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Research article

Effect of processing methods on physicochemical and cup quality of coffee at Jimma, Ethiopia

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ABSTRACT

Coffee quality is a complex attribute influenced by a variety of factors, including postharvest processing methods. The goal of this study was to investigate the impact of coffee processing methods on coffee quality (raw, cup, and biochemical makeup) in Jimma, which represents the midland areas. Coffee samples were collected for Jimma agricultural research center and processed with three methods (washed, Semi-washed and dry process). The result indicated that washed coffee beans scored significantly the highest color (13.43) and odor [10] score than the other processing methods. The statistically best raw quality score (35.57 %) was therefore reported for washed coffee in Jimma. Cup quality attributes however were not significantly affected by processing methods. Among chemical composition studied, lipid was significantly affected by processing methods and highest lipid 13.74 and 13.17 g/100g was reported for semi-washed and washed coffee beans respectively. Generally, washed and semi-washed coffee were preferable in terms of bean color and odor quality. Correlations were found among cup quality attributes and chemical compositions. However, further research into the accessibility and economics of coffee processing methods in the area is necessary.

1. Introduction

Coffee plants belong to the *Rubiaceae* family, which includes more than 70 species of coffee. Among these, two coffee species Arabica and Robusta are of significant economic importance [1]. Coffee is among the most important agricultural products in the world and is widely cultivated in the tropical and subtropical regions of Africa, Southeast Asia, and South America [2]. It is a major foreign exchange earner in several developing countries. Coffee is a global commodity, and its beverage is a popular beverage worldwide [3]. Coffee, specifically Arabica coffee, is indigenous to Ethiopia and originates in the country. Therefore, coffee is backbone of economy of Ethiopians, as livelihoods of many people in the country are dependent on it [4] and it contributes an average 5 % to Ethiopian gross domestic product (GDP) [5].

Coffee bean and beverage quality are important factors as they determine the market price for coffee [2,6]. Coffee quality is determined by an array of factors, ranging from genetic, environmental, and postharvest processing to handling and storage practices [2]. These authors further elaborated that overall postharvest processing contributes about 60 % of the overall final quality of coffee. Various postharvest processing methods can produce different levels of aromatic compounds in coffee beans, leading to differences in the final cup quality of coffee [7].

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Coffee can be processed using a washed, semi-washed, or dry processing method. In Ethiopia, coffee can be processed using one of the two most common methods: washing and dry processing. Approximately 65 % Ethiopian coffee is produced by dry processing, while only approximately 35 % is by washed coffee processing method [3]. Semi-washed processing is still at emerging stage in Ethiopia owing to the adoption of recently developing and growing technologies. The choice among these processing methods largely depends on the environmental conditions [8,9]. There are environments where certain processing methods can produce premium quality coffee, whereas other environments are considered less acceptable in terms of the quality and accessibility of the method. For instance, in Guatemala, dry processing is considered unacceptable because of the high humidity in the area and fermentation of coffee cherries [10]. Similarly, dry processing has a negative impact on coffee bean quality in the highly humid environments of Ethiopia, including Jimma, Gambela, and Kaffa the like [11]. According to these authors, both dry- and wet-processed Ethiopian coffee have some basic quality issues that affect their market competency and price. Therefore, it is important to comparatively evaluate the effects of coffee processing methods on coffee quality in Jimma.

Coffee seed germination is initiated during postharvest processing [12]. The differences in flavor between wet and dry processed coffees therefore emanate from this differential expression of the germination process. Complex metabolic reactions related to this germination process result in differences in the chemical profile of coffee. The difference in chemical profile, on the other hand, is very important for imparting the flavor and overall final quality of coffee beverages. Therefore, the cup quality of coffee is the result of differences in the metabolic activities that occur in each type of coffee processing. There are limited research-based reports concerning the effects of the three processing methods (washed, semi-washed and dry processing) on the biochemical, physical and cup quality of Arabica coffee in Jimma, Ethiopia. So far, there have been some research reports on one or two coffee processing methods in combination with other factors [13,14]. In all these previous work, atleast one of the processing method is missing. Therefore, a comparative evaluation of the three coffee processing methods for their potential impact on coffee quality remains unstudied to the required level. Hence, the present study was designed with the objective of investigating the effects of different coffee processing methods including the newly emerging artificial demucilaging unit (semi-washed processing) on coffee quality under Jimma conditions.

2. Materials and methods

The study was conducted in Jimma which is midland high potential coffee growing agro-ecologies [15]. The coffee beans for the experiment was collected from coffee plants established by breeders for field experiments for which all managements including mulching and organic manure applications were performed in compliance with provided guidelines [16]. Coffees were planted at 2 m × 2 m spacing between plants, with population no more than 5000 tree h^{-1}. The shade canopy range between 60 and 75 % consisted of mostly of trees like *Acacia abyssinica, Erythrinia abyssinica, and Cordia African*. The coffee management, was consistently followed according the recommended practices [16].

2.1. Research design

The research was conducted in a completely randomized design (CRD) with three treatments (coffee processing methods) in three replications. The experiment was conducted at the Jimma Agricultural Research Center (JARC), coffee processing and quality research laboratory. The biochemical analysis was conducted at Ethiopian Institute of Agricultural Research, Food Science and Nutrition Research Laboratory, Addis Ababa.

2.2. Sample preparation

Fully matured red ripe cherry (54 kg), 18 kg for each processing method, was harvested from a well-adapted and previously released *arabica* coffee variety (74110 variety) during the main harvesting season (October) of the 2018/19 harvesting year. Any unripe green, over ripe black and foreign matter mixed with red ripe cherry were sorted out. The coffee samples were processed in Jimma Agricultural Research Center using three processing methods (wet, dry, and semi-washed) in three replicates.

For washed coffee processing, coffee samples were pulped using (motorized single-disc coffee pulpier (IRIMA-67, England). The pulped wet parchment left into fermentation tank for 36 recommended hours for the area [17]. It was then washed and soaked in water for 24 h and left to dry under open sun on a mesh wire raised bed. In the semi-washed processing, coffee samples were subjected to an artificial demucilaging unit (EZMA Lodosa, Spain), which does not require fermentation for mucilage removal. After pulping, the parchment was passed through demucilaging units, which mechanically removed the mucilage with some water poured continuously to clean the parchment. The clean parchment was left to dry on a raised mesh-based drying bed. For dry processing, the ripe cherry coffee samples were left to dry naturally on a raised wire mesh-based bed. After complete drying, dried chery samples were pulped and prepared for laboratory analysis. Samples were followed up during drying to be turned regularly to maintain uniform drying to the desired moisture level, 10–11.5 % in all processing methods. An electronic rapid moisture taster was used to measure the moisture content during drying for all processing methods. Dried coffee was collected in the JARC Coffee Processing and Quality Research Laboratory and prepared for physical, sensory, and chemical evaluation.

2.3. Physical and cup quality evaluation

Raw quality and cup evaluations were performed at the Jimma Agricultural Research Center (JARC), a coffee quality research laboratory. For raw quality evaluation, 100 g of coffee beans were used following the methods outlined in the laboratory manual of Jimma Agricultural Research. Accordingly, the percentage of beans remaining on a screen with a size of 14 mm was measured and expressed as a percentage. The other raw quality attributes, including shape and make (SM), color, and odor, were evaluated by certified coffee sensory quality panelists [17] (Table 5). For cup quality evaluation, coffee samples were medium roasted at 200 °C for 8 min, and 8 g coffee powder added to 180 mL of hot water (100 °C) brew was prepared. 3 cups per single coffee sample were prepared. Then, It was kept at room temperature until palatable temperature of approximately 55 °C attained. Cupping was performed following the laboratory manual procedure of the Ethiopian Institute of Agricultural Research [17]. The evaluators rinsed their mouths with fresh water after cupping each cup of coffee. Cup quality attributes, aromatic intensity, aromatic quality, astringency, and bitterness were tested on a scale of 0–5, while acidity, body, flavor, and overall cup quality were assessed on a scale of 0–10 (Table 5). Five trained and certified coffee quality panelists from the Ethiopian Institute of Agricultural Research were recruited.

2.4. Extraction and determination of biochemical compounds

The biochemical compositions of green coffee (caffeine, chlorogenic acids, and trigonelline) were analyzed using the method described by Refs. [18,19]. The samples were ground using a coffee grinder (High speed multi-function comminutor, RRH-A400) to pass through 0.46 mm sieve. The extraction of caffeine, chlorogenic acids, and trigonelline was done by using hot distilled water at 95 °C, following the method described by Ref. [20]. A 0.5 g of sample of coffee flour weighed and added to flask and extracted with 50 mL of distilled water at 95 °C temperature. The solution was then heated for 20 min on a heating plate. Finally, the extract was filtered through a Whitman filter paper of 0.45 mm for further purification.

Trigonelline, chlorogenic acid, and caffeine levels were determined using (higherformance liquid chromatography (HPLC). AGILENT, USA) with Discovery C_{18} (250 × 4.6 mm, 5 μm, Alltech, Belgium) and isocratic flow of 1 mL/min. The Working standards of 10, 20, 40, 60, and 80 mg per 100 mL of mobile phase (0.2 % acetic acid in water (v/v) and HPLC grade methanol) were injected into the HPLC. A calibration curve was constructed using the standard concentration, and trigonelline, chlorogenic acid, and caffeine were identified by comparing the retention times of TRG standard (Sigma Aldrich), CGA standard (Acros organics), and caffeine standard (99 %) (Fischer Scientific), and their concentrations calculated from peak areas using calibration equations as indicated in Fig. 1. Detection was then carried out at 266 nm (trigonelline), 324 nm (CGA), and 278 nm (caffeine) using HPLC equipped with a photodiode array (PDA) detector (Surveyor, Thermo Finnigan, USA).

2.5. Extraction and determination of lipids

The lipid contents of the green coffee bean samples were determined following the Soxhlet extraction method described by Ref. [21] (No. 991.36, AOAC, 1996). The moisture content of each sample of ground green coffee powder was determined using the oven-drying method (OHAUS-MB45). Five [5] grams of the powder were weighed in a thimble, marked as W, and dried for 2 h at 100 °C. The empty round-bottomed flask was dried at 105 °C for 1 h, cooled in a desiccator, weighed, and recorded as W_1. The thimble (with the green coffee sample) was placed in a Soxhlet extraction apparatus, and lipids were extracted with n-hexane solvent for 8 h. The extract was left to evaporate to near dryness using a rotavapor before further drying in an oven for 1 h at 105 °C, after which it was cooled and weighed again. Drying and weighing were alternated at 30 min intervals until no further weight loss was observed between two successive intervals. The lowest attainable weight was recorded as W_2 and the percentage of lipids on a dry-weight basis (DWB) was calculated using the following formula:

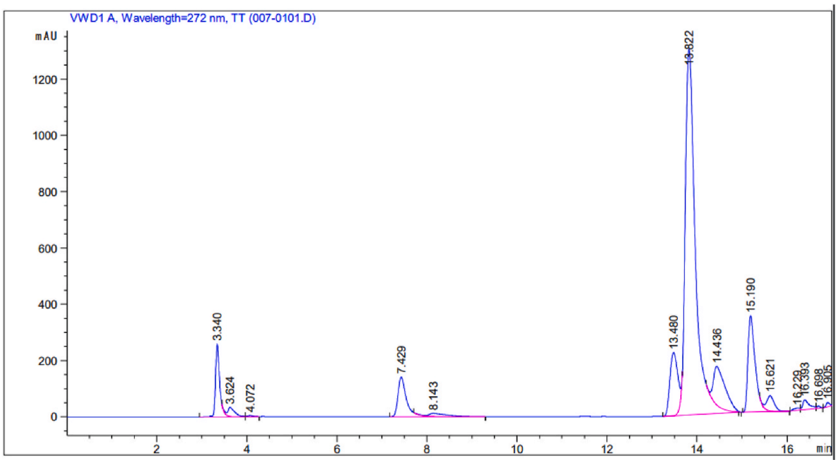

Fig. 1. A chromatograms, highlighting the retention time and peaks of caffeine, chlorogenic acids and trigonelline.

$$Lipid\ (\%) = \frac{10000\ (W2 - W1)}{W(100 - M)}$$

Where:

M: moisture content, W_1- empty flask, W- weight of timble and sample, and W_2: weight of lipid.

2.6. Statistical analysis

All treatments were performed in triplicate, and data were analyzed using SAS [22]. Analysis of variance (one-way ANOVA) was conducted, and the difference between groups was analyzed using least significant difference (LSD). Statistical significance was tested at 5 %.

3. Results and discussion

3.1. Influence of processing methods on coffee quality

3.1.1. Influence of processing methods on raw quality attributes of coffee beans

The effect of processing methods on raw coffee quality attributes was significant ($P < 0.05$) only for the color and odor of coffee beans (Table 1). The largest bean size, measured by retention percentage on screen 14 (96 %), was recorded for semi-washed coffee, followed by washed (95.67 %) coffee. Comparable results for bean size have been reported so far in research conducted in eastern Ethiopia, Hararge, on the effect of harvest and processing methods on coffee quality [23]. According to the report by these authors, coffee bean size as high as 90.53 % was reported for washed coffee and as low as 85.87 % was reported for dry processed under similar harvesting and drying materials (selective hand picking and drying on wire mesh) used in this research. The discrepancy between the data in this research and the literature stated above might be attributed to the difference in the environment under which the two studies were conducted and coffee variety.

The screen size retention attribute, which is related to the bean size of coffee is a very important quality characteristic of coffee beans. Medium to large beans are preferable in terms of both marketability and consumer preference. Therefore, the bean size reported in this study is acceptable, provided that appropriate agricultural practices are considered from field, harvest, processing to drying, and storage, as it was in this experiment. Coffee bean size is one of the important attributes of coffee quality. Accordingly, the larger the coffee bean, the higher the price of coffee will be. Because, bean size can be considered as the first step in the selection of coffee beans [24].

The effect of coffee processing methods on shape and make was insignificant ($P > 0.05$) as shown in Table 1. The average shape and make score recorded was 12.04 as indicated in Table 1. The shape and make of coffee can be all about uniformity of coffee beans which always described as oval, rounded, elongated, and flat and others of coffee bean. This can be described as the structure and/or makeup of coffee beans [25]. The shape and make of coffee beans is of critical importance to coffee industries, as are other physical and cup quality attributes of coffee [26]. The range of shape and make reported in this study (12.00–12.10) are approximately 12, which is described as 'good' in the coffee quality evaluation manual followed during the study and hence are acceptable [17].

The color of coffee beans is another raw quality attribute that was significantly affected ($P < 0.05$) by the processing methods (Table 1). Accordingly, the washed coffee scored better than the other processing methods. Under the Jimma condition, semi-washed coffee was statistically similar to dry-processed coffee in terms of color score. This indicates that the color of the washed coffee beans is better than that of the dry and semi-washed coffee beans. However, all the color scores in this study are related to the sensory terminology 'grayish' [12,17] and/or above, and hence, are all acceptable.

Postharvest processing contributes to the final color of coffee beans [27]. Therefore, this study also revealed that the color of coffee is affected by processing methods. However, the range of the color score, which is between 12.03 and 13.43 is to the standard and is acceptable. Color is among the most important attributes governing quality and, in turn, the market value of coffee beans [28]. It is utilized as a qualitative indicator of coffee quality and for optimization of the drying process optimization [29].

Washed coffee was also statistically ($P < 0.05$) better in terms of odor score than other processing methods, as indicated in Table 1. Although the odor of washed coffee beans is superior to that of semi-washed coffee beans, it is acceptable in semi-washed coffee as suggested in literature [30]. The better odor of the washed coffee may be ascribed to the washing process used in this processing

Table 1
Effect of processing methods on physical quality of coffee beans under Jimma location.

Processing methods	Bean size (%)	Shape and Make	Color	Odor
Washed	95.67 ± 1.79^a	12.00 ± 0.21^a	13.43 ± 0.22^a	10.0 ± 0^a
Semi-washed	96.00 ± 1.80^a	12.03 ± 0.21^a	12.37 ± 0.20^b	9.70 ± 0^b
Dry processed	92.00 ± 1.72^b	12.10 ± 0.21^a	12.03 ± 0.20^b	9.70 ± 0^b
CV (%)	1.87	1.75	1.65	0
LSD (0.05)	3.52	0.421	0.416	0
Mean	94.56	12.04	12.61	9.80
P value	0.058	0.84	0.0004	<0.0001

Small letters in the same column indicate level of significance of difference.

method.

3.1.2. Influence of processing methods on cup quality of coffee

Almost all sensory cup quality attributes of coffee were not significantly affected ($P>0.05$) by the coffee processing methods in the Jimma environment (Table 2). The sensory cup quality scores for aromatic intensity, aromatic quality, acidity, astringency, bitterness, body, flavor, and overall cup quality ranged from 3.73 to 4.07, 3.77–4.00, 6.67–7.13, 4.03–4.27, 3.83–4.10, 7.03–7.33, 6.53–7.10 and 6.73–7.23 respectively as indicated (Table 2). All sensory cup quality scores were within the acceptable ranges indicated in the coffee quality evaluation manual of the Ethiopian Institute of Agricultural Research [17].

3.1.3. Influence of processing methods on overall raw and cup quality of coffee

The processing methods of coffee beans significantly affected the total raw quality of the coffee (Table 3). Accordingly, washed coffee scored the highest (35.57) in total raw quality compared to the two processing methods. Various postharvest processing and handling practices have been reported to affect the final coffee raw and cup quality attributes. These processing methods are determined by culture, coffee type, and origin and/or growing altitude [31]. In general, the final quality of coffee is determined by taking the total raw, total cup, and total quality of coffee into consideration [17]. Hence, the results reported in this study indicate that coffee quality processed using any of the three methods is in the range of acceptable standards, although there are statistically different results in terms of total raw quality. However, the total cup and overall total sensory quality were not significantly affected by the processing methods.

3.1.4. Influence of processing methods on chemical composition of coffee beans

The effect of processing methods on the chemical composition, including trigonelline, chlorogenic acid, and caffeine, was not statistically significant (Table 4). Typical chromatogram of the separations of trgonelline, CGA and caffeine were indicated in Fig. 1. The trigonelline, chlorogenic acid, and caffeine contents of coffee beans in this study ranged between 0.847 and 0.967 g/100 g, 4.44 and 4.52, 1.06 and 1.22g/100 g respectively. The trigonelline, chlorogenic acid and caffeine content reported in this study were found to be in line with literature (0.81 and 0.90 g/100 g, 3.2 g/100 g and 1.12–1.54 g/100 g) for both washed and semi-washed processing methods [31].

However, the lipid content was also not significantly ($P> 0.05$) affected by the processing methods (Table 4). The highest lipid content (13.74 g/100 g) was reported for semi-washed coffee, followed by washed coffee (13.17) beans. The lowest lipid (12.01 g/100 g) was reported for dry-processed coffee beans. In line with the results of this study, washed coffee also had a higher lipid content than dry processed coffee in prior literature [32]. Previous studies have also implied that coffee processing methods with fermentation exhibit lower fatty acid levels than methods without the fermentation process [33].

3.1.5. Correlation of coffee cup quality attributes and chemical compositions

A correlation analysis was performed to investigate the association between pairs of cup quality attributes and chemical composition (Fig. 2). The acidity of coffee had a strong negative and highly significant correlation (−0.81, $P < 0.01$) with chlorogenic acid and a strong positive and highly significant correlation (0.78, $P < 0.01$) with caffeine content. Similarly, the overall acceptability of coffee quality shows highly significant strong negative ($P < 0.01$, −0.71) correlation with chlorogenic acid and highly significant strong and positive ($P < 0.01$, 0.75) correlation with caffeine content of coffee. In line with this study, a correlation between cup quality attributes and chemical compositions has been reported, which implies that the biochemical content of coffee influences cup quality [34].

A weak negative and non significant correlation (−0.28) and a positive correlation (0.30) were also reported between bitterness and chemical compositions (chlorogenic acid and caffeine content respectively) in coffee beans. Similarly, a weak correlation between caffeine and trigonelline and final cup quality attributes reported [35]. Moreover, literature also sought correlations between some chemical components (caffeine, trigonelline, chlorogenic acid) in green coffee and the final beverage quality [36]. The flavor, overall cup, total cup, and total coffee quality had strong correlations of 0.66, 0.75, 0.51, and 0.51, respectively, with the caffeine content of coffee although the correlation is none significant. This indicates that caffeine content is an important determinant of coffee cup quality. This is in line with the prior literature, which implied an association between caffeine content and good quality [19].

Table 2
Effect of processing methods on cup quality attributes of coffee under Jimma condition.

Processing Methods	AI	AQ	AC	AS	BI	BO	FL	OAQ
Washed	4.00 ± 0.22[a]	4.00 ± 0.32[a]	7.03 ± 0.39[a]	4.27 ± 0.02[a]	4.00 ± 0.22[a]	7.03 ± 0.31[a]	7.00 ± 0.36[a]	7.10 ± 0.45[a]
Semi-washed	3.73 ± 0.21[a]	3.77 ± 0.30[a]	6.67 ± 0.37[a]	4.03 ± 0.26[a]	3.83 ± 0.21[a]	7.23 ± 0.32[a]	6.53 ± 0.34[a]	6.73 ± 0.43[a]
Dry processed	4.07 ± 0.23[a]	4.00 ± 0.32[a]	7.13 ± [a]	4.10 ± 0.26[a]	4.10 ± 0.23[a]	7.33 ± 0.33[a]	7.10 ± 0.37[a]	7.23 ± 0.46[a]
CV (%)	5.62	7.97	5.58	6.35	5.50	4.46	5.20	6.40
LSD	0.442	0.625	0.774	0.524	0.437	0.642	0.714	0.898
Mean	3.93	3.92	6.94	4.13	3.98	7.20	6.88	7.02
P value	0.228	0.600	0.363	0.565	0.381	0.543	0.198	0.424

Small letters in the same column indicate level of significance of difference.
AI, aromatic intensity; AQ, aromatic quality; AC, acidity; AS, astringency; BI, bitterness; BO, body; FL, flavor; OAQ, overall quality.

Table 3
Coffee quality as affected by processing methods under Jimma location.

Processing	Raw quality (%)	Cup quality (%)	Total quality (%)
Washed	35.57 ± 0.36[a]	44.47 ± 2.3[a]	80.07 ± 2.2[a]
Semi-washed	34.10 ± 0.35[b]	42.50 ± 2.2[a]	76.60 ± 2.1[a]
Dry processed	33.80 ± 0.34[b]	45.07 ± 2.4[a]	78.87 ± 2.1[a]
CV (%)	1.02	5.26	2.72
LSD	0.705	4.626	4.263
Mean	34.49	44.01	78.51
P value	0.0018	0.419	0.211

Small letters in the same column indicate level of significance of difference. Raw quality was recorded out of 40 %, Cup quality was recorded out of 60 % and Total quality (sum of raw and cup quality out of 100 %.

Table 4
Effect of processing methods on chemical compositions of coffee beans in Jimma.

Processing methods	Trigonelline (g/100 g)	Chlorogenic acid (g/100 g)	Caffeine (g/100 g)	Lipid (g/100 g)
Washed	0.967 ± 0.13[a]	4.44 ± 0.60[a]	1.15 ± 0.14[a]	13.17 ± 0.84[ab]
Semi-washed	0.907 ± 0.12[a]	4.49 ± 0.61[a]	1.22 ± 0.15[a]	13.74 ± 0.89[a]
Dry processed	0.847 ± 0.11[a]	4.52 ± 0.61[a]	1.06 ± 0.13[a]	12.01 ± 0.77[b]
CV (%)	13.54	13.59	12.26	6.38
LSD (0.05)	0.245	1.22	0.280	1.65
Mean	0.907	4.48	1.14	12.97
P value	0.526	0.986	0.413	0.103

Small letters in the same column indicate level of significance of difference.

Table 5
Raw and cup quality record sheet.

Character	Sample Code
M. content %	
Over Screen (%)	
Shape Make	
Color/Defect count	
Odor	
Raw Total (40 %)	
Aromatic Intensity	
Aromatic Quality	
Acidity	
Astringency	
Bitterness	
Body	
Flavor	
Typicity*	
Overall cup quality+	
Cup Total (60 %)	
Defects	
Remark	
Total Quality (100 %)	

3.2. Conclusion and recommendations

The quality of coffee is a complex attribute that is affected by a variety of factors. Among these factors, coffee processing methods are particularly important. Coffee processing methods have a considerable effect on the raw quality (color and odor) of the coffee. On the otherhand, the raw qualities of coffee beans are of high interest in the coffee market and consumer preferences. Accordingly, washed coffee can produce better raw-quality coffee, such as color and odor in the study location. However, coffee produced by dry processing methods is also of acceptable quality, even though it is statistically lower than washed coffee in some raw quality attributes. The washed coffee beans scored the highest color (13.43) and odor [10] scores compared to the other processing methods. However, there was no statistically significant difference in the cup quality attributes of coffee in the Jimma condition. The high lipid 13.74 and 13.17 g/100 g were reported for wet processed coffee beans in Jimma station. In general, as far as raw quality is considered, washed and semi-washed coffee were found to be preferable in Jimma. This implies that wet-processed coffee beans, both washed and semi-washed, are good for better color and other raw quality attributes in Jimma. Therefore, accessibility of the methods and costs are important factors that require future research attention. Moreover, it is important to conduct a comparative study of coffee processing methods in other major coffee-producing regions in Ethiopia.

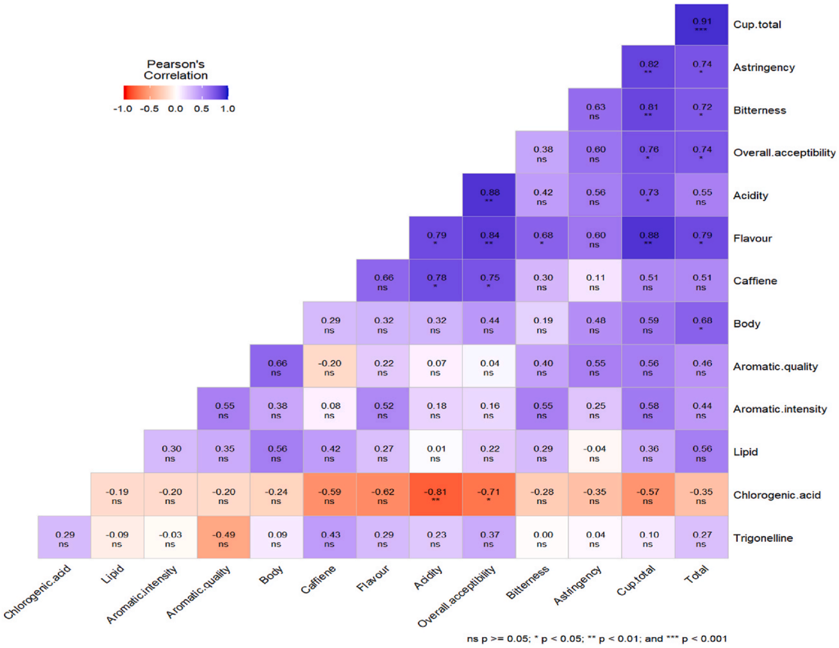

Fig. 2. Pearson's Correlation between sensory and chemical quality attributes
AI, aromatic intensity; AQ, aromatic quality; AC, acidity; AS, astringency; BI, bitterness; BO, body; FL, flavor; OAQ, overall quality; TCQ-total cup quality; Trig-trigonelline, CGA-chlorogenic acid, caf-caffeine.

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Data availability statement

All data generated during the study are submitted with this manuscript. All data generated during the study are included in the manuscript. Incase raw data required; it can be obtained from corresponding author upon request at misganabanti2013@gmail.com email account.

Ethical statement

There are no human subjects in this article, and an informed consent is not applicable. For sensory evaluation, only panelists trained and certified for similar responsibilities were invited and involved.

CRediT authorship contribution statement

Misgana Banti: Formal analysis, Data curation, Conceptualization, Writing – review & editing, Investigation, Methodology, Software, Writing – original draft. **Tegene Atlaw:** Conceptualization, Formal analysis, Writing – review & editing.

Declaration of competing interest

Authors have no conflict of interest to declare.

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