28th Conference ASIC 2021 From 28 June to 1 July 2021

S6-P-01

Biochemical composition and mineral content of Ethiopian green arabica coffee beans varied with growing region

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Introduction

Green coffee beans are composed of volatile and nonvolatile fractions of compounds, which are responsible for the coffee aroma and basic tastes, such as sourness, bitterness and astringency, and whose compositions are influenced by various factors along the coffee value-chain - from farm to cup. The most abundant classes of volatile compounds are alcohols, esters, hydrocarbons and aldehydes and those of nonvolatile compounds are caffeine, trigonelline, chlorogenic acids (CGA), organic acids, carbohydrates, fibers, proteins, amino acids, lipids and minerals (Table 1). Of these compounds, caffeine, trigonelline, CGA, soluble fiber and diterpenes are important contributors to the beverage flavor after coffee roasting. Several carbohydrate compounds including sucrose are precursors for the Maillard reaction and caramelization, which are vital for color and aroma development and contributors to the brew acidity and body after roasting. As precursors for the Maillard reaction and the formation of several volatile compounds; protein, peptides and amino acids are also vital for coffee flavor (Farah, 2012). Ethiopian coffee is produced in four major coffee-growing regions, varying in growing environment and coffee management (or production system) that can influence chemical composition of green coffee beans.

This paper focused on caffeine, trigonelline, chlorogenic acids and sucrose contents as main aroma and flavor precursors and bioactive compounds and mineral contents of green arabica coffee beans from four coffee growing-regions in Ethiopia.

Materials/Methods

This paper is based on own data and data from six published research papers that have been carried out in four major coffee-growing regions of Ethiopia (Eastern or Harar, Southeastern, Southwestern and Northwestern Ethiopia) (Habte et al. , 2016; Mehari et al., 2016a, 2016b; 2016c; Tolessa et al., 2017; Tolessa, 2017) and some others from world wide (Farah, 2012).

Table 1. Approximate chemical composition of green C. *arabica* and C. *canephora* beans ; adapted from Farah (2012).

Components	Content (g kg^{-1})[a, b]	
	C. arabica	*C. canephora*
Caffeine	9.0–13.0	15.0–25.0
Trigonelline	6.0–20.0	6.0–7.0
Chlorogenic acids	41.0–79.0	61.0–113.0
Aliphatic acids	10.0	10.0
Quinic acid	4.0	4.0
Sucrose	60.0–90.0	9.0–40.0
Reducing sugars	1.0	4.0
Polysaccharides	340–440	480–550
Lignin	30.0	30.0
Pectin	20.0	20.0
Proteins/peptides	100.0–110.0	110.0–150.0
Free amino acids	50.0	8.0–10.0
Fats	150.0–170.0	70.0–100.0
Diterpenes	5.0–12.0	2.0–8.0
Minerals	30.0–42.0	44.0–45.0

[a] Content varies according to cultivar, agricultural practice, climate, soil composition and method of analysis.
[b] The data are given in the original source as g 100 g^{-1} of dry weight.

Table 2. Chemical composition of green C. *arabica* beans growing in four coffee regions of Ethiopia; author's computation based own data and data from Farah (2012), Habte et al. (2016), Mehari et al.. (2016a, 2016b, 2016c), Tolessa et al. (2017), Tolessa (2017).

Components	Content (g kg^{-1})[a, b, c]					
	East (Harar)	Southeast	Southwest	Northwest	Ethiopia	Worldwide
Caffeine	8.7–13.1 (10.5)	9.5–12.0 (10.9)	9.1–17.2 (13.6)	11.2–13.8 (12.5)	10.5–13.6	9.0–13.0
Trigonelline	10.6–13.2 (11.9)	10.1–13.1 (11.5)	9.8–12.0 (11.0)	11.5–12.9 (12.2)	11.0–12.2	6.0–20.0
Chlorogenic acids	52.0–66.0 (61.0)	50.0–68.0 (60.0)	42.1–66.0 (55.0)	62.0–68.0 (64.0)	55.0–64.0	41.0–79.0
Sucrose	–	–	28.7–91.8 (65.0)	–	65.0	60.0–90.0
Minerals	18.1–25.0 (20.2)	16.7–26.5 (20.7)	15.4–24.4 (20.2)	17.1–20.5 (19.9)	19.9–20.7	30.0–42.0

[a] Content varies according to production region, growing elevation, cropping-season, postharvest processing method and study.
[b] The data are given in the original sources either as percentage, μg g^{-1}, mg g^{-1} or g 100 g^{-1} of dry weight.
[c] Numbers between parentheses are means.

Results/Discussion

Except some study reports on mineral contents, the average contents of caffeine, trigonelline, chlorogenic acids (CGA), sucrose and minerals reported for Ethiopian coffee from four coffee regions are generally comparable to those values reported for arabica coffee from elsewhere in the world (Table 1). The four regional coffees (Table 2) and the coffee types (*Harar*, *Sidamo*, *Yirgacheffe*, *Jimma*, *Kaffa*, *Wellega* and *Gojam coffees*) have different levels of caffeine, trigonelline, individual CGAs (except 5-pCoQA) and minerals. Particularly, caffeine content was significantly higher in *Gojam coffee* than in the other coffee types. *Harar coffee* contained lower levels of caffeine; but, the difference was significant only compared to *Jimma*, *Wellega* and *Gojam coffees*. Similarly, *Kaffa coffee* had a significantly lower content of trigonelline than the other coffee types, except for *Jimma* and *Wellega coffees*. The southeastern coffee contained higher amounts of Cu, Fe, Mg, Mn, P, Si and S than the southwestern and Harar coffees. These findings indicate Ethiopian coffee potential for quality profile mapping and geographic origin indication.

Conclusion

Except some study reports on mineral contents, the average contents of caffeine, trigonelline, chlorogenic acids (CGA), sucrose and minerals reported for Ethiopian coffee from four coffee regions are generally comparable to those values reported for arabica coffee from elsewhere in the world. The four regional coffees and the coffee types (i.e., *Harar*, *Sidamo*, *Yirgacheffe*, *Jimma*, *Kaffa*, *Wellega* and *Gojam coffees*) have different levels of caffeine, trigonelline, individual CGAs (except 5-*p*CoQA) and minerals. There were, however, statistically similar levels of total CGA across the four regional coffees. These findings generally indicate the possibility of mapping the quality profile and geographic origin indication of Ethiopian coffee.

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