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# Analysis of coffee quality along the coffee value chain in Jimma zone, Ethiopia

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**This study assesses the effect of cooperative, certification, private trader, farmers, sorting and processing methods on Arabica coffee quality. Coffee samples were collected from certified cooperatives, non-certified cooperatives, private traders and farmers (members of certified cooperatives, non-certified cooperatives and non-members of cooperatives). The study showed that coffee beans sampled from cooperatives had higher quality scores and were classified as specialty 1 (Q1) (33%) or specialty 2 (Q2) (67%). About 78% of coffee beans sampled from private traders fall in grade 3, while 22% of their beans qualified for Q2. Coffee certification, in general, did not add any value to coffee quality. No quality differences were also observed between coffee beans sampled from farmers. Coffee quality differences were observed between coffee processing methods. Dry processing method improved coffee quality. However, this can only be achieved by using ripe red cherries. Cherry sorting also improved coffee quality and the percentage of coffee samples that fall in Q1. In general, proper coffee cherries type together with site specific coffee processing approach helps coffee actors to produce high quality coffee.**

**Key words:** Arabica coffee, flavor, body, specialty, cherry, acidity.

## INTRODUCTION

Coffee is the world's favorite beverage and most traded commodity (Barbosa et al., 2014; Davis et al., 2012; Murthy and Naidu, 2012). Coffee quality is an important attribute in the international market and triggers coffee producing countries to produce high quality coffees (Curzi et al., 2014). Ethiopia is known for the origin and wide diversity of Arabica coffee and has enormous, unexplored potential to produce top specialty coffees (Anthony et al., 2001; Coste et al., 1992). Coffee production is the backbone of the Ethiopian economy, contributing 25 to 30% of total export earnings (Tefera and Tefera, 2014). Coffee further plays a major role in sustaining the livelihoods of more than 15 million households in the country (Davis et al., 2012). Majority

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of coffee produced in the country is grown by smallholders farmers, while about 5% comes from large coffee plantations (Tefera, 2015).

Coffee produced by these smallholder farmers reaches consumers by passing through different value chain actors. In Ethiopia, coffee value chain actors include: input providers, producers (smallholder farmers, private growers and coffee plantation), private trader, cooperatives, unions (association of cooperatives), Ethiopia Commodity Exchange (ECX), various government institutions, exporters and finally the consumer (Gemech and Struthers, 2007). Cooperatives enhance the competitiveness of the smallholder coffee farmers through modernization of coffee production and marketing system (Bernard and Spielman, 2009; Dorsey and Assefa, 2005). Cooperatives also enable farmers to improve coffee quality and ultimately their income (Dempsey and Campbell, 2006; Kodama, 2007).

Unions are associations of cooperatives that enhance the economic scale by increasing the bargaining power of cooperatives in selling their product (Emana, 2009; Meijerink et al., 2010). Unions took the lead to establish international market linkage and facilitate direct export on behalf of smallholder coffee producers. This linkage encourages coffee growers to produce quality product and receive premium prices (Dempsey, 2006). Hence, the “new” coffee value chain: cooperatives and unions, have gained particular importance on international specialty coffee market (Stellmacher, 2011) and increased local farmers’ market share in the international market (Emana, 2009; Kodama, 2007).

In consumer countries, in addition to quality, there is also a growing demand for healthier and eco-friendly produced coffee (Giovannucci et al., 2014; Jena et al., 2012; Stellmacher, 2007). For differentiation and creation of niche markets for such coffee products, certification has become an important tool (Grote et al., 2007; Daniele, 2008). In northern Nicaragua, smallholder coffee producers and certified cooperatives significantly benefited from certification (Bacon, 2005; Dorr et al., 2010; Philpott et al., 2007; Poncelet et al., 2005). In Ethiopia, however, there are no studies that report impacts of cooperatives and certification on coffee bean quality.

Postharvest processing method is another key factor that influences the final coffee quality and chemical compounds (Bytof et al., 2005; Duarte et al., 2010; Knopp et al., 2006; Selmar et al., 2002). In Ethiopia, about 70 to 80% coffee beans are processed via dry processing methods while the remaining 20 to 30% are washed processed coffee beans (Bart et al., 2014). Washed processing methods use red ripe cherries while cherries of different ripening stages are usually processed via dry processing method. This might affect qualities of dry processed coffee beans. Almost all cooperatives use washed processing. This method is, however, expensive, consume large amounts of water and pollute the environment. Hence, this needs further research to show the impacts of processing methods on coffee quality by considering identical coffee cherries. This study therefore, aimed to determine the effects of certification, processing methods, coffee bean sorting and actors in the value chain on coffee bean quality.

## MATERIALS AND METHODS

### Study site

The experiment was carried out in three districts (Mana, Goma and Limu) of Jimma zone, Oromia regional state, Ethiopia. Mana district is located at an elevation of 1400 - 2610 m asl and 7° 67' N, 37° 07' E with mean annual temperature and rainfall of 20.5°C and 1525 mm, respectively. The soil of the area is characterized as a Nitisol, with pH ranging from 4.5 to 5.5 (ARDO, 2008). Goma district is located at an elevation of 1400 - 2270 m asl and geographical location of 7° 57' N, 36° 42' E, with annual mean temperature and rainfall of 21.7°C and 1600 mm, respectively. The soil of the area is characterized as an Eutric Nitisol, with pH ranging from 4.5 to 6.0 (IPMS, 2007). The third site, Limu, is located at an elevation of 1600 - 1800 m asl, 8° 05' N, 36° 57' E, with an annual mean temperature and rainfall of 20.4°C and 1616 mm, respectively. The soils are dominated by Eutric Nitisols with pH ranging of 4.5 to 5.8.

### Treatments and experimental design

For this study, coffee actors along the value chain (cooperatives, private traders and farmers) of three districts (Mana, Goma and Limu) were considered. The study was composed of three experiments. In experiment 1, washed processed coffee beans were sampled from cooperatives: certified cooperatives (CC) and non-certified cooperatives (NCC) and private traders (PT). In experiment 2, red coffee cherry samples were collected from farmers: members of certified cooperatives (FMCC), members of non-certified cooperatives (FMNCC) and non-members of cooperatives (FNMC). In experiment 3, red coffee cherry samples were also collected from farmers; members of certified cooperatives (FMCC), members of non-certified cooperatives (FMNCC) and non-members of cooperatives (FNMC). The collected samples were sorted out as ripe and unripe cherries and were then subjected to dry and wash processing methods. In all the experiments, coffee samples were collected from October 2012 to February 2013. Detailed description of each experiment is presented as follows.

### Experiment 1

Six coffee cooperatives (three certified and three non-certified) were selected from both Mana and Goma district. In Limu, since all cooperatives were certified, three cooperatives were randomly selected. In addition, nine private traders, three from each district, were randomly selected. Certified and non-certified cooperatives bought coffee cherries from their own respective members while private traders bought from farmers who were not members of cooperatives. For each treatment, composite samples of one kilogram of washed processed green coffee beans were collected for quality analysis. These composite samples were taken from 30 bags containing green coffee beans. The experiment was arranged in a “split plot” design, with district as “main plot” and three levels of actors (certified cooperatives, non certified cooperatives and private traders) as “sub-plot”.

**Table 1.** Effect of actors (A): certified cooperatives (CC), non-certified cooperatives (NCC) and private traders (PT) on preliminary cup quality (PCQ), preliminary total quality (PTQ), total specialty cup quality (TSCQ) and specific specialty cup quality scores of washed processed coffee beans.

| Factors | | PCQ | PTQ | TSCQ | Specific specialty cup quality attributes | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | OCP[1] | Acidity | Body | Aroma | Flavour | AT[2] |
| A | CC | 47.3 ± 0.6[b] | 74.3 ± 1.0[b] | 82.3 ± 0.5[a] | 7.5 ± 0.2[b] | 7.7 ± 0.1[a] | 7.4 ± 0.1[a] | 7.4 ±<0.1[a] | 7.4 ± 0.1[a] | 7.3 ± 0.1[a] |
| | NCC | 50.0 ± 0.6[a] | 77.7 ± 1.1[a] | 84.3 ± 0.9[a] | 7.9 ± 0.2[a] | 8.1 ± 0.2[a] | 7.6 ± 0.2[a] | 7.7 ± 0.1[a] | 7.8 ± 0.2[a] | 7.5 ± 0.2[a] |
| | PT | 46.8 ± 0.5[b] | 73.6 ± 0.9[b] | 78.8 ± 0.9[b] | 6.9 ± 0.2[b] | 7.2 ± 0.1[b] | 6.9 ± 0.1[b] | 6.9 ±<0.1[b] | 7.1 ± 0.1[b] | 6.9 ± 0.1[b] |
| ***P*- value** | | **0.0017** | **0.009** | **0.0036** | **0.027** | **0.03** | **0.011** | **0.003** | **0.013** | **0.013** |

[1]Overall cup preference, [2]After taste, different letters in the same column indicate significant difference, according to Tukey's HSD post hoc test (P<0.01) are shown as mean ± standard error.

**Experiment 2**

The aim of this experiment is to examine the variability of coffee quality among farmers (members of certified cooperatives, members of non-certified cooperatives and non-member of cooperatives) and also processing method (dry and washed). From each three districts, six farmers were randomly selected and coffee cherries were collected from local market places where farmers sell cherries to either cooperatives or private traders. The collected samples (14 kg from each farmer) were subjected to two processing methods (dry and washed) at Goma I and Limu washing stations. These coffee samples were then processed without sorting out unripe, ripe and overripe cherries. The experiment was arranged in a "split-split plot" design with districts as "main plot", farmer type as "sub-plot" and processing type as "sub-sub-plot".

**Experiment 3**

In this experiment, coffee cherries collected from farmers (members and non-members of cooperatives) were sorted for ripe, unripe and overripe coffee cherries before processing. For this, only Goma district was considered and coffee cherries (28 kg per farmer) were collected at the local market from six farmers per type. Half of the cherries (14 kg) were sorted as ripe, unripe and overripe cherries and only clean and ripe coffee cherries were subjected to dry and wash processing. The other 14 kg of unsorted coffee cherries were also subjected to dry and wash processing methods. The experiment was arranged in a "split-split plot" design with actors as "main plot", sorting treatment as "sub-plot" and processing methods (washed and dry processing) as "sub-sub-plot".

**Coffee quality analysis**

Coffee quality was assessed based on both physical and cup quality analysis. Cup tasting was performed by a team of three experts working in Ethiopia Commodity Exchange (Tolessa et al., 2016). For scores higher than 70 cup quality, specialty coffees were further assessed for overall cup preference, acidity, body, aroma, flavour, aftertaste, uniformity, cup cleanness, sweetness and balance.

**Data analysis**

Data were analyzed using SAS (v. 9.2, SAS Institute Inc., Cary, NC USA) mixed model procedure for a split plot design. Significant differences between treatment means were determined using Tukey's honest significant difference (HSD) test at P < 0.01 and P < 0.05.

## RESULTS

### Coffee quality

The result of experiment 1 (Table 1) indicated that different coffee actors significantly influenced (P < 0.01) preliminary cup quality, preliminary total quality, total specialty cup quality, acidity and aroma of coffee beans. Coffee beans of non-certified cooperatives had higher quality scores for preliminary cup quality (50.0) and preliminary total quality (77.7) than beans from certified cooperatives and private traders (Table 1). Total specialty cup quality of certified (82.3) and non-certified cooperatives (84.3) was higher as compared to private trader's coffee (78.8). Acidity and aroma scores were also higher for certified (7.7 and 7.4) and non-certified (8.1 and 7.7) cooperatives as compared to private traders (7.2 and 6.9), respectively (Table 1). Different coffee growing districts, on the other hand, did not show any significant effect on all coffee quality attributes. In experiment 2 (Table 2), interactions between actors and processing methods significantly affected overall cup preference (P < 0.01). Dry processed coffee beans sampled from non-certified cooperatives gave the highest quality scores as compared to beans from any other treatment combinations (Table 3).

Districts as main effect had a significant effect on preliminary cup quality, total specialty cup quality and flavor characteristics of coffee bean (Table 3). For these quality attributes, coffee beans sampled from Limu had the highest scores while coffees from Mana had the lowest. Similarly, dry processed coffee beans had higher physical

**Table 2.** The interactive effect of actors (A): farmers who are a member of certified cooperatives (FMCC), farmers who are a member of non- certified cooperatives (FMNCC), farmers who are non-member of cooperatives (FNMC) and processing methods (PM): dry (DP) and washed (W) method on total specialty cup quality (TSCQ) and specific specialty cup quality scores.

| **A** | **PM** | **TSCQ** | **Specific specialty cup quality attributes** | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | **OCP[1]** | **Acidity** | **Body** | **Aroma** | **Flavour** | **AT[2]** |
| FMCC | DP | 84.2 ± 0.3$^{a}$ | 7.8 ± 0.1$^{a}$ | 7.9 ± <0.1$^{a}$ | 7.9 ± 0.1$^{a}$ | 7.6 ±<0.1$^{a}$ | 7.7± 0.1$^{a}$ | 7.7 ±<0.1$^{a}$ |
| | W | 82.8 ± 0.4$^{b}$ | 7.5 ± 0.1$^{b}$ | 7.7 ± 0.1$^{b}$ | 7.5 ± 0.1$^{a}$ | 7.5 ±<0.1$^{a}$ | 7.6 ± 0.1$^{a}$ | 7.4 ± 0.1$^{a}$ |
| FMNCC | DP | 84.7 ± 0.3$^{a}$ | 7.9 ± 0.1$^{a}$ | 7.9 ± 0.1$^{a}$ | 7.9 ± 0.1$^{a}$ | 7.7 ± 0.1$^{a}$ | 7.8 ± 0.1$^{a}$ | 7.8 ±<0.1$^{a}$ |
| | W | 82.9 ± 0.6$^{b}$ | 7.7 ± 0.1$^{ab}$ | 7.8 ± 0.1$^{b}$ | 7.5 ± 0.1$^{a}$ | 7.6 ± 0.1$^{a}$ | 7.7 ±0.1$^{a}$ | 7.6 ± 0.1$^{a}$ |
| FNMC | DP | 83.5 ± 0.3$^{a}$ | 7.6 ±<0.1$^{ab}$ | 7.9 ± <0.1$^{ab}$ | 7.8± <0.1$^{a}$ | 7.5 ±<0.1 | 7.7 ±<0.1$^{a}$ | 7.6 ±<0.1$^{a}$ |
| | W | 83.3 ± 0.2$^{a}$ | 7.7 ± 0.1$^{ab}$ | 7.8 ± <0.1$^{ab}$ | 7.6 ±<0.1$^{a}$ | 7.5 ±<0.1$^{a}$ | 7.6 ±<0.1$^{a}$ | 7.5 ±<0.1$^{a}$ |
| ***P* -value** | | **0.038** | **0.0062** | **0.039** | **0.115** | **0.787** | **0.76** | **0.32** |

[1]Overall cup preference, [2]After taste, different letters in the same column indicate significant difference according to Tukey's HSD post hoc test (*P*<0.01); mean ± standard error.

**Table 3.** Effect of district (D), actors (A): farmers who are a member of certified cooperatives (FMCC), farmers who are a member of non- certified cooperatives (FMNCC), farmers who are not member of cooperatives (FNMC) and processing methods (PM): dry (DP) and washed (W) methods on physical quality (PQ), preliminary cup quality (PCQ), preliminary total quality (PTQ), total specialty cup quality (TSCQ) and specific specialty cup quality scores.

| **Factor** | | **PQ** | **PCQ** | **PTQ** | **TSCQ** | **Specific specialty cup quality attributes** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | **OCP[1]** | **Acidity** | **Body** | **Aroma** | **Flavour** | **AT[1]** |
| D | Mana | 35.1 ± 0.7$^{a}$ | 47.5 ± 0.8$^{b}$ | 82.6 ± 0.4$^{a}$ | 82.8 ± 0.3$^{b}$ | 7.6 ±<0.1$^{b}$ | 7.8 ± 0.1$^{a}$ | 7.6 ± 0.1$^{b}$ | 7.5 ±<0.1$^{a}$ | 7.6 ±<0.1$^{b}$ | 7.5 ±<0.1$^{b}$ |
| | Goma | 34.2 ± 0.7$^{a}$ | 48.9 ± 0.9$^{ab}$ | 83.6 ± 0.5$^{a}$ | 83.8 ± 0.3$^{ab}$ | 7.8 ± 0.1$^{a}$ | 7.9 ±<0.1$^{a}$ | 7.8 ±<0.1$^{a}$ | 7.5 ±<0.1$^{a}$ | 7.7 ±<0.1$^{ab}$ | 7.6 ±<0.1$^{ab}$ |
| | Limu | 34.3 ±1.2$^{a}$ | 49.6 ± 1.4$^{a}$ | 83.9 ± 0.5$^{a}$ | 84.1 ± 0.2$^{a}$ | 7.8 ±<0.1$^{a}$ | 7.9 ±<0.1$^{a}$ | 7.7 ±< 0.1$^{a}$ | 7.6 ±<0.1$^{a}$ | 7.8 ± 0.1$^{a}$ | 7.9 ±<0.1$^{a}$ |
| | ***P* -value** | **0.841** | **0.0072** | **0.466** | **0.008** | **0.014** | **0.058** | **0.014** | **0.106** | **0.006** | **0.031** |
| A | FMCC | 35.0 **±** 0.8$^{a}$ | 48.3 ± 0.9$^{b}$ | 83.4 ± 0.4$^{a}$ | 83.5 ± 0.3$^{a}$ | 7.7 ± 0.1$^{a}$ | 7.8 ±<0.1$^{a}$ | 7.7 ±<0.1$^{a}$ | 7.5 ±<0.1$^{a}$ | 7.7 ± 0.1$^{a}$ | 7.6 ±<0.1$^{a}$ |
| | FMNCC | 35.0 ± 0.7$^{a}$ | 49.5 ± 0.8$^{a}$ | 84.5 ± 0.5$^{a}$ | 83.8 ± 0.3$^{a}$ | 7.8 ± 0.1$^{a}$ | 7.9 ± 0.1$^{a}$ | 7. 7± 0.1$^{a}$ | 7.6 ±<0.1$^{a}$ | 7.8 ± 0.1$^{a}$ | 7.7 ±<0.1$^{a}$ |
| | FNMC | 34.3 ± 0.8$^{a}$ | 48.2 ± 0.9$^{b}$ | 82.5 ±0.5$^{a}$ | 83.4 ± 0.2$^{a}$ | 7.7 ±<0.1$^{a}$ | 7.8 ± <0.1$^{a}$ | 7.7 ±<0.1$^{a}$ | 7.5 ±<0.1$^{a}$ | 7.7 ± <0.1$^{a}$ | 7.6 ±<0.1$^{a}$ |
| | ***P* -value** | **0.831** | **0.04** | **0.301** | **0.38** | **0.31** | **0.768** | **0.94** | **0.0.06** | **0.31** | **0.24** |
| PM | DP | 37.1 ± 0.5$^{a}$ | 48.8 ± 0.7$^{a}$ | 85.9 ± 0.4$^{a}$ | 84.1 ± 0.2$^{a}$ | 7.8 ±<0.1$^{a}$ | 7.9 ±<0.1$^{a}$ | 7.8 ±<0.1$^{a}$ | 7.9 ±<0.1$^{a}$ | 7.7 ± <0.1$^{a}$ | 7.7 ±<0.1$^{a}$ |
| | W | 32.5 ± 0.6$^{b}$ | 48.3 ± 0.8$^{a}$ | 80.8 ± 0.4$^{b}$ | 82.9 ± 0.2$^{b}$ | 7.5 ± 0.1$^{b}$ | 7.8 ±<0.1$^{b}$ | 7.6± <0.1$^{b}$ | 7.5 ±<0.1$^{b}$ | 7.5 ± <0.1$^{b}$ | 7.4 ±<0.1$^{b}$ |
| | ***P* -value** | **<0.0001** | **0.22** | **<0.001** | **<0.001** | **<0.001** | **<0.001** | **<0.001** | **0.008** | **0.01** | **<0.001** |

[1]Overall cup preference, [2]After taste, different letters in the same column indicate significant difference, according to Tukey's HSD post hoc test (*P*<0.01); results are shown as mean ± standard error.

quality, preliminary total quality, total specialty cup quality and specialty cup quality scores than washed processed coffee beans. Preliminary cup

**Table 4.** Effect of actors (A): farmers who are members of certified cooperatives (FMCC), farmers who are members of non-certified cooperatives (FMNCC), farmers who are non-members of cooperatives (FNMC), sorting treatment (Tr): sorted and unsorted and processing methods (PM): dry (DP) and washed (W) methods on physical quality (PQ), preliminary total quality (PTQ), total specialty cup quality (TSCQ) and specific specialty cup quality scores.

| | Factor | PQ | PTQ | TSCQ | Specific specialty cup quality attributes | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | OCP 1 | Acidity | Body | Flavour | AT2 |
| A | FMCC | 38.2 ± 1.2[a] | 83.0 ± 0.9[a] | 83.8 ± 0.7[a] | 7.7 ± 0.1[a] | 7.7 ± 0.1[a] | 7.7 ± 0.1[a] | 7.6 ± 0.1[a] | 7.6 ± 0.1[a] |
| | FMNCC | 37.3 ± 0.9[a] | 84.1 ± 0.6[a] | 84.6 ± 0.4[a] | 7.8 ± 0.1[a] | 7.9 ± 0.1[a] | 7.8 ± 0.1[a] | 7.8 ± 0.1[a] | 7.6 ± 0.1[a] |
| | FNMC | 38.2 ±0.5 [a] | 82.5 ± 0.5[a] | 83.9 ± 0.5[a] | 7.6 ± 0.1[a] | 7.8 ± 0.1[a] | 7.7 ± 0.1[a] | 7.7 ± 0.1[a] | 7.5 ± 0.1[a] |
| | ***P* -value** | **0.03** | **0.025** | **0.1** | **0.13** | **0.03** | **0.2** | **0.09** | **0.49** |
| Tr | sorted | 38.3 ± 0.7[a] | 85.3 ± 0.6[a] | 85.2 ± 0.3[a] | 7.9 ± 0.1[a] | 7.9 ± 0.1[a] | 7.9 ± 0.1[a] | 7.8 ± 0.1[a] | 7.7 ± 0.1[a] |
| | Unsorted | 36.5 ± 0.6[b] | 80.0 ± 0.4[b] | 83.0 ± 0.4 [b] | 7.5 ± 0.1[b] | 7.7 ± 0.1[b] | 7.5 ± 0.1[b] | 7.6 ± 0.1[b] | 7.4 ± 0.1[b] |
| | ***P-value*** | **0.004** | **0.0004** | **<0.0001** | **0.001** | **0.002** | **0.003** | **0.0028** | **0.003** |
| PM | DP | 38.9 ± 0.8[a] | 85.1 ± 0.6[a] | 84.8 ± 0.4[a] | 7.9 ± 0.1[a] | 7.9 ± 0.1[a] | 7.9 ± 0.1[a] | 7.8 ± 0.1[a] | 7.7 ± 0.1[a] |
| | W | 35.9 ± 0.7[a] | 81.2 ± 0.5[b] | 83.4 ± 0.4[b] | 7.6 ± 0.1[b] | 7.7 ± 0.1[b] | 7.6 ± 0.1[a] | 7.6 ± 0.1[a] | 7.5 ± 0.1[a] |
| | ***P* -value** | **0.009** | **0.0003** | **0.0009** | **<0.001** | **0.002** | **0.04** | **0.02** | **0.01** |

Overall cup preference, [2]After taste, different letters in the same column indicate significant difference, according to Tukey's HSD post hoc test (P<0.01); results are shown as mean ± standard error; results are shown as mean ± standard error

**Table 5.** Percentage of coffee samples under specialty 1 (Q1), specialty 2 (Q2) and grade 3.

| Actors[1] | Q1 | Q2 | Grade 3 |
|---|---|---|---|
| CC | 33 | 67 | 0 |
| NCC | 50 | 50 | 0 |
| PT | 0 | 22 | 78 |

[1]Coffee beans were obtained from different actors: certified cooperatives (CC), non-certified cooperatives (NCC) and private traders (PT).

quality, on the other hand, was not significantly affected by processing methods (P > 0.01; Table 3). In addition, no significant effect of actors was observed for all bean quality attributes (P > 0.01; Table 3).

The result of experiment 3 (Table 5) showed that cherry sorting significantly affected (P < 0.01) all coffee quality attributes except preliminary cup quality. As compared to the unsorted coffee beans, sorted coffee beans gave higher quality scores for physical quality (38.3), preliminary total quality (85.3) total specialty cup quality (85.2), overall cup preference (7.9), acidity (7.9), body (7.9), aroma (7.8), flavour (7.8) and aftertaste (7.7) (Table 4).

Coffee quality attributes were also significantly influenced by processing method (P < 0.01). Dry processing methods enhanced quality scores of physical quality (38.9), preliminary total quality (85.1), total specialty cup quality (84.8), overall cup preference (7.9) and acidity (7.9). Processing methods, on the other hand, did not significantly affect preliminary cup quality, body, aroma, flavour and aftertaste (P > 0.01). Differences among farmers on the other hand, did not significantly affect (P > 0.01; Table 4) coffee quality. Generally, the three and two - way interactions between farmers, sorting treatments and processing methods did not significantly affect coffee quality attributes.

## DISCUSSION

This study showed that coffee bean quality attributes: preliminary cup quality, preliminary total quality, total specialty cup quality, acidity and aroma showed significant differences among the different coffee actors in the value chain. Coffee beans that passed through a cooperative system had higher quality scores than beans that passed via private traders. An unexpected result from this study was that coffee certification did not result in any quality improvement. This is probably due to the fact that certification mainly focuses on promotion of socioeconomic advantage and environmental sustainability rather than coffee quality. In other studies by Bart et al. (2014), it was reported that certification did not necessarily affect coffee quality but marketability and prices. The certification schemes should therefore include criteria that improve farmer's management practice and their livelihood. The certification cost, on the other hand, is very high (ca. $6000) and probably restricts the practicability of the scheme.

Coffee beans collected from private traders were classified mainly into commercial grade 3 (ca. 78%), only 22% of the samples were qualified as Q2 and none as Q1 (Table 5). Quality differences between cooperative and private traders coffee beans could be explained by the differences in type of coffee cherries (red ripe, unripe and overripe) delivered by farmers and growing environment. In coffee cooperatives, coffee cherries

**Table 6.** Percentage of coffee samples under specialty 1 (Q1), specialty 2 (Q2) and grade 3 obtained from different actors: farmers, member of certified cooperatives (FMCC), farmers, member of non-certified cooperatives (FMNCC), farmers, non-member of cooperatives (FNMC) and processed by dry and washed methods.

| Actors | PM | Q1 | Q2 | Grade 3 |
|---|---|---|---|---|
| FMCC | DP | 33 | 61 | 6 |
| | W | 16 | 78 | 6 |
| FMNCC | DP | 42 | 50 | 8 |
| | W | 25 | 67 | 8 |
| FNMC | DP | 31 | 63 | 6 |
| | W | 15 | 79 | 6 |

harvested from different production sites are less likely mixed with each other and are processed separately, while private traders collected coffee cherries from different growing environments (altitude) and processed bulk coffee beans regardless of coffee production sites. Majority of coffee beans processed by cooperatives are qualified for specialty coffees which is not the case for private traders. This shows that a site-by-site processing approach (processing coffee harvested from similar growing environments) contributes to improved bean quality and links bean characteristics with production site.

Coffee cooperatives have their own rules on harvesting and handling of coffee beans. They teach and follow up each farmer on how to harvest and handle coffee cherries. Accordingly, farmers in the cooperatives supply red ripe cherries free from any other foreign materials. Premium prices that are paid by the cooperatives also encourage farmers to give due attention to coffee bean quality. In another study, Kodama (2007) also reported that because of premium prices, farmers pay more attention on coffees supplied to cooperatives than to private traders.

The growing demand for specialty coffee market can therefore be much better exploited by coffee cooperative (Dempsey and Campbell, 2006). This indicates that there is potential for Ethiopian coffee cooperatives to produce high quality coffee beans and increase their share in the international specialty coffee market. Apart from quality improvement, the establishment of cooperatives in the study area also enhanced coffee price paid by private traders. In an area without cooperatives, farmers receive low prices ($ 0.3 per kilogram of red cherries) as compared to areas with cooperatives ($ 0.5 per kilogram of red cherries). But, currently, the share of coffee cooperatives in the study area is small; ca. 15 to 20% as compared to the private traders. Thus, increasing cooperatives' share in coffee export might enhance Ethiopian coffee quality in the international market. This can be achieved through institutional interference to encourage and organize farmers into cooperatives.

Site-specific sample collection and processing also reduce coffee bean quality deterioration. However, this requires appropriate processing method. The results in experiment 2 (Tables 2 and 3) supported this hypothesis. Coffee beans collected from farmers not in the cooperatives had comparable quality as compared to those not in cooperatives (Table 3). About 33, 42 and 31% of coffee samples collected from farmers that are members of certified cooperatives (FMCC), members of non-certified cooperatives (FMNCC) and non-members of cooperatives (FNMC) and processed via dry processing were respectively, classified as Q1 (Table 6).

This finding, on the other hand, is an "apparent paradox" to the result obtained for beans collected from cooperatives and private traders. The possible explanation could be that coffee collected from farmers is site specific or less mixed as compared to coffee beans sampled from private traders. Hence, from these result, it can be concluded that the major cause of quality loss by private traders (experiment 1) is bulking of coffee beans from different environments and processing methods.

The result observed in experiment 2 also revealed that differences in processing methods significantly influenced coffee quality attributes (physical quality, preliminary total quality, total specialty cup quality, overall cup preference and acidity). For these quality attributes, dry processing method gave higher quality scores than washed methods. Furthermore, the largest percentage of coffee samples classified as Q1 were from dry compared to washing processing method (Tables 6 and 7). In Ethiopia, however, dry processed coffee beans are often viewed as an inferior coffee and receive the lowest price. This indicates that improving dry processing methods enhance Ethiopian coffee competitiveness and the share of specialty coffee export. Hence, the present study in general demonstrated that applying consistent quality control methods and via dry processing method increases the percentage of specialty coffee beans. Moreover, appropriate drying materials also need to be considered to achieve superior quality dry processed coffee beans (Abasanbi, 2010; Subedi, 2011; Tsegaye et al., 2014).

In this study, it was also found that sorting coffee cherries before processing improved percentage of Q1 coffee beans from 17 to 61% (Table 7). This also indicates that the presence of small portion of low quality cherries e.g. unripe and overripe in a certain coffee batch can cause a dramatic quality loss. However, sorting after harvest may lead to quantity reduction. For this selective picking of ripe red cherries and consequently arranging more harvesting rounds for cherries enhance both quality and quantity of the coffee beans. Moreover, farmers need to be trained on how inappropriate coffee cherries result in a drastic quality deterioration. Strict assessment of the quality of coffee cherries at the local market, sorting and specific site processing further improved coffee bean

**Table 7.** Percentage of coffee samples within specialty 1 (Q1) and specialty 2 (Q2) obtained from different actors of Goma district, Jimma zone: farmers who are members of certified cooperatives (FMCC), farmers who are members of non-certified cooperatives (FMNCC), farmers who are not members of cooperatives (FNMC), treated (sorted and unsorted cherries) and processed by dry and washed methods.

| | | Percentage of specialty 1 and 2 | | |
|---|---|---|---|---|
| **Treatment** | **Actors** | **PM** | **Specialty (Q1)** | **Specialty (Q2)** |
| **Sorted** | FMCC | DP | 100 | 0 |
| | | WP | 33 | 67 |
| | FMNCC | DP | 100 | 0 |
| | | WP | 33 | 67 |
| | FNMC | DP | 100 | 0 |
| | | WP | 0 | 100 |
| Mean | | | 61 | 39 |
| **Unsorted** | FMCC | DP | 0 | 100 |
| | | WP | 0 | 100 |
| | FMNCC | DP | 33 | 67 |
| | | WP | 0 | 100 |
| | FNMC | DP | 33 | 67 |
| | | WP | 33 | 67 |
| Mean | | | 17 | 83 |

qualities.

## Conclusions

This study in general showed that coffee beans managed by cooperatives had better quality scores than beans managed by private traders. Coffee certification, on the other hand, did not result in any quality improvement. Coffee beans from farmers, non-members of cooperatives had better quality than coffee beans of private traders. The study also revealed that dry processing method improved coffee bean quality and high percentage of these beans fell under Q1 grades than wash processing methods. However, to enhance coffee quality of dry processing method, proper coffee cherries e.g. ripe red and clean cherries need to be considered. Sorting of unripe and overripe coffee cherries also improved coffee quality and all sorted coffee samples of dry processed coffee beans fell under Q1 coffee. Further studies that consider different seasons and other coffee growing regions can substantiate these findings.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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