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Coffee Quality Profile of Jimma Zone, South Western Ethiopia

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Abstract: Coffee is one of the most important crops in Ethiopia and the world. Ethiopia is the genus's origin and the focal point of Arabica coffee. The objective of this research study was to assess the raw, cup and biochemical composition of Jimma coffee and it ssoil and environmental variables in the Jimma zone. The survey was conducted in seven major coffee growing woredas of Jimma zone. Seven kebeles were selected from each woreda and 5kg of red coffee cherries and soil samples were collected from each kebele. Red coffee cherries were processed using a dry or wet method of processing. Raw and cup quality was assessed. Determination of caffeine (CAF), trigonelline (TRG) and chlorogenic acids (CGA) were done using the HPLC. Soil analysis of total available nitrogen, cation exchange capacity (CEC), soil pH were done coffee shade type, coffee based major crops production, etc., were recorded. Over all quality of samples from the kebeles Atnago, Yeddo, Komma, Kuralebu, Debello, Wollensu, Kechotrtra, Dengajasole, Kellagebiss, Dorra Omofuntule, Qota, Tesosedecha, Choche, and Omoboqo kebeles and all Gomma, Manna, Gummay, Gera, and Shebe-Sombo woredas were very good and highly acceptable. Typical spicy flavor were obtained from Atnago, Yeddo and Omofuntale kebeles sample. While Kilokirkr samples have a fruity flavor, those taken from Gatogore and Gerenaso kebele have a winy flavor. Biochemicals compositions were ranged from 0.64 to 1.51; from 3.82 to 6.10 and from 0.81 to 1.16 percent of TRG, CGA and CAF respectively. Nito-sol and clay make up the soil. Soil analysis results revealed that pH, total N (%) and CEC ranges of 4.37 - 6.0, 0.12 -0.6, and 6.24-30.78, respectively. Coffee quality profile of Jimma zone showed good to very good quality with acceptable to highly acceptable in their overall quality standards, with a unique typicity of spicy, fruity and winy.

Keywords: Biochemical, Coffee, Jimma, Quality, Soil

1. Introduction

Arabica coffee (*Coffea arabica* L.) is a cash crop of major economic importance in Ethiopia and many other countries. Arabica coffee thrives in Ethiopia at elevations ranging from 550 to 2600 m.a.s.l. [1]. The mean optimum temperature and annual rainfall for coffee are 15–24°C and 1500–2500 mm, respectively. The most productive coffee soils tend to be of volcanic origin and have a high base exchanges capacity; the soil should be deep, friable, open-textured, and permeable. The soil pH ranges from 4.5 to 5.6, while it is also true that there are highly productive plantations on soils that are much less acidic, nearly neutral [2]. Forinstance, coffee quality is strongly influenced by environmental factors such as altitude, climate, and shade, which play an important role through temperature, availability of light, and water during the coffee bean ripening period [3]. Variable coffee growing environments in Ethiopia have a variety of characteristics sought in the international market. Jimma Zone is one of the coffee-growing zones in Oromia Regional State, which spans 1,093,268 hectares. Currently, coffee covers roughly 105,140 hectares of land in the zone, which includes small-scale

farmer holdings as well as public and private-owned plantations. About 28–35 thousand tons of the zone's 40–55 thousand ton [4], while the rest is consumed locally [5]. In Ethiopia, coffee is grown almost everywhere, but the major coffee growing areas are Oromia (64%), Southern nation's nationalities and peoples region (35%), and (1%) from others.

Most coffee-growing areas' coffee quality brands were identified. The Sidama area is known for its unique and internationally branded spicy flavors, while the Yirgacheffe coffee growing area is known for its internationally branded flora flavor and the Harerghe coffee-growing agro-ecology is also known for its unique mocha flavor. Similarly, the coffee-growing regions of Limu and Wollega are recognized for their fruity and winy aromas, respectively in the market. In recent study of BenchMaji and Sheka Zones honey coffee flavour was reported [6]. In South western Ethiopia, the Jimma zone is one of the known potential coffee growing areas. But there is no deep research work conducted on the vast Jimma zone coffee growing area of quality coffee. So, to come up with a known flavor character for the study area, coffee quality attributes were conducted. Therefore, the objective of the study was to assess the physical, organoleptic, and biochemical composition of Jimma coffee and its correlation with soil and environmental variables of the Jimma zone.

2. Materials and Methods

The Jimma zone is one of the known coffee-growing areas in the south western part of Ethiopia, in the Oromia regional state. The survey was conducted in seven (7) major coffee-growing woredas of the Jimma zone, i.e., Manna, Gomma, Gummay, Gera, Limmu Kossa, Limmu Seqqa, and Shebe Sombo woredas. From each woreda, seven (7) kebeles were selected and 5kg of red coffee cherries and soil were sampled. Coffee cherries were harvested at fullmaturity, between October and November 2019, which is usually when the coffee is of better quality. At the spot of coffee harvesting, altitude, latitude, and longitude coordinates were recorded.

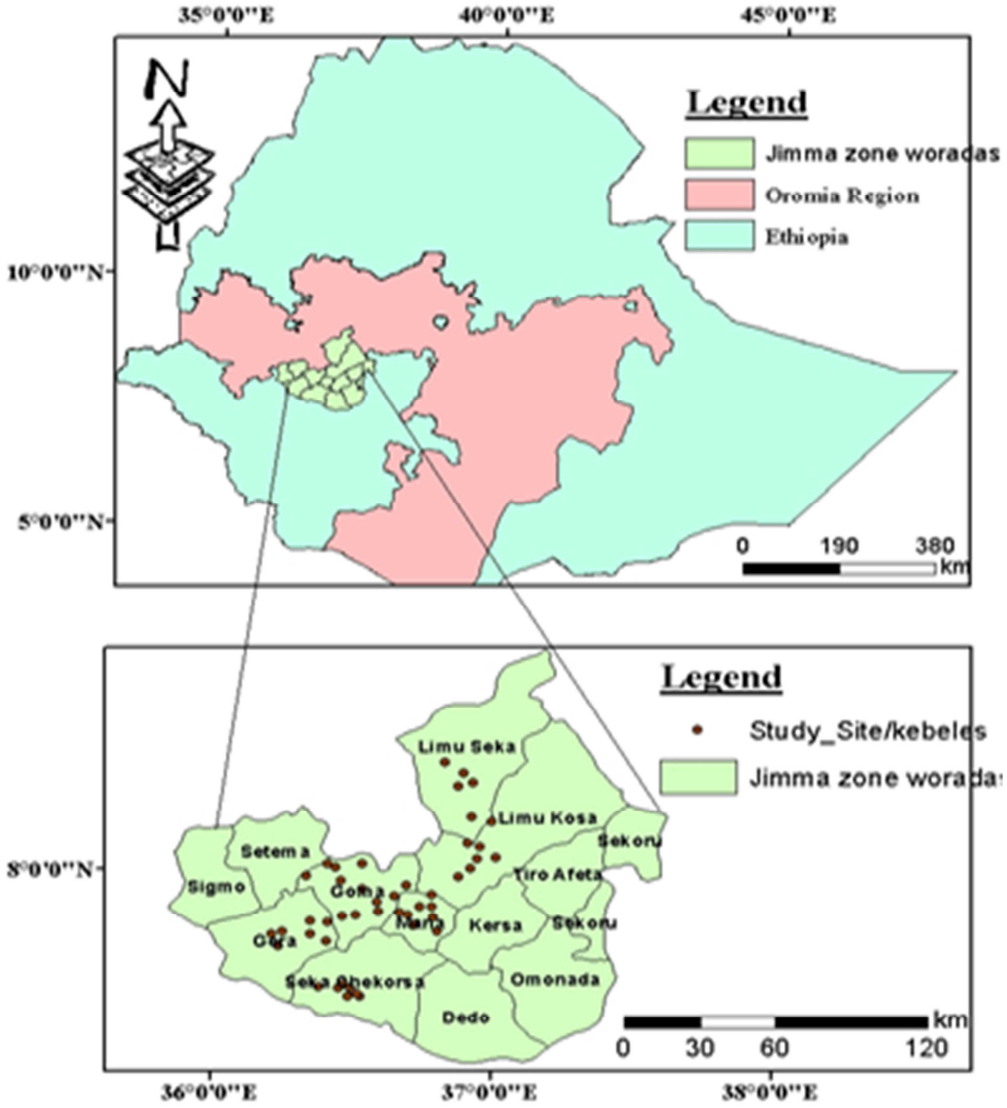

Figure 1. *Map of the Study Area.*

Red cherries were handpicked and processed using a dry or wet method of processing. Coffee samples were dried to moisture content (MC) of 10.5–11.0% for all samples uniformly [7]. To remove the parchment and silver skins from green coffee, dry parchment or cherry coffee samples were hulled and hand-polished. Finally, each sample had 300g of green coffee ready for physical and cup quality testing. Raw quality beans: screen size, bean shape and make, color and odor, aromatic intensity, aromatic quality, astringency, and bitterness were evaluated on a scale of 0 to 5. Acidity, body, flavor, and overall cup quality were assessed on 0 to 10 scales. Cup evaluation was done by a panel of 3 experienced, certified Q-grade cuppers [8]. Simultaneous determination of caffeine, trigonelline, and chlorogenicacids were done using the HPLC system consisting of a Discovery C18 column with an isocratic flow of 0.7mL/min and methodology adapted from [9] with some modification. Soil analysis: physiochemical total available nitrogen [10], CEC (cation exchange capacity), soil PH, etc. Climate data, such as cultural practice, vegetation type, coffee based major crops, climate data, rainfall, temperature, etc., were recorded. Statistical Analysis Software Version 9.3 [11] was employed for analysis of variance.

3. Results and Discussion

The screen size, raw, cup and total coffee quality are presented in Table 1. There was no significance difference ($P > 0.05$) among coffee samples for screen size but significant difference were achieved raw, cup and total coffee quality. Coffee samples from Atnago, Yeddo, Komma, Kuralebu, and Dorra samples were obtained from LimmuSeqqa woreda and showed very good and highly acceptable overall quality standards. The samples from the kebeles of Atnago and Yeddo have a typical spicy flavor. However, samples collected from the kebeles of Seqqa and Chika reveal good and acceptable overall quality. The overall quality standards of samples from the kebeles of Debello, Wollensu, Kechotrtra, Dengajasole, and Kellagebissa have been shown by LimmuKossa woreda to be very good and highly acceptable. The overall quality of the samples gathered from the kebeles of Tenebo and Denbigabona is good and acceptable. Except for samples taken from Somodo kebele, which revealed good and acceptable overall quality, all samples were collected from Manna woreda and showed very good and highly acceptable overall quality standards. Gomma woreda samples of Omofuntule, Qota, Tesosedecha, Choche, and Omoboqo kebeles exhibited a very good and highly acceptable overall quality standard. The overall quality of the samples obtained from the kebeles of Buladochoche and Kilokirkr is good and acceptable. Omofuntale sample have a spicy flavor, while Kilokirkr sample have a fruity flavor.

Except for samples taken from Efoyachi kebele, which showed good and acceptable overall quality, all samples were collected from Gummay woreda and showed very good and highly acceptable overall quality standards. A sample taken from Gatogore kebele has a winy flavor. All samples were taken from Gera woreda and indicated very good and highly acceptable overall quality standards. A sample collected from this woreda at Gerenaso kebele resembles the Winy flavor. All samples were collected from ShebeSombo woreda and showed very good and highly acceptable overall quality standards, except the sample collected from ShebeSombo desso kebele showed good and acceptable overall quality. Biochemicals compositions were ranged from 0.64 to 1.51; from 3.82 to 6.10 and from 0.81 to 1.16 percent of TRG, CGA and CAF respectively (Table 1). The contents of TRG, CGA and CAF exhibited in the present research work were within the ranges observed in other similar studies by Kassaye, Mohammed and Getachew, et al. [12-14].

The correlation between coffee quality and biochemical composition was investigated using a Pearson correlation coefficient (r) with a significance level. The Pearson correlation analysis results show that there is a highly positive and significant association between overall quality and cup quality (Table 2). Overall quality showed a positive correlation between color, odor, aromatic intensity, and aromatic quality, while trigonelline, chlorogenic acids, and caffeine exhibited negative correlations. The overall quality and aromatic quality have a good and highly significant correlation. There was a significant, positive relationship between trigonelline and astringency in the body. Caffeine has a significant and positive impact on the body. Caffeine has a positive and significant relationship with aromatic quality and acidity. However, no significant relationship was seen between chlorogenic acids and the body.

There were both permanent and temporary coffee shade trees found, but almost all of them were planted without regard to spacing, and their distribution varied between sites. Albizia spp., Croton macrostachyus, and Cordia africana are the most widely spread shade trees, followed by Croton macrostachyus and Cordia africana (Table 3). Close planting spacing (1.5m×1.5m) and (2m×1.5m) were more prevalent in almost all areas, and a free-growing coffee production method was found. Slashing was used to control weeds, although pruning and rejuvenation are not prevalent practices in all locations. Intercropping: Coffee was intercropped with Persea americana, banana, Enset, and Mangifera indica L. at Manna woreda, whereas coffee was intercropped with Persea americana at Gummay and Gera (Table 3).

The soil is made up primarily of nitosol and clay. The pH, total N (percentage), and CEC ranges for the soil were found to be 4.37–6.0, 0.12–0.6, and 6.24–30.78, respectively, at the JARC soil laboratory (Table 4). The result revealed that the soil is extremely acidic (pH = 5.1-5.5) since the majority of the soil pH is below the recommended range (pH = 5.5-6.0) for coffee. Except in Gera woreda, the results showed that total N (percentage) was consistent with prior data (> 20 mg/kg) and cation exchange capacity was greater than ten. A cation exchange capacity of more than 10 implies a heavy soil type, according to a recent analysis [15].

Table 1. *Physical, cup quality and biochemical characteristics of coffee samples from Jimma zone.*

Ser.no.	Woreda	Kebele	Screen	Raw (40%)	Cup (60%)	TQ (100%)	CAF (%)	TRG (%)	*CGA* (%)	Typicity
1	Limmu Seqqa	Atnago	97.0	36.0	48.5	84.5	1.28	1.21	5.67	Spicy
2	Limmu Seqqa	Yeddo	95.0	35.5	45.8	81.3	1.10	1.07	4.93	
3	Limmu Seqqa	Komma	96.0	34.3	50.0	84.3	0.84	0.95	4.92	Spicy
4	Limmu Seqqa	Chika	97.0	34.2	44.5	78.7	1.11	0.75	4.67	
5	Limmu Seqqa	Kuralebu	97.0	35.2	46.7	81.8	1.31	0.71	4.59	
6	Limmu Seqqa	Dorra	95.0	36.3	49.5	85.8	0.81	0.64	3.82	Rue
7	Limmu Seqqa	Seqqa	96.0	34.8	44.7	79.5	0.96	1.09	5.24	
8	Limmu Kossa	Tenebo	93.0	34.5	44.7	79.2	0.92	0.70	5.19	
9	Limmu Kossa	Debello	98.0	35.5	44.5	80.0	0.98	0.84	4.97	
10	Limmu Kossa	Wollensu	98.0	36.2	46.3	82.5	0.96	0.69	4.91	
11	Limmu Kossa	Denbi gabona	95.0	34.7	44.2	78.8	0.88	0.64	4.90	
12	Limmu Kossa	Kecho trtra	96.0	34.5	46.3	80.8	1.02	0.92	6.10	
13	Limmu Kossa	Dengaja Sole	92.0	34.7	45.7	80.3	0.83	0.70	4.15	
14	Limmu Kossa	Kella gebissa	96.0	36.7	48.5	85.2	1.11	0.82	5.40	
15	Manna	Kenteri	93.0	35.7	46.5	82.2	0.88	0.71	3.93	
16	Manna	Bilida	94.0	34.8	45.7	80.5	0.87	0.75	4.59	
17	Manna	Haro	95.0	36.7	49.0	85.7	1.35	1.10	5.12	
18	Manna	Kela guda	99.0	37.0	45.5	82.5	0.92	1.12	6.08	
19	Manna	Seyebontu	98.0	37.7	46.8	84.5	1.49	1.15	5.60	
20	Manna	Hunda toil	98.0	35.7	50.2	85.8	1.46	1.21	5.96	
21	Manna	Somodo	99.0	36.3	43.5	79.8	1.43	1.07	4.69	
22	Gomma	Omofuntule	98.0	37.0	50.2	87.2	1.38	1.31	5.04	
23	Gomma	Qota	98.0	35.0	52.5	87.5	1.43	1.05	5.04	Spicy
24	Gomma	Kilole kirkr	98.0	36.0	43.7	79.7	1.66	1.51	5.96	
25	Gomma	Teso sedecha	97.0	36.3	51.5	87.8	1.50	1.21	5.37	Fruity
26	Gomma	Choche	93.0	37.0	47.3	84.3	1.52	1.37	5.26	
27	Gomma	Omoboqo	99.0	36.3	49.2	85.5	1.16	1.01	4.31	
28	Gomma	Bulado choche	98.0	34.3	45.5	79.8	0.88	1.09	5.05	
29	Gummay	Efo yachi	98.0	37.0	42.5	79.5	0.90	1.08	4.61	
30	Gummay	Qodaqunacho	99.0	35.3	51.3	86.7	1.25	1.10	4.82	
31	Gummay	Nego agaye	98.0	35.3	48.3	83.7	1.05	0.91	4.02	
32	Gummay	Gato qore	98.0	36.0	48.0	84.0	1.05	0.99	4.85	
33	Gummay	Awsabullo	98.0	36.7	48.8	85.5	1.05	1.01	5.24	Winy
34	Gera	Gore Dako	98.0	35.3	48.3	83.7	1.11	0.95	4.52	
35	Gera	Gerenaso	98.0	37.0	46.5	83.5	0.89	0.90	3.93	
36	Gera	Ginchi chala	99.0	35.0	51.3	86.3	0.88	0.79	4.74	Winy
37	Gera	Wanja kersa	96.0	35.0	48.8	83.8	1.30	0.88	4.51	
38	Gera	Qola qnbibit	96.0	36.0	47.3	83.3	1.24	0.90	5.46	
39	Gera	Qola sulaja	97.0	34.3	46.5	80.8	1.17	0.98	4.69	
40	Gera	Sedi	97.0	35.7	46.8	82.5	1.42	1.18	5.00	
41	Shebe	Angacha	94.0	35.7	47.0	82.7	1.41	1.04	4.80	
42	Shebe	Anja genbo	97.0	36.3	47.0	83.3	1.37	0.91	4.23	
43	Shebe	Halo Gudante	93.0	35.7	44.3	80.0	1.49	0.88	4.42	
44	Shebe	Shebe desso	98.0	35.0	44.3	79.3	1.46	0.99	4.49	
45	Shebe	Yangadugoma	97.0	36.3	46.5	82.8	1.31	1.02	4.66	
46	Shebe	Sebeka debye	97.0	36.0	45.0	81.0	1.37	1.06	4.68	
47	Shebe	Hallo Sebeka	99.0	36.0	48.5	84.5	0.97	1.16	5.43	
		Mean	96.0	35.7	47.1	82.8	1.16	0.98	4.91	
		CV (%)	-	3.57	4.97	3.15	0.81	0.64	3.82	
		LSD (0.05)	NS	1.04	1.91	2.13	1.66	1.51	6.10	

CAF = Caffeine CGA = Chlorogenic acids, TQ = Total Quality, TRA = Trigonelline.

Table 2. *Pearson correlation coefficients(r) between biochemical and cup quality attributes.*

	TRA	CGA	CAF	SCR	SM	CO	OD	AI	AQ	AC	AS	BI	BO	FL	OAQ	CT	TQ
TRA	1.00	0.54**	0.61**	0.34*	0.36*	0.27	0.26	0.29*	0.25	0.40*	-0.39**	-0.46**	0.56**	-0.19	-0.05	0.14	0.26
CGA		1.00	0.26	0.20	0.06	0.13	0.01	0.16	0.24	0.04	-0.06	-0.16	0.06	-0.06	-0.01	0.05	0.09
CAF			1.00	0.11	0.36	0.11	0.17	0.31*	0.25	0.32*	-0.37**	-0.31*	0.51**	-0.19	-0.12	0.11	0.20
SCR				1.00	0.27	0.08	0.13	0.30*	0.31*	0.41**	-0.18	-0.26	0.42**	-0.01	0.05	0.21	0.27
SM					1.00	0.25	-0.15	0.12	0.01	0.17	-0.31*	-0.31*	0.30*	-0.29*	-0.23	-0. 07	-0.19
CO						1.00	0.34*	0.14	0.01	0.30*	-0.05	-0.06	0.29*	0.20	0.20	0.20	0.46**
OD							1.00	0.14	0.12	0.20	-0.07	-0.08	0.27	0.16	0.15	0.18	0.23
AI								1.00	0.89	0.53**	0.12	-0.01	0.46**	0.42**	0.48**	0.69**	0.69**
AQ									1.00	0.51*	0.28	0.17	0.42**	0.49**	0.55**	0.76**	0.70**

	TRA	CGA	CAF	SCR	SM	CO	OD	AI	AQ	AC	AS	BI	BO	FL	OAQ	CT	TQ
AC										1.00	0.19	0.17	-0.90**	0.50*	0.62**	0.80**	0.83**
AS											1.00	0.87**	-0.06	0.64**	0.58**	0.55**	0.42*
BI												1.00	-0.05	0.63**	0.55**	0.50*	0.37*
BO													1.00	0.23	0.38*	0.62**	0.69**
FL														1.00	0.94**	0.84**	0.75**
OAQ															1.00	0.89**	0.81**
CT																1.00	0.94**
TQ																	1.00

Note - * and ** shows the significant level at P<0.05 and P<0.01, respectively
CAF- Caffeine, CGA - Chlorogenic acids, TRG- Trigonelline, SCR-Over Screen, SM-Shape and Make, CO-Color, OD-Odor, AI-Aromatic Intensity, AQ-Aromatic Quality, AC- Acidity, AS-Astringency, BO-Body, FL-Flavor, OCQ-Overall Cup Quality, CT-Cup Total.

Table 3. *Coffee shade tree types and their distributions.*

Woreda	Distribution (%)	Shade tree type
Limu Seka	13.6-22.7	*Albizia spp, Acacia abyssinica, Cordia africana, Croton macrostachyus, Milletia ferruginea, Sesbania sesban and Ficus vasta*
Limu Kosa	4-24	*Croton macrostachyus, Cordia africana, Albizia spp, Acacia abyssinica, Milletia ferruginea, Ficus vasta and Grevillea robusta*
Gumay	5.3-21.1	*Albizia spp, Cordia africana, Croton macrostachyus, Acacia abyssinica, Sesbania sesban, Milletia ferruginea, Mangifera indica L. and Persea Americana*
Manna	3.8-19.0	*Albizia spp, Croton macrostachyus, Acacia abyssinica, Cordia africana, Milletia ferruginea, Sesbania sesban, Persea americana, Banana, Enset and Mangifera indica L.*
Gomma	11.8-35.3	*Croton macrostachyus, Albizia spp, Cordia africana and Milletia ferruginea*
Gera	5.6-27.8	*Albizia spp, Milletia ferruginea, Sesbania sesban, Acacia abyssinica, Cordia africana, Croton macrostachyus, Erythrnia abssinica, and Persea Americana*
Shebe	11.8-23.5	*Croton macrostachyus, Albizia spp, Cordia africana, Milletia ferruginea, Acacia abyssinica and Sesbania sesban*

Table 4. *Soil pH, total N and CEC parameters.*

Woreda's	pH (1:2.5)	Total N (%)	CEC
Limu Seka	4.86-6.0	0.20-0.33	10.28-30.78
Limu Kosa	4.84-5.86	0.12-0.35	10.20-22.04
Gumay	5.00-5.28	0.15-0.60	12.70-24.02
Manna	4.99-5.77	0.22-0.33	12.60-18.66
Gomma	4.72-5.72	0.18-0.34	12.78-22.10
Gera	4.37-5.46	0.21-0.28	6.24-20.24
Shebe	5.16-5.48	0.22-0.29	19.28-29.76

4. Summary and Conclusion

There was no significance difference (P > 0.05) among coffee samples for screen size but significant difference were achieved raw, cup and total coffee quality. The overall quality standards of most coffee samples were very good and highly acceptable. Typical spicy flavor were obtained from some kebeles sample. Fruity and winy flavor also achieved from other kebeles of Jimma zone woredas. Biochemical compositions were ranged from were ranged from 0.64 to 1.51; from 3.82 to 6.10 and from 0.81 to 1.16 percent of TRG, CGA and CAF respectively. Soil analysi sresult showed pH 4.37 to 6.0, total N (percent) 0.12 to 0.6 and CEC 6.24 to 30.78. Coffee quality profile of Jimma zone showed good to very good quality with acceptable to highly acceptable in their overall quality standards, with a unique typicity of spicy, fruity and winy. The presented result supports to map the coffee quality profile in the country to use the unique natural endowment of unexploited special coffee.

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