Effect of Soils Properties on the Quality of Compact Arabica Hybrids in Tanzania

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Abstract

A study was conducted to assess the beverage of Compact Arabica varieties as influenced by soil properties in Tanzania. This study was necessary as there is lack of information on how soils properties influence attributes of cup taste in the country. Samples for the study were collected from altitudinal range of 1200 to 1800 m a. s. l.; soil types described as clay, loam and silt loam; type of rainfall bi-modal (1500 mm per annum) and uni-modal (1700 mm per annum), and flat and or sloppy terrain. Forty (40) samples of coffee green beans collected from descriptive area of the study were considered in this study. Red ripe coffee cherries were handpicked, wet processed, dried, and graded with only AAs, As and PBs considered in the study. For beverage assessment green beans were roasted allowed to rest for 4 hr, grinded, then dry fragrance of the samples were evaluated by sniffing. Proteins, caffeine and mineral contents of the coffee beans were analyzed. Soils samples were collected from three depths: 0-30 cm, 30-60 cm, and 60-90 cm. Analysis was done to measure pH, cation exchange capacity (CEC), and available soil nutrient and texture. Design for the experiment was Randomized Completely Design, and data were analyzed using Genstat statistical package. Out of 40 samples, 2 of the compacts scored class 4 for specialty coffee. N39 traditional Arabica cultivar scored specialty description. These findings indicate that, to attain specialty or premium coffee from prevailing soil properties in Arabica coffee areas the best cup with excellent aroma is supposed to be prepared from green beans of; Calcium (g/Kg) 0.8-0.9, Potassium (g/Kg) 2.9 to 6.0, proteins (%m/m) 8.0 to 9.0 and caffeine (g/Kg) 10.8 to 13.7. It was also found out that soils with adequate P, K, Clay-loam and silt influences positively the cup taste. Positive correlation coefficient r was found between the cup taste and pH (0.49), cup taste and calcium (0.45), cup taste and potassium (0.46) and cup taste and sodium (0.48) (r_t at 0.05 0.40).

Key words: Coffee quality, Arabica coffee, Agro-ecological areas, Tanzania

{**Citation:** Kilambo, Deusdedit L.; Mlwilo, Bahati L,; Mtenga, Damian J.; Maro, Godsteven P. Effect of soils properties on the quality of compact Arabica hybrids in Tanzania. American Journal of Research Communication, 2015, 3(1): 15-19} www.usa-journals.com, ISSN: 2325-4076.

Introduction

Tanzanian coffee from both Arabica and Robusta is currently ranked among the best coffee in the world (TCB, 2012). Decazy *et al.* (2003) observed, the types of varieties cultivated, post-harvest processes applied to coffee, geographical areas (soils and climatic conditions), and agronomic practices to a greater extent influence the taste of coffee. Slagle *et al.* (2004) reported that concentrations of nutrients in different soils would also have an impact on the variations in cup quality of coffee. This is because nutrients are required for both vegetative growth of coffee trees and production of high quality beans, and thereby coffee quality (Njoroge, 1998). For example volcanic soils often produce a potent acidity and a fine flavour and for that matter such soils can lead to a more balanced cup. Areas of wet and dry cycles and precipitation which does not exceed 1500 mm have a tendency of producing high quality coffee due to regular cherry ripening and proper bean drying conditions after harvesting (van der Vossen, 1985). The objective of this study was to assess the influence of soils on the cup taste of coffee genotypes established in different ecosystems in Tanzania.

Materials and methods

Coffee cherries were handpicked when fully red ripen between May to September 2013 at Lyamungu (Slopes of Mount Kilimanjaro) and Ugano (Southern Highlands). Wet processing of cherries, followed by fermentation of the parchments and drying of coffee green beans were performed as per the method described by Robinson (1964). Coffee green beans were graded, and beans with AA and A grade selected, weighed in 100 gm. Coffee green beans were analyzed for organoleptic taste and mineral composition. The caffeine content and mineral contents of the coffee beans were determined as per the method adopted by Tanzania Food and Drug Agency (TFDA, 2010). For protein analysis, Kjeldal method was used. To determine sodium and potassium, the filtrate was subjected to spectrometer flame emission. To determine sodium, a wavelength of 589.6 nm was adopted with a special band width of 1.0 nm, and potassium at a wavelength of 769.9 nm with a special band width of 1.0 nm.

Soil sampling from Lyamungu and Ugano was done following the criteria suggested by Cordingley (2010), which include the size of the plot and the level of homogeneity within the plots. This included varying positively the number of auguring within a plot size, and auguring guided on “W” root of sampling within a plot. Soils were collected in three depths (0-30 cm, 30-60 cm, and 60-90 cm) then transported to Lyamungu for analysis.

The cup taste of the coffee samples were assessed by experts’ liquorers using sensorial criteria: aroma, body, acidity, bitterness, astringency, sourness and grassy taste. The flavour class assigned; score fine, Good to fine class1; Fair to Good class 3; Fully Fair class 4; Fair Average Quality class 5; About Fair class 6; Poor to Fair class 7; and Poor class 8.

Results and discussion

Results for the samples collected from different locations on description of the cup, mineral, proteins and caffeine contents are as summarized in Table 1.

Table 1: Description of the cup, mineral, proteins and caffeine contents of compact coffee genotypes

Location	Genotype	Cup taste	Class	Description	Mineral content			
					Calcium (g/Kg)	Potassium (g/Kg)	Protein (% m/m)	Caffeine (g/Kg)
Lyamungu	CVT1	Medium acidity, body & flav	4	Fruity aroma, dark choc	0.9cde	4.1c	10.2a	9.7efg
	CVT2	Medium acidity, body & flav	6	Chocolate	1.1bc	4.0c	9.2c	9.7efg
	CVT3	Light medium acidity, body	6	Chocolate	1.2ab	6.3c	9.0cd	11.8abc
	CVT4	Medium body, light med acid	5	Aroma taste tones	0.5f	12.7ab	9.1c	10.5cdef
	CVT5	Light medium acidity, body	5	Sweet aroma	0.7ef	3.1c	9.5bc	11.3bcde
	CVT6	Medium acidity, body	4	Dark chocolate	0.8de	6.0c	8.5de	12.8ab
	CVT7	Light medium acidity, body	6	Aroma coffee pulp tones	1.1bc	4.6c	9.2c	11.5abcd
	CVT8	Medium body, light med acid	5	Chocolate	0.9cde	4.8c	9.5bc	9.6efgh
	CVT9	Light medium acidity, body	5	Fruity aroma strawberry	1.1bc	4.9c	9.5bc	13.1a
	CVT10	Medium body, light med acid	5	Fruity aroma strawberry	1.2ab	4.5c	9.0cd	9.8defg
	CVT11	Medium body, light med acid	5	Dark chocolate	1.1bc	5.4c	8.4e	78.9fgh
	CVT12	Light medium body, acidity	5	Fruity taste	0.9cde	16.1a	9.2c	8.7gh
	CVT13	Light medium body, acidity	6	Harsh aroma	1.2ab	4.6c	8.5de	11.8abc
	CVT14	Light medium acidity, body	5	Aroma berry tones	1.4a	5.4c	9.4bc	9.1fgh
	CVT15	Light medium body	5	Harsh aroma	0.9cde	4.5c	9.4bc	8.8fgh
	CVT16	Light medium acidity, flavour	6	Dark chocolate	0.9cde	5.7c	9.0cd	11.6abc
	N39-6	Medium body, light med acid	5	Lemonish citrus aroma	1.0bcd	5.3c	9.2c	7.9h
	KP423-2	Light medium body, acid, flav	6	Lemonish aroma	1.1bc	5.5c	9.9ab	10.5cdef
	PNI088	Light medium acidity, flv, bod	6	Strawishy aroma	1.4a	2.9c	9.3c	10.5cdef
	N39	Light medium acidity, body,fl	5	Aroma berry tones	0.9cde	10.5b	7.6f	8.9fgh
	Mean				1.0	6.0	9.1	10.3
	Tukey's				0.04	0.7	0.1	0.3
Ugano	CVT1	Light medium acidity, body,fl	6	Sourish	1.3abc	5.9bcde	7.9efg	10.7gh
	CVT2	Light medium acidity, body,fl	6	Sourish	1.4ab	7.0bc	9.5ab	11.7efgh
	CVT3	Light medium acidity, body,fl	6	Sourish	0.9bcd	6.5bcd	8.8bcdefg	15.1b
	CVT4	Medium body, light med ac/fl	5	Cean cup	1.1abcd	3.0f	8.8bcdefg	14.8bc
	CVT5	Light medium acidity, flavour	5	Sweet aroma	1.4ab	3.5f	8.9bcdefg	11.6efgh
	CVT6	Medium body, acidity, flavour	5	Fruity taste aroma	1.2abcd	3.0f	9.3bc	12.2defg
	CVT7	Light medium acidity, bod, flv	6	Sourish	1.5a	4.7cdef	8.8bcdefg	12.7cdefg
	CVT8	Medium body, light acidity, fl	5	Chocolate	0.7d	7.7ab	8.8bcdefg	12.6cdefg
	CVT9	Light medium body, acidity, fl	6	Sourish	1.3abc	3.1f	8.2cdefg	12.1efg
	CVT10	Medium body, light acidity, fl	6	Lemonish aroma	0.7d	3.0f	7.7g	17.7a
	CVT11	Light medium body, acidity,fl	6	Sourish	0.9bcd	6.5bcd	7.8fg	11.5efgh
	CVT12	Light medium body, acidity,fl	6	Lemonish	1.2abcd	2.7f	8.0defg	11.4efgh
	CVT13	Light medium body, acidity,fl	6	Sourish	0.8cd	3.4f	10.5a	11.2fgh
	CVT14	Light medium body, acidity,fl	6	Sourish	1.5a	9.5a	7.9efg	11.5efgh
	CVT15	Medium body, light acidity, fl	5	Chocolate	0.9bcd	6.0bcd	9.1bcde	11.1fgh
	CVT16	Light medium acidity, flavour	5	Fruity aroma	1.1abcd	4.4def	7.8fg	9.5h
	N39-6	Medium acidity, flavour, body	4	Dark chocolate	0.9bcd	4.8cdef	9.0bcde	13.7bcde
	KP423-2	Medium body, light acidity, fl	5	Sourish	0.8cd	2.7f	8.0defg	14.5bcd
	PNI088	Light medium acidity, fl, body	5	Dark chocolate	1.3abc	3.6ef	8.1defg	13.2bcdef
	N39	Medium acidity, body, flavour	4	Fruity aroma, d/ch	0.9bcd	2.9f	8.0defg	10.8gh
	Mean				1.1	4.7	8.5	12.5
	Tukey's				0.1	0.4	0.2	0.4

Genotypes with the most outstanding cup taste scores at Lyamungu were CVT1 and CVT6, at Ugano were N39-6 and N39. Almost all coffee genotypes scored class 5 to 6, described for export value. N39 and N39-6 both commercial coffee cultivars maintained their genetic ability in showing excellent cup taste. The position of the contents analyzed which gave the best cup taste results of class 4 at Lyamungu site was on genotype CVT6 whereby Calcium levels in the sample were 0.8 g/Kg, Potassium 6.0 g/Kg, Proteins 8.5% m/m, and caffeine 12.8 g/Kg. Coffee genotype CVT1 at the same site the levels of the contents were Calcium 0.9 g/Kg, Potassium 4.2 g/Kg, Proteins 10.2% m/m, and caffeine 9.79 g/Kg. The description of the cup for CVT1 was fruity aroma, dark chocolate; and CVT6 was dark chocolate. At Ugano, the analysis for the contents of N39-6 were Calcium 0.9 g/Kg, Potassium 4.8 g/Kg, Proteins 9.0% m/m and caffeine 13.7 g/Kg. N39, calcium 0.9 g/Kg, Potassium 2.9 g/Kg, Proteins 8.0% m/m and caffeine 10.8 g/Kg. This could translate that the best cup of coffee with excellent aroma flavour is supposed to be prepared from green beans with contents of Calcium 0.8 g/Kg to 0.9 g/Kg, Potassium 2.9 g/Kg to 6.0 g/Kg, Proteins 8.0% m/m to 9.0% m/m and caffeine 10.8 g/Kg to 13.7 g/Kg.

Table 2 summarizes result on soil analysis collected from Lyamungu and Ugano where the compact genotypes were established. Soils pH levels at Lyamungu site falls under neutral positions (4.7 to 5.9), and at Ugano slightly alkaline; 5.3 to 7.4. This may influence the availability of soil nutrients to be available for absorption by the coffee plants. Soils with free draining loams with a good water retention capacity and a pH of 5 to 6, and contain proportions of clay usually produces high quality of Arabica (van der Vossen, 1985). But at the same time soils with excessive calcium and potassium produce hard and bitter tasting liquor. Lyamungu soils had good proportions of loam and clay-loam compared to Ugano (Table 2), this could be possibly a reason for 14 samples scoring class 5-4, viz. a.viz 9 of the same class at Ugano.

Table 2: Analytical results for soil samples collected from Lyamungu and Ugano

Site	Depth (cm)	pH (H20)	Exchangeable cation in me/100 sample						Total % N	Trough (ppm P)	Soil type
			Ca^{2+}	Mg^{2+}	K^{+}	Na	%BS	CEC			
Lyamungu	0-30	4.7	8.1	0.3	2.2	0.5	77	16	0.14	1.32	Loam
	30-60	5.2	9.4	0.7	1.7	0.6				1.95	Loam
	60-90	5.6	10.2	1.2	1.8	0.6				0.99	Clay loam
Ugano	0-30	6.2	1.4	0.2	0.7	0.3	23	12	0.13	2.28	Silt clay
	30-60	5.8	0.9	0.5	0.4	0.3				1.07	Clay loam
	60-90	5.4	0.8	1.6	0.3	0.3				1.02	Clay

Results show that there is positive correlation between cup taste and some of the soil nutrients (Table 3).

Table 3: Correlation coefficients between pH, Ca2+, K+, Na+, Mg2+ versus cup taste

	pH	Ca^{2+}	Mg^{2+}	K^{+}	Na^{+}
Cup taste	0.49	0.45	0.13	0.46	0.48
	**	**	ns	**	**

$r_{t \text{ at } 0.05 (0.40)}$

When studying the influence of soil properties on cup quality of wild Arabica coffee in forest ecosystem of Ethiopia, Yadessa *et. al.* (2008) reported that better cup quality was detected form soil properties with higher levels of available P, K, clay and silt. Potassium increases bean density and augment flavour, and phosphorus contributes to a balanced flavour.

Conclusion

This study demonstrated that soil properties have an effect on compact coffee genotypes. It has been shown that the best cup with excellent aroma of the compact coffee genotype is supposed to be prepared from green beans with contents of Calcium 0.8 g/Kg to 0.9 g/Kg, Potassium 2.9 g/Kg to 6.0 g/Kg, Proteins 8.0% m/m to 9.0% m/m and caffeine 10.8 g/Kg to 13.7 g/Kg. As most of soils are deficiency of these nutrients, it is recommended to supplement from application of the farm yard manure or inorganic fertilizer.

Acknowledgements

We thank Tanzania coffee growers and the European Commission for their generous financial support. Acknowledgement is also accorded to farmers and coffee traders in Tanzania and the Tanzania Coffee Borad who participated in the field and laboratory evaluations.

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