular markers. *Euphytica* 118: 53-65.

Arya M., and Rao LJM (2000). An impression of coffee carbohydrates. Critical Reviews in Food Science and Nutrition. 47: 51-67.

Barel M and Jacquet M (2006). Coffee quality: its causes, appreciation and improvement. *Plant Rech. Develop*. 1:5-13.

Clarke R J (1987). Roasting and grinding In: Coffee, Volume 2, Technology (eds R.J. Clarke and R. Macrae) Elsevier Applied Science, Barking.

Clifford MN (1985). Chemical and physical aspects of green coffee and coffee products. pp. 305-374. In: M.N. Clifford and K.C. Willson (Eds.), Coffee Botany, Biochemistry, and Production of Beans and Beverage, Croom Helm, London.

EEA (Ethiopian Economic Association) (2001). Annual report on Ethiopian Economy. 1999/2000, EEA, Addis Ababa, Ethiopia.

Garcia AO, Teles RCSC, Ormenese CM, Schmidt CAP. and Miglioranza E. (2008). Evaluation of coffee sensory quality submitted to different degrees of roasting: Medium and Dark. pp. 386-389. Proceedings of 22nd International Scientific Conference on Coffee Science (ASIC). Campinas, Brazil, 14 -19 September 2008.

Gomez KA and Gomez AA (1984). Statistical procedure for Agricultural Research (2nd) John Wiley and Sons, New York.

Illy A, and Viani R. (2005). Espresso coffee: The science of quality. London, UK: Academic Press.

ITC (International Trade Centre) (2002). Coffee An exporter's guide. UNCTAD/WTO. Switzerland, Geneva. pp. 243-289.

Jackelers SC. and Jackels CF. (2005). Characterization of the Coffee Musillage Fermentation Process using chemical Indicators: A field study in Nicaragua. Journal of Food Science 70: 321- 325.

Kristina Bagdonaite (2011). Formation of Acrylamide during Roasting of Coffee http:\\www.foodscience.tugraz

Leroy T, Fabienne R, Benoit B, Pierre C, Magali D, Christophe M, Pierre M. and David P. (2006). Genetics of Coffee Quality. Brazilian J. Plant Physiol.18(1):229-242.

Moura SCSR, Germer SPM, Anjos VDA, Mori EEM, Mattoso LHC, Firmino A. and Nascimento CJF. (2007). Influence of roasting parameters on the physical, chemical and sensorial characteristics of pure Arabica coffee. Bra. J.Food Technol., Campinas 10(1): 17- 25.

Mwithiga G. and Jindal VK. (2007). Changes in properties of coffee brew due to roasting, World Appl. Sci. J. 2(5): 527-535.

Richard M, Charles A. and Mitiku M (2007). Primary coffee processing in Ethiopia: patterns constraints and determinants, African Crop Science Conference Proceedings 8: 1417-1424.

Rick H. and Graham F. (2004). Crop Post-Harvest: Science and Technology Volume 2 Durables Case studies in the handling and storage of durable commodities. Blackwell Science Ltd.

SAS (Statistical Analysis System) (2008). (Version 9.2). SAS Institute, Cary, NC. USA.

Velmourougane K. (2011). Effect of wet processing method and subsequent soaking of coffee under different organic acids on cup quality. World J. Sci. Technol. 1(7): 32-38.

Woelore WM. (1993). Optimum fermentation protocols for arabica coffee under Ethiopian conditions. pp. 727-733. Proceedings of the 15th International Scientific Colloquium on Coffee (ASIC). Montpellier, France, June 6-11 1993.