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Regrow Yirga Project

2023/24 Coffee Harvest Season Experiment Report

Cherry Delivery Impact on Cup Quality




Prepared: April 2024

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Abstract

This study, conducted in collaboration with Technoserve during the 2023/24 Ethiopian coffee harvest season, investigates the impact of coffee cherry delivery composition on cup quality. Situated across three distinct elevation zones within the Gedio Zone, the research focused on assessing how varying ratios of ripe, overripe, and immature coffee cherries influence sensory attributes and overall cup quality. Our analysis leverages ANOVA tests and Tukey's HSD post-hoc analysis to dissect the effects of cherry quality on coffee profiles.

Our findings reveal a significant difference in cup quality influenced by the proportion of ripe cherries. Higher ratios of ripe cherries correlate with improved overall cup quality, particularly at high elevations (>2000 m.a.s.l.). This underscores the importance of strategic cherry selection and provides a quantitative basis for implementing quality-based cherry purchasing standards.

Implications of this research extend beyond academic interest, offering actionable insights for wetmill managers and owners. By establishing a clear link between cherry composition and cup quality, our study advocates for enhanced cherry selection protocols to boost the quality, and potentially, the profitability of coffee producers in the region.

Introduction

The coffee industry widely recognizes that processing only red ripe coffee cherries yields the best quality coffee, provided that proper processing practices are followed at the wetmill. The adage "coffee quality cannot be improved, only maintained" suggests that starting with the highest quality 100% red ripe cherries should result in the best quality coffee for buyers and the highest quantity of quality coffee for wetmills to sell, theoretically improving wetmill profitability.

However, the reality of cherry selection and harvesting is fraught with challenges. Selecting only ripe cherries is a labor-intensive endeavor that demands precision and patience. For wetmills, the pursuit of perfectly ripe cherries is not without risks. High-quality cherries command premium prices, necessitating increased capital for smaller volumes of cherries. Moreover, the margin for post-harvest processing errors narrows significantly with increased prices and smaller volumes, amplifying the risks of each batch processed. These challenges, coupled with the competitive landscape of the coffee market, render the decision to invest in quality a complex one for wetmill managers and owners.

Despite these challenges, prevailing cherry purchasing standards in the Gedio Zone remain minimal to non-existent. This gap in quality cherry sourcing practices, driven by competition, fragmented outgrower relationships, and a lack of comprehensive understanding of the impact of cherry quality, suggests a significant opportunity for improvement in Gedio wetmill operations.

In collaboration with Technoserve (TNS), a series of coffee quality experiments were undertaken during the 2023/24 Ethiopian coffee harvest season to better understand the impacts of cherry delivery on cup quality. By examining the relationship between the ratios of ripe, overripe, and immature cherries and their subsequent impact on the sensory attributes of coffee, this research aims to quantify these effects and translate them into actionable data. This endeavor seeks to provide wetmill managers and owners with the insights necessary to make informed decisions about cherry quality, potentially informing new strategies in cherry procurement that align with reduced risk and quality-focused coffee production.

Our study established experimental sites at three locations of varying elevation within the Gedio Zone of the Southern Ethiopia Regional State (SERS). These sites were strategically chosen to represent different coffee production conditions and to ensure the relevance and applicability of our findings. The lowland site was established at the TNS office in Dilla (~1500 m.a.s.l.), the mid-elevation site at the Finchewa Cooperative in Wonago (~1800 m.a.s.l.), and the highland site at the Aynalem Kupo Wetmill in Gedeb (~2000 m.a.s.l.).

The primary objective of this study is to assess whether the composition of coffee cherry deliveries, categorized into ripe, overripe, and immature, affects the cup quality of the coffee produced. This research seeks to empower wetmill managers and owners with actionable data, enabling them to discern the value of accepting cherries of varying qualities. By providing insights into how cherry composition influences final cup quality, we aim to support decision-making processes that could lead to enhanced quality control and profitability in coffee production.

In summary, this study endeavors to bridge the gap in knowledge regarding the impact of cherry quality on cup quality, offering a data-driven rationale for improved cherry selection and procurement strategies in the Gedio Zone. The findings of this research are expected to contribute significantly to the development of quality-focused coffee production standards, enhancing both the quality and marketability of Ethiopian coffee.

Scope of the Study

We established experimental sites at three locations of varying elevation within the Gedio Zone of the Southern Ethiopia Regional State (SERS). Including sites of varying elevation allows us to determine if results vary across different elevations and provides accurate insights to wet mill managers. To facilitate cherry acquisition and comply with local regulations, these sites were constructed within the compounds of partner wet mills or at TNS facilities.

The first experimental site was established at the TNS office in Dilla. This site represented our lowland facility (< 1,600 m.a.s.l.) with an elevation of approximately 1,500 m.a.s.l. The second experimental site was established in Wonago at the Finchewa Cooperative, a member of the Yirgachefe Union, representing our mid-elevation site (1,700 - 1,800 m.a.s.l.) with an elevation of about 1,800 m.a.s.l. The final site was constructed in Gedeb, at the Aynalem Kupo Wetmill, representing our highland site (>1,900 m.a.s.l.) with an elevation of approximately 2,000 m.a.s.l.

Each experimental site was constructed to mirror the prevailing practices at partner wet mills, ensuring the relevance and applicability of our findings. The facilities at each site included 62m^2 of raised drying beds, constructed with eucalyptus poles for the bed framing, bamboo poles laid horizontally across the bed frames, and chicken wire covered with black plastic shade netting to simulate common drying conditions. Additionally, each site featured a small shade structure (2m x 3m) with eucalyptus poles, tin roofing, and jute sidewalls for controlled fermentation conditions.

By strategically selecting these sites and standardizing the experimental facilities, we aimed to capture a broad spectrum of coffee production conditions within the Gedio Zone. This approach ensures that our findings are robust and applicable across different elevations, providing wet mill managers and owners with comprehensive insights into the impact of cherry composition on cup quality.

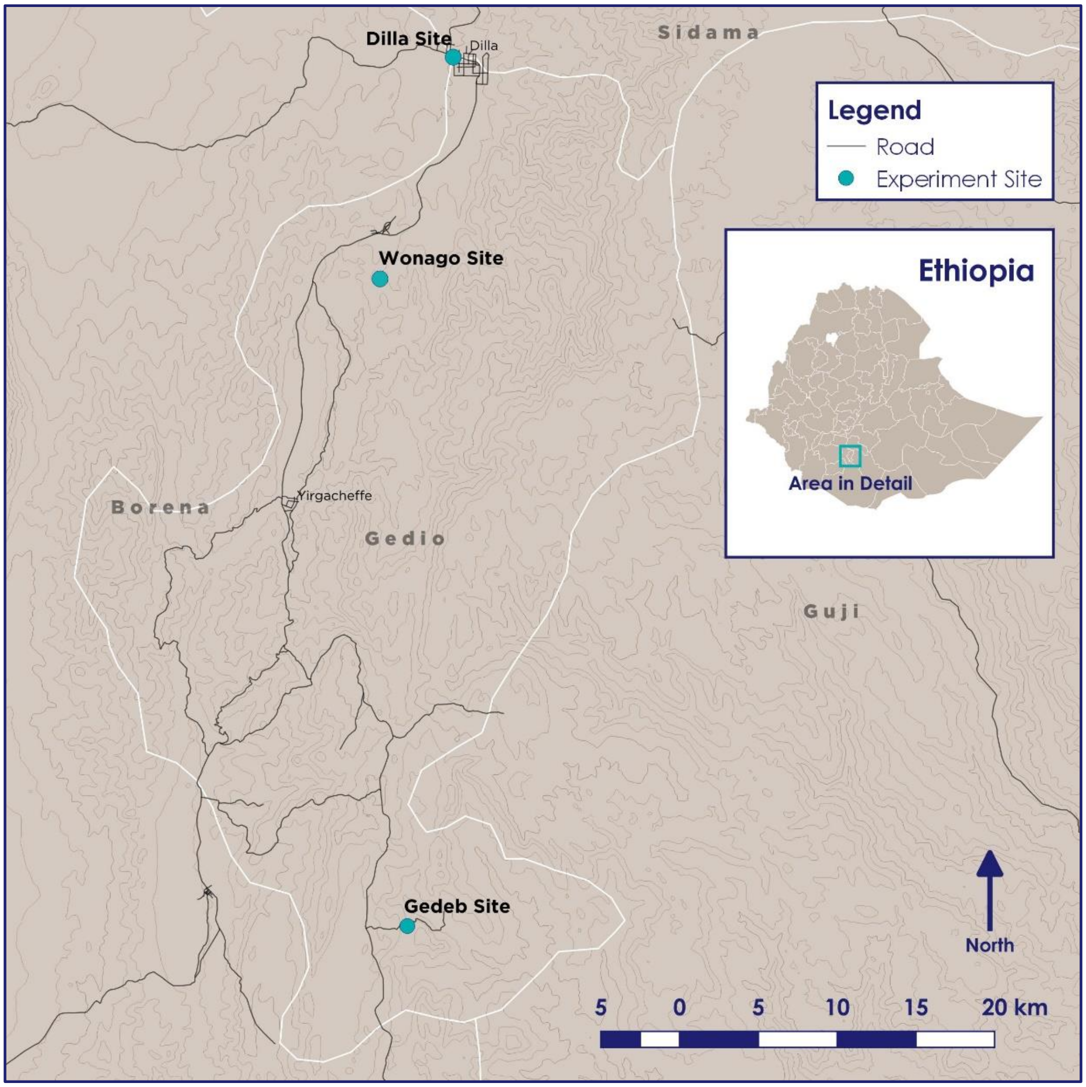

Figure 01. Locations of experimental sites established in Gedio Zone, SERS for the coffee harvest season of 2023/24.

Methodology

Experiment Sites:

To capture a broad spectrum of coffee production conditions, our experiment was conducted across three strategically selected sites within the Gedio Zone, distinguished by their varying and representative elevation. Each site was constructed to mirror the prevailing practices at partner wetmills, thereby ensuring the relevance and applicability of our findings.

Experiment facilities were constructed in a similar fashion across all sites. Each included 62m^2 of raised drying beds. Drying beds were comprised of eucalyptus poles

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for the bed framing. The bed surface was furnished of bamboo poles laid horizontally across the bed frames. Chicken wire was then tacked over this surface serving as a support layer to distribute the coffee parchment evenly. A final overlay of black plastic shade netting was used to simulate the common drying conditions, offering protection from direct sunlight while allowing for air circulation.

Each experimental site also included a small shade structure measuring 2m x 3m framed with eucalyptus poles and tin roofing. Jute was tacked to the side walls to create shade for fermentation which aided in controlling fermentation conditions which can be difficult with small batches of parchment.

Cherry Acquisition, Processing and Fermentation:

At the lowland site, coffee cherry was from the Dilla Zuria area and transported back to Dilla for experimental processing. At the mid and high elevation sites cherry was collected directly from the partner wetmills. New coffee cherry was purchased after the previous fermentation trial was completed. For each trial, 50 to 80kg of coffee cherry were purchased per trail depending upon cherry availability.

Upon receival, the cherry was floated in water to remove floaters and then placed onto a drying bed where the cherry was sorted into three categories including ripe, overripe and immature. Depending upon the final volumes of the three cherry types, five trial lots of varying ratios of 'Ripe' and 'Reject' cherry were processed. Reject cherry was composed of equal parts immature and overripe cherry. Ratios created were 100%, 90%:10%, 80%:20%, 70%:30%, and 60%:40% of 'Ripe' and 'Reject' cherry respectively.

Once measured out, trail lots were blended to homogenize the mass and then pulped. Pulping machines varied. A Penagos drum pulper was used at the lowland and highland sites while a disc pulper was used at the mid-elevation site. After pulping fermentation in water commenced in 25lt plastic buckets within the shade structure at each site. Buckets were labeled to ensure lot separation was maintained.

Figure 02. Picture of cherry sorting at the lowland site in Dilla, Gedio**.**

Fermentation and ambient conditions were then recorded throughout the fermentation process. These measurements included the date, time, atmospheric temperature (°C), the temperature of the parchment mass (°C), parchment mass pH, and Brix measurement (% sugar). These measurements were taken on an hourly basis during working hours and every three hours at night.

Figure 03. Measuring temperature of parchment at the mid-elevation site in Wonago, Gedio.

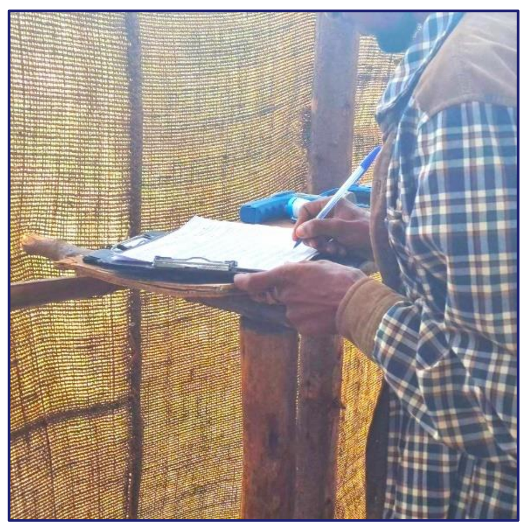

Figure 04. Recording data at the highland site in Gedeb, Gedio.

Figure 05. Different cherry ratios created for a single trial run at the lowland site in Dilla, Gedio.

Fermentation was considered complete when the parchment reached a pH level of 4.6. At this point, parchment was removed from the buckets and washed by vigorously rubbing parchment by hand and rinsing with clean water. Parchment was washed several times until all mucilage was removed.

Drying:

After washing, parchment was placed onto the raised beds for drying. The parchment was heaped into a layer of ~5cm thickness. When drying, the mass was rotated or thoroughly mixed on an hourly basis during the day and every two hours at night which allowed for even drying. Parchment was covered by shade netting during the extreme heat of the day 1,100 hours through 1,400 hours. In the event of rain, parchment was covered with plastic sheeting. Parchment was covered by both shade netting and plastic sheeting at night.

Drying measurements were taken every two hours during working hours and every three hours at night. These measurements included date, time, atmospheric temperature (°C), parchment temperature (°C), ambient humidity (%), moisture content of parchment (%), density (g/lt.), weather condition (sunny, partly cloudy,

cloudy, raining), if the parchment was covered (Y/N), if the parchment was mixed (Y/N), and if the parchment depth on the drying bed was checked (Y/N).

These measurements were continued until the parchment reached a percent moisture content of ≤12% after which, the parchment was moved into a clean PP bag, labeled and put into a cool location for storage as provided by the partner wetmill staff.

Cupping:

Parchment was allowed to rest for at least four weeks (one month) following completion of drying to allow the coffee beans to cure, and the free water molecules within the coffee beans to settle. Coffee from each lot was then roasted as per SCAA standard protocols in our partner cupping facility in Addis Ababa. Three Arabica Q-graders were invited to participate in the cupping events. Cupping took place over the course of three days. Before cupping any trial lots, a calibration cupping round using eight samples of varying origin and processing method was cupped through and discussed by participants.

Figure 06. Roasted samples for the lowland site trial lots that are ready for cupping in Addis Ababa, Ethiopia.

Cupping of trial lots was organized in a blind and randomized fashion. Because the differences between experimental trials was thought to be minute, we decided to divide cupping by experimental sites and different trials. For example, on the first day of cupping we cupped all experimental lots from the lowland site (i.e. Dilla). Additionally, each table consisted of five coffees that were produced during a single trial each represented one of the five different ratios of ripe and reject cherry produced on a given day. The order in which trails were placed on cupping tables was random. Additionally, the order in which the cherry ratios appeared on a table was also random.

Analysis:

Fermentation, and drying was compiled, cleaned and prepared for analysis. Fermentation and drying data was compared within sites using a series of ANOVA tests to identify an significant differences that could be responsible for observed variance in cupping results.

Cupping data was then compiled, and outlier data points were identified using the Inter Quartile method analyzing Total Cup score to assess. Identified outliers were then reviewed and if they were ≥1.5 cup points away from other cupping scores, they were removed from subsequent analyses. A series of ANOVA tests were then completed for each cup attribute (i.e. acidity, body, aftertaste, total cup score, etc.) at each site comparing the various cherry ratios to identify any significant differences in scores. If significant differences were found HSD Tukey post-hoc analyses were completed to identify between which cherry ratios the differences existed.

Results

Site Trends:

In total, 32 fermentation trials were conducted across all experimental sites (ten lowland, ten mid-elevation, and 12 highland). Each trial consisted of five cherry ratios and totaled 159 unique trail lots.

Fermentation at the lowland site (Dilla) took on average 35.25 hours (SD = 8.42) to complete and there was no statistically significant difference between any of the ratios in time to complete fermentation ($f(4, 43) = [0.06]$, $p = 0.99$). Average drying time at the lowland site was 260.9 hours (SD = 85.9) with no significant difference between any of the ratios ($f(4,44) = [0.89]$, $p = 0.88$).

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At the mid-elevation site, (Wonago) fermentation took an average of 30.14 hours (SD = 15.68) to complete. There was no statistical difference in the time to complete fermentation between any of the tested cherry ratios ($f(4, 45) = [0.25]$, $p = 0.91$). Average drying time between lots was 223.8 hours (SD = 78.35) with no significant difference between any of the ratios ($f(4,45) = [0.72]$, $p = 0.58$).

At the highland site (Gedeb) coffee took on average 43.35 hours to complete fermentation (SD = 7.85). Like the other sites, there was no significant difference between for any of the tested ratios in time to complete fermentation ($f(4,55) = [0.05]$, $p = 0.99$). Average drying time for parchment was 284.5 hours (SD = 52.23) and there was no significant difference between the various cherry ratios ($f(4,55) = [0.003]$, $p = 0.99$).

Cherry Quality & Cup Attributes:

Cupping scores were compiled, and trials were analyzed for each site to assess for significant differences in total cup scores and attribute scores within each site. At the lowland site our ANOVA tests revealed several significant differences for the Aftertaste ($f(4, 184) = [2.64]$, $p = 0.03$) cup attribute and Total Cup Score ($f(4, 184) = [6.15]$, $p = 0.0001$) meaning there was a significant difference in the cupping scores for these factors across different cherry ratios at the lowland site. Additionally, Sweetness, although not significant, showed a trend towards significance ($f(4, 184) = [2.34]$, $p = 0.06$).

Subsequent Tukey HSD analysis found a significant difference for the total cup score between 100 v 60:40 (mean diff.= -1.035, 95% CI [-1.88, -0.18], $p < 0.05$), 100 v. 70:30 (mean diff.= -1.357, 95% CI [-2.2, -0.51], $p < 0.05$), 90:10 v. 70:30 (mean diff.= 0.96, 95% CI [0.13, 1.79], $p < 0.05$), and 80:20 v. 70:30 (mean diff.= 0.84, 95% CI [0.01, 1.67], $p < 0.05$). Additionally, there was a significant difference found for the aftertaste attribute between 90:10 and 60:40 (mean diff.= 0.27, 95% CI [0.01, 0.54], $p < 0.05$).

Table 01. Post Hoc results for Tukey's HSD Test for multiple comparisons of cup attributes at the lowland site in Dilla.

Cup Attribute	Tested Group Pairs	Mean Diff.	p-adj.	95% Confidence Interval		Significant Result
				Lower	Upper	
Aftertaste	100 v 90:10	0.102	0.832	-0.1659	0.37	No
	100 v 80:20	-0.0646	0.9637	-0.3326	0.2033	No
	100 v 70:30	-0.1429	0.5896	-0.4125	0.1267	No
	100 v 60:40	-0.1714	0.4124	-0.4427	0.1	No
	90:10 v 80:20	0.1667	0.4067	-0.0959	0.4292	No
	90:10 v 70:30	0.2449	0.0835	-0.0193	0.5092	No
	90:10 v 60:40	0.2734	0.0407	0.0073	0.5394	Yes
	80:20 v 70:30	0.0783	0.9254	-0.186	0.3425	No
	80:20 v 60:40	0.1067	0.8037	-0.1593	0.3728	No
	70:30 v 60:40	0.0284	0.9984	-0.2393	0.2962	No
Total Cup Score	100 v 90:10	-0.3937	0.698	-1.2348	0.4474	No
	100 v 80:20	-0.5155	0.4436	-1.3566	0.3256	No
	100 v 70:30	-1.3571	0.0002	-2.2035	-0.5107	Yes
	100 v 60:40	-1.0347	0.0087	-1.8866	-0.1828	Yes
	90:10 v 80:20	0.1218	0.9942	-0.7023	0.9459	No
	90:10 v 70:30	0.9634	0.0139	0.1339	1.7929	Yes
	90:10 v 60:40	0.641	0.2183	-0.1941	1.4762	No
	80:20 v 70:30	0.8416	0.0449	0.0121	1.6711	Yes
	80:20 v 60:40	0.5192	0.4286	-0.3159	1.3544	No
	70:30 v 60:40	-0.3224	0.8283	-1.1628	0.5181	No

Anova tests completed for various cup attributes processed at the mid-elevation site, revealed several significant differences in cup attributes including Aroma ($f(4, 189) = [5.93]$, $p = 0.0001$), Flavor ($f(4, 189) = [4.28]$, $p = 0.002$), Aftertaste ($f(4, 189) = [2.45]$, $p = 0.04$), Body ($f(4, 189) = [3.98]$, $p = 0.004$), Sweetness ($f(4, 189) = [3.07]$, $p = 0.02$), Balance ($f(4,189) = [3.82]$, $p = 0.005$), and Overall ($f(4, 189) = [4.98]$, $p = 0.007$). Additionally there was a marked difference in Total Cup Scores at the mid-elevation site ($f(4, 189) = [33.23]$, $p = 5.58 \times 10^{-21}$) suggesting a strong difference between different cherry ratios.

Follow up Tukey HSD analyses returned somewhat ambiguous results with differences primarily arising between quality cherry deliveries (i.e. 100% and 90% ripe ratios) and lower quality deliveries (i.e. 70% and 60% ripe). Results can be found in Appendix IV. There were no clear trends in the differences between any individual attributes across the various cherry ratios. Total Cup Score showed a significant difference for 100% and 90% ripe cherry ratios when compared against all others, suggesting that they are significantly different from all other coffee ratios tested.

Additionally, 80% ripe ratio showed significant difference between 60% ripe but not 70% ripe and 70% ripe showed no difference between 60% ripe (Appendix IV.)

At the highland site in Gedeb, Anova tests identified several significant differences between various cup attributes including Aroma (f(4, 232) = [5.462, p =0.0003), Flavor (f(4, 232) = [12.75], p = 2.11×10^{-9}), Aftertaste (f(4, 232) = [16.28], p = 8.96×10^{-12}), Acidity (f(4, 232) = [4.32], p = 0.002), Body (f(4, 232) = [4.53], p = 0.001), Sweetness (f(4, 232) = [3.091], p = 0.01), Balance (f(4, 232) = [4.93], p = 0.0008), Overall (f(4, 232) = [5.26], p =0.0004). Total Cup Score also showed a large significant difference (f(4, 232) = [40.9], p = 1.11×10^{-16}) between various cherry ratios.

Follow up Tukey's HSD analyses for the highland site cupping data again returned ambiguous results. With some attributes showing a difference between just a single ratio comparison while other attribute showed some delineation between high quality (i.e. 100% and 90% ripe ratios) and low quality (80% ripe ratios and below). Total Cup Score at the highland site showed a clear delineation between high quality (100% and 90% ripe ratios) and low quality (80%, 70% and 60% ripe ratios) but not between themselves. Low quality ratios were a bit ambiguous in their delineation. These results can be found in Appendix V below.

Conclusion

Our findings demonstrate that the quality of coffee cherries significantly impacts overall cup quality, with higher ratios of ripe cherries leading to notable improvements in total cup score. These results, however, varied with elevation, which needs to be accounted for when providing recommendations to wet mill owners and managers. It is important to note that while differences in some cup attributes were identified (Appendix I, II, and III), results were mixed across sites, making it challenging to isolate the impact of cherry deliveries on any given attribute. This variability likely stems from cupper bias and the small differences in the scores of specific attributes. Consequently, our focus is on the overall cup score.

Results at the lowland site in Dilla were less clear than at other sites, likely due to higher variances in the total cupping scores among different cherry ratios. This variability may be attributed to higher instances of pest damage in lowland coffee and the lower quality associated with low elevation farms. Despite these challenges, there was a perceived difference in the cup scores of different cherry ratio trial lots (Figure 07). Data suggests that wet mills should purchase cherries with a ratio of at least 80% red ripe cherries (Table 02) to achieve a 0.5-point increase in cup scores, provided quality post-harvest processing standards are maintained (Table 05).

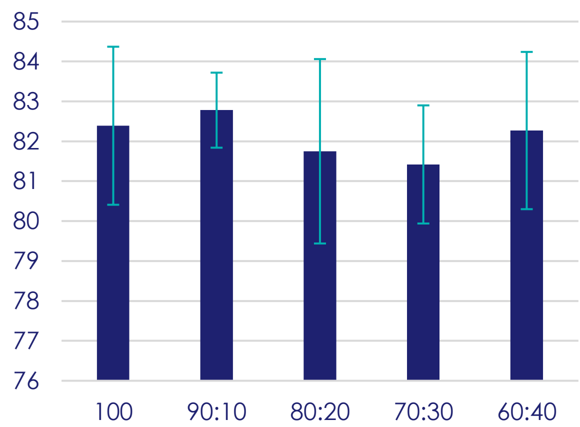

Figure 07. Average Total Cup Score of varying cherry ratios at the lowland (Dilla) site.

Table 02. Comparison of Total Cup Score between various cherry ratios at the lowland site in Dilla, Gedio.

Ratios	100	90:10	80:20	70:30	60:40
100	NA	No Sig. Diff.	No Sig. Diff.	Sig. Diff.	Sig. Diff.
90:10	No Sig. Diff.	NA	No Sig. Diff.	Sig. Diff.	No Sig. Diff.
80:20	No Sig. Diff.	No Sig. Diff.	NA	Sig. Diff.	No Sig. Diff.
70:30	Sig. Diff.	Sig. Diff.	Sig. Diff.	NA	No Sig. Diff.
60:40	Sig. Diff.	No Sig. Diff.	No Sig. Diff.	No Sig. Diff.	NA

Note: Cells highlighted in green show no significant difference in the ratios tested while orange denote a significant difference was detected.

At the mid-elevation site in Wonago, differences in total cupping scores across various cherry ratio lots followed a more linear trend, with cup scores descending as the ratio of ripe cherries decreased (Figure 08). The data suggests that wet mill managers at mid-elevation sites should aim to purchase the highest quality cherries possible (Table 03). For every 10% increase in the ratio of ripe cherries from a base of 70% red, there is an estimated 0.74-point increase in cup scores, assuming proper post-harvest processing practices are followed. This indicates that a wet mill purchasing 70% ripe cherries would score 1.5 points lower than one purchasing 90% ripe cherries, and 2.2 points lower than one purchasing 100% ripe cherries (Table 05).

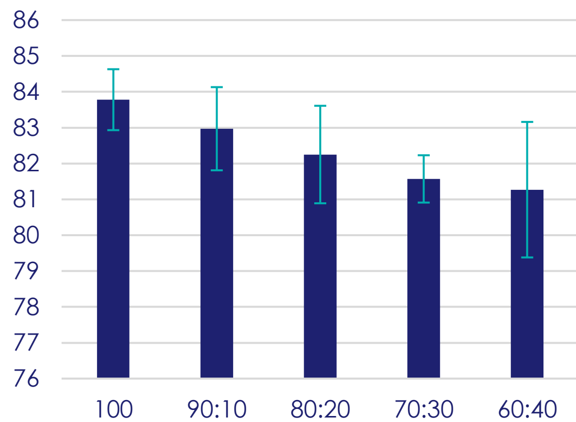

Figure 08. Average Total Cup Score of varying cherry ratios at the mid-elevation (Wonago) site.

Table 03. Comparison of Total Cup Score between various cherry ratios at the mid-elevation site in Wonago, Gedio.

Ratios	100	90:10	80:20	70:30	60:40
100	NA	Sig. Diff.	Sig. Diff.	Sig. Diff.	Sig. Diff.
90:10	Sig. Diff.	NA	Sig. Diff.	Sig. Diff.	Sig. Diff.
80:20	Sig. Diff.	Sig. Diff.	NA	No Sig. Diff.	Sig. Diff.
70:30	Sig. Diff.	Sig. Diff.	No Sig. Diff.	NA	No Sig. Diff.
60:40	Sig. Diff.	Sig. Diff.	Sig. Diff.	No Sig. Diff.	NA

Note: Cells highlighted in green show no significant difference in the ratios tested while orange denote a significant difference was detected.

At the highland site in Gedeb, significant differences in total cup score were identified (Figure 09). At this site, there was a significant difference in the total cup score at 90% ripe cherry and below (Table 04) meaning that wetmill managers should aim to be purchasing cherry of ≥ 90% ripe cherry which would results in an average cup score increase of 2.6 points as compared to cherry purchases of < 90% (Table 05).

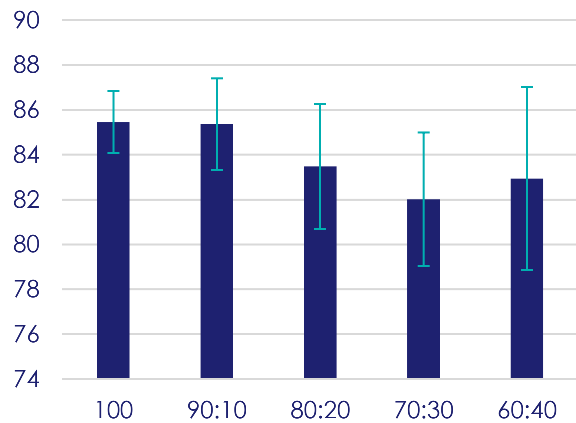

Figure 09. Average Total Cup Score of varying cherry ratios at the highland (Gedeb) site.

Table 04. Comparison of Total Cup Score between various cherry ratios at the mid-elevation site in Gedeb, Gedio.

Ratios	100	90:10	80:20	70:30	60:40
100	NA	No Sig. Diff.	Sig. Diff.	Sig. Diff.	Sig. Diff.
90:10	No Sig. Diff.	NA	Sig. Diff.	Sig. Diff.	Sig. Diff.
80:20	Sig. Diff.	Sig. Diff.	NA	Sig. Diff.	No Sig. Diff.
70:30	Sig. Diff.	Sig. Diff.	Sig. Diff.	NA	No Sig. Diff.
60:40	Sig. Diff.	Sig. Diff.	No Sig. Diff.	No Sig. Diff.	NA

Note: Cells highlighted in green show no significant difference in the ratios tested while orange denote a significant difference was detected.

Table 05. Average Total Cup Score of cherry ratios across trial sites.

	Lowland (Dilla)		Mid-elevation (Wonago)		Highland (Gedeb)	
Cherry Ratio	Mean	Var.	Mean	Var.	Mean	Var.
100	82.39	1.98	83.78	0.85	85.45	1.38
90:10	82.78	0.94	82.97	1.16	85.36	2.04
80:20	81.75	2.31	82.25	1.36	83.48	2.79
70:30	81.42	1.48	81.57	0.66	82.01	2.98
60:40	82.27	1.97	81.27	1.89	82.94	4.07

These results provide a data-driven rationale for implementing stricter cherry selection criteria. By prioritizing higher quality cherry deliveries, wet mills can enhance the quality of their coffee, improve market positioning, and increase profitability. Wet mill managers should adjust their purchasing strategies according to their operational elevations to set and achieve effective cherry delivery goals. This nuanced understanding of cherry impact on coffee quality offers a valuable framework for developing targeted strategies to enhance coffee production standards.

Summary of Key Findings:

- Higher ratios of ripe cherries consistently led to improved cup scores across all sites.
- The impact of cherry quality was most pronounced at higher elevations.
- Recommendations for cherry selection should be tailored to the specific elevation and conditions of the wet mill.

Moving Forward

There are numerous variables to consider when conducting coffee experiments, some of which are beyond researchers' control unless in closed facilities. While our findings are strong, we urge caution when making any major sourcing or processing changes based on this data alone. Factors such as environmental conditions, seasonal variations, and processing practices can significantly influence results.

Regardless, improving cherry deliveries and its subsequent impact of coffee quality can very likely impact the profitability of wetmills. The degree of improvement is highly variable depending upon target markets, prices received, volumes produced, volumes contracted and much more. The Specialty coffee Transaction Guide (Figure 06) shows the differences in pricing paid for coffees as reported by coffee buyers. From this table it is evident that greater prices can be received from better quality coffees. Additionally, high quality coffees demonstrate a detachment from the highly volatile New York C market. This could mean more predictable and stable prices for wetmills producing higher volumes of quality coffee allowing them to better prepare business operation from year to year. This detachment does not appear to be present for 83-point or grade 2 coffees although they do receive a premium on top of the New York C price.

If we were to try to quantify the impact of proper cherry deliveries for wetmills, we could divide the difference in the average prices received for an 83-point coffee and an 87-point coffee price by the difference in cup points (4 points). This ***very*** roughly corresponds to a 68usc/lb increase in profit for every cup point. To put this into context, let's take the mid-elevation data where a 10% increase in ripe cherry deliveries corresponds to a 0.74 point increase in cup score. Multiplying that through by the price equivalent shows that for every 10% increase in ripe cherry delivery a wetmill could potentially see an increase of about 50usc/lb. ***Please note*** that this should be taken as a very ***rough*** estimate. In fact, pricing is extremely variable and based on many factors including destination market, roast profiles, customer preferences, customer bottom lines, international markets, post-harvest processing, and a plethora of other factors. For this reason, we ***strongly*** discourage that this interpretation be used to advise any wetmills and instead only focus on the impact of improved cherry deliveries on cup quality.

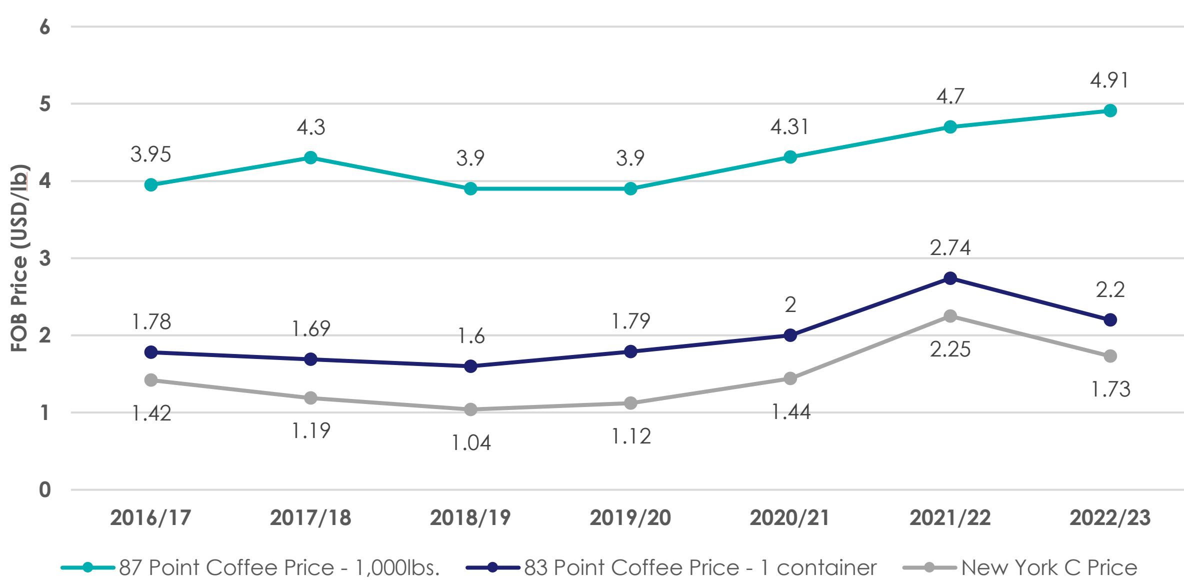

Figure 06. Specialty Coffee Transaction Guide Version 6.0. Released: January, 2024. www.tarnsactionguide.coffee.

Moving forward, it is recommended for stakeholders within the coffee production chain to consider these findings if they are thinking of implementing new quality improvement programs. Emphasizing quality in cherry selection processes can very likely serve as a cornerstone for quality improvement initiatives boosting the profitability of wetmills and driving the Gedio coffee industry towards higher standards of excellence and global competitiveness.

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Appendix I. ANOVA tests results for compiled cup attribute scores from the lowland site in Dilla.

SUMMARY					df between groups		4
					df within group		184
Groups	*Count*	*Sum*	*Average*	*Var.*	*F*	*p*	*F crit.*
Aroma/Fragrance							
100	39	304.50	7.808	0.153			
90:10	36	282.00	7.833	0.146			
80:20	37	288.50	7.797	0.340			
70:30	38	294.00	7.737	0.169			
60:40	39	301.50	7.731	0.228			
ANOVA Result					**0.373**	**0.823**	**2.421**
Flavor							
100	39	305.75	7.840	0.136			
90:10	36	282.75	7.854	0.119			
80:20	37	288.25	7.790	0.255			
70:30	38	293.00	7.710	0.228			
60:40	39	300.50	7.705	0.335			
ANOVA Result					**0.861**	**0.489**	**2.421**
Aftertaste							
100	39	309.75	7.942	0.186			
90:10	36	282.25	7.840	0.075			
80:20	37	283.75	7.669	0.222			
70:30	38	292.50	7.697	0.183			
60:40	39	303.25	7.776	0.213			
ANOVA Result					**2.638**	**0.035**	**2.421**
Acidity							
100	39	304.00	7.795	0.161			
90:10	36	286.25	7.951	0.085			
80:20	37	290.00	7.838	0.219			
70:30	38	295.75	7.783	0.254			
60:40	39	303.00	7.769	0.274			
ANOVA Result					**1.006**	**0.405**	**2.421**
Body							
100	39	307.00	7.872	0.164			
90:10	36	282.75	7.854	0.130			
80:20	37	290.00	7.838	0.251			
70:30	38	291.50	7.671	0.250			
60:40	39	309.50	7.936	0.190			
ANOVA Result					**1.882**	**0.115**	**2.421**
Sweetness							
100	39	304.00	7.795	0.101			
90:10	36	282.25	7.840	0.104			
80:20	37	284.00	7.676	0.180			
70:30	38	288.50	7.592	0.194			
60:40	39	305.25	7.827	0.349			
ANOVA Result					**2.340**	**0.056**	**2.421**

Balance							
100	36	281.25	7.812	0.130			
90:10	37	280.75	7.588	0.296			
80:20	38	294.50	7.750	0.260			
70:30	39	304.25	7.801	0.151			
60:40	39	303.50	7.782	0.116			
ANOVA Result					**1.650**	**0.164**	**2.421**
Overall							
100	36	282.75	7.854	0.191			
90:10	36	282.75	7.854	0.191			
80:20	37	285.50	7.716	0.268			
70:30	38	289.00	7.605	0.228			
60:40	39	305.25	7.827	0.280			
ANOVA Result					**1.689**	**0.154**	**2.421**
Uniformity							
100	39	386.00	9.897	0.200			
90:10	36	358.00	9.944	0.111			
80:20	37	366.00	9.892	0.210			
70:30	38	378.00	9.947	0.105			
60:40	39	388.00	9.949	0.102			
ANOVA Result					**0.213**	**0.931**	**2.421**
Clean Cup							
100	39	388.00	9.949	0.102			
90:10	36	360.00	10.000	0.000			
80:20	37	368.00	9.946	0.108			
70:30	38	377.50	9.934	0.164			
60:40	39	388.00	9.949	0.102			
ANOVA Result					**0.247**	**0.911**	**2.421**
Total Score							
100	39	3213.25	82.391	1.983			
90:10	36	2980.25	82.785	0.936			
80:20	37	3024.75	81.750	2.312			
70:30	38	3094.25	81.428	1.476			
60:40	39	3208.50	82.269	1.975			
ANOVA Result					**6.150**	**0.0001**	**2.421**

Appendix II. ANOVA tests results for cup scores from the mid-elevation site in Wonago.

SUMMARY					df between groups		4
					df within group		189
Groups	***Count***	***Sum***	***Average***	***Var.***	***F***	***p***	***F crit.***
Aroma/Fragrance							
100	36	287.25	7.98	0.144			
90:10	40	315.25	7.88	0.211			
80:20	39	303.75	7.79	0.262			
70:30	39	303.00	7.77	0.192			
60:40	40	300.00	7.5	0.234			
ANOVA Result					**5.934**	**0.0001**	**2.421**
Flavor							
100	36	288.75	8.02	0.169			
90:10	40	312.75	7.82	0.208			
80:20	39	303.00	7.77	0.169			
70:30	39	296.50	7.60	0.209			
60:40	40	308.25	7.71	0.288			
ANOVA Result					**4.285**	**0.002**	**2.421**
Aftertaste							
100	36	283.25	7.868	0.116			
90:10	40	317.00	7.925	0.122			
80:20	39	303.00	7.769	0.208			
70:30	39	300.25	7.699	0.172			
60:40	40	307.00	7.675	0.302			
ANOVA Result					**2.448**	**0.047**	**2.421**
Acidity							
100	36	285.00	7.917	0.111			
90:10	40	313.50	7.837	0.139			
80:20	39	305.00	7.820	0.246			
70:30	39	298.50	7.654	0.288			
60:40	40	308.25	7.706	0.220			
ANOVA Result					**2.103**	**0.082**	**2.421**
Body							
100	36	286.50	7.958	0.148			
90:10	40	315.50	7.887	0.109			
80:20	39	307.00	7.872	0.210			
70:30	39	301.25	7.724	0.236			
60:40	40	304.50	7.612	0.243			
ANOVA Result					**3.985**	**0.003**	**2.421**
Sweetness							
100	36	288.00	8.000	0.207			
90:10	40	314.00	7.850	0.198			
80:20	39	304.25	7.801	0.122			
70:30	39	299.75	7.686	0.150			
60:40	40	309.00	7.725	0.240			
ANOVA Result					**3.073**	**0.017**	**2.421**

Balance							
100	36	288.50	8.014	0.132			
90:10	40	315.25	7.88	0.160			
80:20	39	301.00	7.718	0.155			
70:30	39	301.00	7.718	0.231			
60:40	40	307.00	7.675	0.315			
ANOVA Result					**3.824**	**0.005**	**2.421**
Overall							
100	36	289.00	8.028	0.096			
90:10	40	317.75	7.944	0.165			
80:20	39	300.75	7.711	0.199			
70:30	39	301.00	7.718	0.181			
60:40	40	307.50	7.687	0.284			
ANOVA Result					**4.984**	**0.0007**	**2.421**
Uniformity							
100	36	360.00	10.00	0.00			
90:10	40	400.00	10.00	0.00			
80:20	39	390.00	10.00	0.00			
70:30	39	390.00	10.00	0.00			
60:40	40	400.00	10.00	0.00			
ANOVA Result					**NAN**	**NAN**	**2.421**
Clean Cup							
100	36	360.00	10.00	0.00			
90:10	40	398.00	9.95	0.10			
80:20	39	390.00	10.00	0.00			
70:30	39	390.00	10.00	0.00			
60:40	40	400.00	10.00	0.00			
ANOVA Result					**0.962**	**0.428**	**2.421**
Total Score							
100	36	3016.25	83.785	0.850			
90:10	40	3319.00	82.975	1.166			
80:20	39	3207.75	82.250	1.362			
70:30	39	3181.25	81.570	0.664			
60:40	40	3251.50	81.287	1.893			
ANOVA Result					**33.23**	**5.58×10^{-21}**	**2.421**

Appendix III. ANOVA tests results for cup scores from the highland site in Gedeb.

						df between groups	4
SUMMARY						df within group	232
Groups	***Count***	***Sum***	***Average***	***Var.***	***F***	***p***	***F crit.***
Aroma/Fragrance							
100	48	397.25	8.269	0.171			
90:10	47	385.25	8.197	0.361			
80:20	48	385.50	8.031	0.190			
70:30	43	336.00	7.814	0.226			
60:40	47	373.25	7.941	0.539			
ANOVA Result					**5.462**	**0.0003**	**2.421**
Flavor							
100	48	397.50	8.288	0.126			
90:10	47	388.25	8.261	0.242			
80:20	48	382.75	7.974	0.280			
70:30	43	333.00	7.744	0.300			
60:40	47	366.25	7.792	0.273			
ANOVA Result					**12.757**	**2.11×10^{-9}**	**2.421**
Aftertaste							
100	48	394.75	8.231	0.132			
90:10	47	386.25	8.218	0.222			
80:20	48	372.25	7.755	0.296			
70:30	43	327.75	7.622	0.224			
60:40	47	364.00	7.745	0.344			
ANOVA Result					**16.289**	**8.96×10^{-12}**	**2.421**
Acidity							
100	48	390.75	8.130	0.121			
90:10	48	381.25	7.943	0.312			
80:20	43	335.50	7.802	0.231			
70:30	47	369.50	7.862	0.315			
60:40	47	382.00	8.128	0.269			
ANOVA Result					**4.320**	**0.002**	**2.421**
Body							
100	48	389.25	8.096	0.162			
90:10	47	384.75	8.189	0.292			
80:20	48	382.25	7.963	0.250			
70:30	43	334.25	7.773	0.270			
60:40	47	369.75	7.867	0.459			
ANOVA Result					**4.530**	**0.001**	**2.421**
Sweetness							
100	48	387.25	8.086	0.181			
90:10	47	378.50	8.053	0.206			
80:20	48	382.75	7.974	0.261			
70:30	43	334.00	7.767	0.186			
60:40	47	370.75	7.888	0.415			
ANOVA Result					**3.091**	**0.016**	**2.421**

Balance							
100	48	387.75	8.091	0.149			
90:10	47	385.75	8.207	0.373			
80:20	48	378.00	7.875	0.263			
70:30	43	333.25	7.750	0.449			
60:40	47	372.00	7.915	0.332			
ANOVA Result					**4.935**	**0.0007**	**2.421**
Overall							
100	48	399.25	8.298	0.198			
90:10	47	381.00	8.106	0.200			
80:20	48	382.25	7.963	0.218			
70:30	43	339.00	7.884	0.218			
60:40	47	372.75	7.931	0.488			
ANOVA Result					**5.264**	**0.0004**	**2.421**
Uniformity							
100	48	478.00	9.961	0.077			
90:10	47	470.00	10.000	0.000			
80:20	48	480.00	10.000	0.000			
70:30	43	426.00	9.907	0.182			
60:40	47	470.00	10.000	0.000			
ANOVA Result					**1.492**	**0.205**	**2.421**
Clean Cup							
100	48	480.00	10.000	0.000			
90:10	47	470.00	10.000	0.000			
80:20	48	480.00	10.000	0.000			
70:30	43	428.00	9.953	0.093			
60:40	47	470.00	10.000	0.000			
ANOVA Result					**1.130**	**0.343**	**2.421**
Total Score							
100	48	4,101.75	85.452	1.382			
90:10	47	4,011.75	85.356	2.045			
80:20	48	4,007.00	83.479	2.795			
70:30	43	3,526.75	82.017	2.977			
60:40	47	3,898.25	82.945	4.071			
ANOVA Result					**40.902**	**1.11×10^{-16}**	**2.421**

Appendix IV. Post Hoc results for Tukey's HSD Test for multiple comparisons in the mid-elevation site in Wonago.

Cup Attribute	Tested Group Pairs	Mean Diff.	p-adj.	95% Confidence Interval		Significant Result
				Lower	Upper	
Aroma	100 v 90:10	-0.0979	0.8848	-0.3878	0.1919	No
	100 v 80:20	-0.1907	0.3759	-0.4823	0.1009	No
	100 v 70:30	-0.2099	0.2784	-0.5015	0.0817	No
	100 v 60:40	-0.4792	0.0001	-0.769	-0.1893	Yes
	90:10 v 80:20	0.0928	0.8966	-0.1911	0.3767	No
	90:10 v 70:30	0.112	0.8133	-0.1719	0.3959	No
	90:10 v 60:40	0.3812	0.0024	0.0991	0.6634	Yes
	80:20 v 70:30	0.0192	0.9997	-0.2665	0.305	No
	80:20 v 60:40	0.2885	0.0444	0.0045	0.5724	Yes
	70:30 v 60:40	0.2692	0.0723	-0.0147	0.5532	No
Flavor	100 v 90:10	-0.2021	0.3103	-0.492	0.0878	No
	100 v 80:20	-0.2516	0.1264	-0.5432	0.04	No
	100 v 70:30	-0.4183	0.001	-0.7099	-0.1266	Yes
	100 v 60:40	-0.3146	0.026	-0.6045	-0.0247	Yes
	90:10 v 80:20	0.0495	0.9891	-0.2344	0.3335	No
	90:10 v 70:30	0.2162	0.2257	-0.0678	0.5001	No
	90:10 v 60:40	0.1125	0.8073	-0.1697	0.3947	No
	80:20 v 70:30	0.1667	0.4951	-0.1191	0.4524	No
	80:20 v 60:40	0.063	0.9732	-0.221	0.3469	No
	70:30 v 60:40	-0.1037	0.8525	-0.3876	0.1803	No
Aftertaste	100 v 90:10	0.0569	0.9785	-0.2156	0.3295	No
	100 v 80:20	-0.0988	0.8583	-0.373	0.1753	No
	100 v 70:30	-0.1693	0.4357	-0.4435	0.1048	No
	100 v 60:40	-0.1931	0.2942	-0.4656	0.0795	No
	90:10 v 80:20	0.1558	0.4946	-0.1112	0.4227	No
	90:10 v 70:30	0.2263	0.1385	-0.0407	0.4932	No
	90:10 v 60:40	0.25	0.0752	-0.0152	0.5152	No
	80:20 v 70:30	0.0705	0.951	-0.1981	0.3391	No
	80:20 v 60:40	0.0942	0.8674	-0.1727	0.3612	No
	70:30 v 60:40	0.0237	0.9992	-0.2432	0.2907	No
Body	100 v 90:10	-0.0708	0.9546	-0.3465	0.2049	No
	100 v 80:20	-0.0865	0.9113	-0.3639	0.1908	No
	100 v 70:30	-0.234	0.1421	-0.5114	0.0434	No
	100 v 60:40	-0.3458	0.0061	-0.6215	-0.0701	Yes
	90:10 v 80:20	0.0157	0.9999	-0.2544	0.2858	No
	90:10 v 70:30	0.1631	0.4589	-0.1069	0.4332	No
	90:10 v 60:40	0.275	0.0416	0.0066	0.5434	Yes
	80:20 v 70:30	0.1474	0.5675	-0.1243	0.4192	No
	80:20 v 60:40	0.2593	0.0665	-0.0108	0.5294	No
	70:30 v 60:40	0.1119	0.7846	-0.1582	0.3819	No

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Sweetness	100 v 90:10	-0.15	0.5481	-0.4211	0.1211	No
	100 v 80:20	-0.1987	0.2667	-0.4714	0.074	No
	100 v 70:30	-0.3141	0.015	-0.5868	-0.0414	Yes
	100 v 60:40	-0.275	0.0449	-0.5461	-0.0039	Yes
	90:10 v 80:20	0.0487	0.9868	-0.2168	0.3142	No
	90:10 v 70:30	0.1641	0.4351	-0.1014	0.4296	No
	90:10 v 60:40	0.125	0.6885	-0.1388	0.3888	No
	80:20 v 70:30	0.1154	0.7575	-0.1518	0.3826	No
	80:20 v 60:40	0.0763	0.9329	-0.1892	0.3418	No
	70:30 v 60:40	-0.0391	0.9943	-0.3046	0.2264	No
Balance	100 v 90:10	-0.1326	0.6972	-0.4157	0.1504	No
	100 v 80:20	-0.2959	0.0372	-0.5807	-0.0112	Yes
	100 v 70:30	-0.2959	0.0372	-0.5807	-0.0112	Yes
	100 v 60:40	-0.3389	0.0101	-0.6219	-0.0559	Yes
	90:10 v 80:20	0.1633	0.485	-0.1139	0.4405	No
	90:10 v 70:30	0.1633	0.485	-0.1139	0.4405	No
	90:10 v 60:40	0.2062	0.241	-0.0692	0.4817	No
	80:20 v 70:30	0.0	1.0	-0.279	0.279	No
	80:20 v 60:40	0.0429	0.993	-0.2343	0.3202	No
	70:30 v 60:40	0.0429	0.993	-0.2343	0.3202	No
Overall	100 v 90:10	-0.084	0.9158	-0.3576	0.1896	No
	100 v 80:20	-0.3162	0.0154	-0.5915	-0.041	Yes
	100 v 70:30	-0.3098	0.0187	-0.5851	-0.0346	Yes
	100 v 60:40	-0.3403	0.0067	-0.6139	-0.0667	Yes
	90:10 v 80:20	0.2322	0.1236	-0.0358	0.5002	No
	90:10 v 70:30	-0.0064	1.0	-0.2761	0.2633	No
	90:10 v 60:40	0.2562	0.0656	-0.0101	0.5226	No
	80:20 v 70:30	0.2258	0.143	-0.0422	0.4938	No
	80:20 v 60:40	0.024	0.9992	-0.244	0.2921	No
	70:30 v 60:40	0.0304	0.9979	-0.2376	0.2985	No
Total Cup Score	100 v 90:10	-0.8097	0.0128	-1.5017	-0.1177	Yes
	100 v 80:20	-1.5347	0.0	-2.2309	-0.8385	Yes
	100 v 70:30	-2.2142	0.0	-2.9104	-1.518	Yes
	100 v 60:40	-2.4972	0.0	-3.1892	-1.8052	Yes
	90:10 v 80:20	0.725	0.0295	0.0471	1.4029	Yes
	90:10 v 70:30	1.4045	0.0	0.7266	2.0823	Yes
	90:10 v 60:40	1.6875	0.0	1.0139	2.3611	Yes
	80:20 v 70:30	0.6795	0.0514	-0.0026	1.3616	No
	80:20 v 60:40	0.9625	0.0012	0.2846	1.6404	Yes
	70:30 v 60:40	0.283	0.7796	-0.3948	0.9609	No

Appendix V. Post Hoc results for Tukey's HSD Test for multiple comparisons in the highland site in Gedeb.

Cup Attribute	Tested Group Pairs	Mean Diff.	p-adj.	95% Confidence Interval		Significant Result
				Lower	Upper	
Aroma	100 v 90:10	-0.0724	0.9643	-0.3733	0.2284	No
	100 v 80:20	-0.238	0.1884	-0.5372	0.0612	No
	100 v 70:30	-0.4553	0.0006	-0.7634	-0.1471	Yes
	100 v 60:40	-0.3277	0.0251	-0.6286	-0.0269	Yes
	90:10 v 80:20	0.1656	0.574	-0.1412	0.4723	No
	90:10 v 70:30	0.3829	0.0087	0.0674	0.6983	Yes
	90:10 v 60:40	0.2553	0.1563	-0.0531	0.5637	No
	80:20 v 70:30	0.2173	0.3185	-0.0966	0.5312	No
	80:20 v 60:40	0.0898	0.9291	-0.217	0.3965	No
	70:30 v 60:40	-0.1275	0.8004	-0.443	0.1879	No
Flavor	100 v 90:10	-0.0278	0.9986	-0.2992	0.2435	No
	100 v 80:20	-0.3145	0.0133	-0.5844	-0.0446	Yes
	100 v 70:30	-0.5443	0	-0.8222	-0.2664	Yes
	100 v 60:40	-0.4959	0	-0.7673	-0.2245	Yes
	90:10 v 80:20	0.2867	0.0381	0.01	0.5634	Yes
	90:10 v 70:30	0.5165	0	0.2319	0.801	Yes
	90:10 v 60:40	0.4681	0.0001	0.1899	0.7462	Yes
	80:20 v 70:30	0.2298	0.1719	-0.0533	0.5129	No
	80:20 v 60:40	0.1814	0.3746	-0.0953	0.4581	No
	70:30 v 60:40	-0.0484	0.9902	-0.3329	0.2362	No
Aftertaste	100 v 90:10	-0.0127	0.9999	-0.2848	0.2594	No
	100 v 80:20	-0.4756	0	-0.7462	-0.2049	Yes
	100 v 70:30	-0.6087	0	-0.8874	-0.33	Yes
	100 v 60:40	-0.4861	0	-0.7582	-0.214	Yes
	90:10 v 80:20	0.4629	0.0001	0.1854	0.7403	Yes
	90:10 v 70:30	0.596	0	0.3107	0.8813	Yes
	90:10 v 60:40	0.4734	0.0001	0.1945	0.7523	Yes
	80:20 v 70:30	0.1331	0.6981	-0.1508	0.417	No
	80:20 v 60:40	0.0105	1	-0.2669	0.288	No
	70:30 v 60:40	-0.1226	0.7621	-0.4079	0.1627	No
Acidity	100 v 90:10	-0.0021	1	-0.2773	0.273	No
	100 v 80:20	-0.1871	0.3312	-0.4608	0.0866	No
	100 v 70:30	-0.3275	0.0137	-0.6093	-0.0457	Yes
	100 v 60:40	-0.2681	0.0602	-0.5433	0.0071	No
	90:10 v 80:20	0.185	0.3689	-0.0956	0.4655	No
	90:10 v 70:30	0.3253	0.0183	0.0368	0.6139	Yes
	90:10 v 60:40	0.266	0.075	-0.0161	0.548	No
	80:20 v 70:30	0.1404	0.6637	-0.1467	0.4275	No
	80:20 v 60:40	0.081	0.9322	-0.1996	0.3616	No
	70:30 v 60:40	-0.0594	0.9798	-0.3479	0.2291	No

Body	100 v 90:10	0.09	0.9181	-0.2049	0.385	No
	100 v 80:20	-0.1326	0.7261	-0.4259	0.1607	No
	100 v 70:30	-0.3229	0.0295	-0.625	-0.0208	Yes
	100 v 60:40	-0.2291	0.2085	-0.5241	0.0658	No
	90:10 v 80:20	0.2226	0.2524	-0.0781	0.5233	No
	90:10 v 70:30	0.4129	0.0028	0.1037	0.7222	Yes
	90:10 v 60:40	0.3191	0.0328	0.0169	0.6214	Yes
	80:20 v 70:30	0.1903	0.4358	-0.1174	0.498	No
	80:20 v 60:40	0.0965	0.9032	-0.2042	0.3972	No
	70:30 v 60:40	-0.0938	0.9199	-0.403	0.2155	No
Sweetness	100 v 90:10	-0.0333	0.9974	-0.3098	0.2431	No
	100 v 80:20	-0.1126	0.7928	-0.3875	0.1624	No
	100 v 70:30	-0.3191	0.0184	-0.6022	-0.036	Yes
	100 v 60:40	-0.1982	0.2832	-0.4747	0.0782	No
	90:10 v 80:20	0.0792	0.9382	-0.2026	0.3611	No
	90:10 v 70:30	0.2857	0.0555	-0.0041	0.5756	No
	90:10 v 60:40	0.1649	0.4989	-0.1185	0.4482	No
	80:20 v 70:30	0.2065	0.2847	-0.0819	0.4949	No
	80:20 v 60:40	0.0857	0.9193	-0.1962	0.3675	No
	70:30 v 60:40	-0.1209	0.7816	-0.4107	0.169	No
Balance	100 v 90:10	0.1161	0.8363	-0.1907	0.4229	No
	100 v 80:20	-0.2163	0.2944	-0.5215	0.0888	No
	100 v 70:30	-0.3413	0.0257	-0.6556	-0.0271	Yes
	100 v 60:40	-0.1765	0.511	-0.4833	0.1304	No
	90:10 v 80:20	0.3324	0.031	0.0196	0.6453	Yes
	90:10 v 70:30	0.4574	0.0011	0.1357	0.7791	Yes
	90:10 v 60:40	0.2926	0.0818	-0.0219	0.607	No
	80:20 v 70:30	0.125	0.8199	-0.1951	0.4451	No
	80:20 v 60:40	-0.0399	0.9967	-0.3527	0.2729	No
	70:30 v 60:40	-0.1649	0.6224	-0.4866	0.1568	No
Overall	100 v 90:10	-0.3672	0.0042	-0.6515	-0.083	Yes
	100 v 80:20	-0.4144	0.0011	-0.7055	-0.1232	Yes
	100 v 70:30	-0.3345	0.0114	-0.6172	-0.0518	Yes
	100 v 60:40	-0.1917	0.3453	-0.476	0.0926	No
	90:10 v 80:20	0.1428	0.657	-0.147	0.4327	No
	90:10 v 70:30	0.2227	0.244	-0.0754	0.5207	No
	90:10 v 60:40	0.1755	0.4631	-0.1158	0.4669	No
	80:20 v 70:30	0.0798	0.9469	-0.2167	0.3764	No
	80:20 v 60:40	0.0327	0.998	-0.2571	0.3225	No
	70:30 v 60:40	-0.0471	0.9925	-0.3452	0.2509	No
Total Cup Score	100 v 90:10	-0.0955	0.9984	-0.9915	0.8005	No
	100 v 80:20	-1.9728	0	-2.8638	-1.0817	Yes
	100 v 70:30	-3.4345	0	-4.3521	-2.5169	Yes
	100 v 60:40	-2.5104	0	-3.4064	-1.6144	Yes
	90:10 v 80:20	1.8772	0	0.9637	2.7908	Yes
	90:10 v 70:30	3.3389	0	2.3995	4.2784	Yes
	90:10 v 60:40	2.4149	0	1.4966	3.3332	Yes
	80:20 v 70:30	1.4617	0.0002	0.527	2.3965	Yes
	80:20 v 60:40	0.5377	0.4873	-0.3759	1.4512	No
	70:30 v 60:40	-0.924	0.0563	-1.8635	0.0154	No