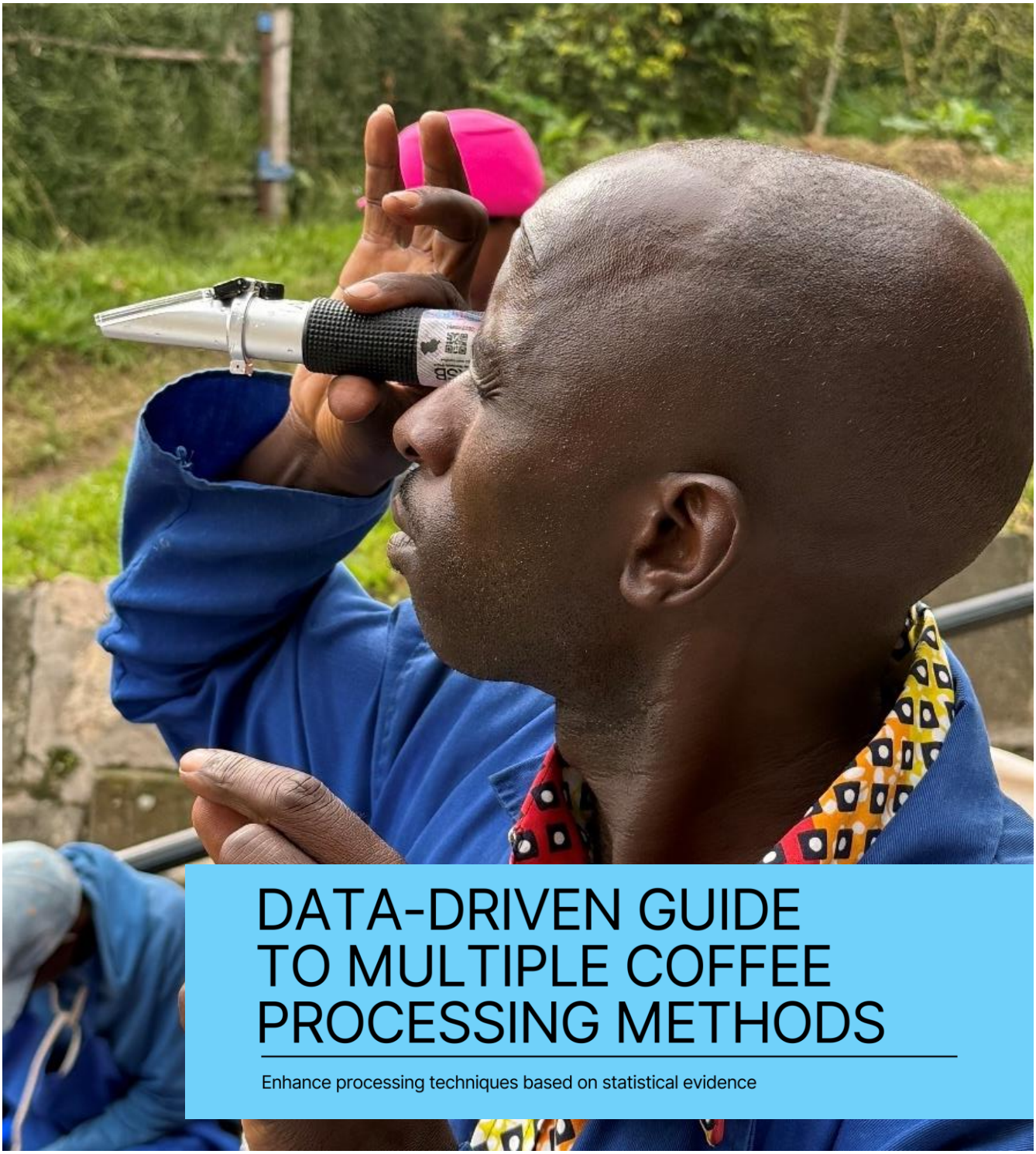


# DATA-DRIVEN GUIDE TO MULTIPLE COFFEE PROCESSING METHODS

Enhance processing techniques based on statistical evidence

JICA Rwanda

*Project for Strengthening Coffee Upgrade & Promotion in Rwanda Phase 2 (CUP2)*

Kigali, 2025

# Table of Contents

## Acknowledgements

This guide was prepared by Japan International Cooperation Agency (JICA) Rwanda under the project called *"Project for Strengthening Coffee Upgrade & Promotion in Rwanda Phase 2" (CUP2)*. Shinsaku Kuramochi, International Coffee Consultant of CUP2, led the drafting. The editorial team was led by Hiroaki Sonoda, Project Coordinator. Overall supervision was provided by Kosuke Nakajima, Chief Advisor of CUP2. The guide has benefited from substantial support from the three project target cooperatives namely ARABICA in Ruhango District, COAKAKI in Kirehe District, and KOPAKAKI in Karongi District, where several experiments were conducted. In addition, the experiment implementation team including Phoebe Kamuzima and Gisele Uwineza supported data collection.

# 1. Background

The international specialty coffee market has witnessed remarkable growth in recent years. This expansion is driven by evolving consumer preferences and a rising global demand for high-quality, differentiated coffee experiences. As competition intensifies, many emerging coffee-producing countries are actively investing in improving the quality and productivity of their specialty coffee. Differentiation strategies vary depending on **terroir, coffee variety, and post-harvest processing methods.** Leading producers such as Colombia and Costa Rica continue to innovate by applying scientific theory and data analysis to **refine and standardize their processing techniques**.

In Rwanda, most washing stations' operations rely on individual experience and intuition rather than structured, evidence-based methods. This often results in inconsistent quality and challenges in replicating successful outcomes.

To address this gap, JICA CUP2 has engaged an international consultant to introduce **a theoretical, data-driven approach to coffee processing**. The goal is to improve the quality and consistency of Rwandan coffee through enhanced post-harvest management, equipping processors with the tools and knowledge to remain competitive in the fast-evolving global market.

# 2. Purposes and main audience of this guide

## 2.1 Purposes

This guide aims to support coffee wet mill managers, processors, and cooperatives in enhancing their post-harvest processing practices through data-driven, evidence-based approaches. By shifting from reliance on individual experience to scientifically grounded methods, this guide seeks to:

1) **Promote** a clear understanding of proper processing procedures, grounded in both theory and practical application;
2) **Enable** effective management of coffee processing under erratic weather conditions, by applying adaptable principles and analytical tools;
3) **Assist** coffee processors in identifying operational challenges and developing context-specific, actionable solutions; and
4) **Encourage** development of original processing methods and recipes, with the aim of unlocking the full potential of Rwandan coffee to deliver exceptional flavor and quality in the global specialty coffee market.

This guide is **not meant to offer fixed recipes**, as processing factors vary depending on microclimates. Instead, it aims to encourage wet mill operators **to develop their own processing methods tailored** to their desired coffee quality and microclimates.

## 2.2 Main audience

This guide is intended for a broad range of stakeholders involved in the Rwandan coffee value chain, with a focus on those directly responsible for or supporting post-harvest processing. Key audiences include:

- **Washing station owners**, who make strategic decisions regarding processing methods, resource allocation, and investments;
- **Wet mill managers and operators**, who oversee daily processing activities and ensure quality control on the ground;
- **Cooperative leaders and members**, engaged in collective coffee processing, quality assurance, and marketing;
- **Post-harvest trainers and extension officers**, who provide technical assistance and capacity building to coffee processors;
- **Quality control and laboratory personnel**, responsible for monitoring, measuring, and maintaining coffee quality standards;
- **Government institutions and policymakers**, particularly those involved in setting national standards and developing strategies to enhance the competitiveness of Rwanda's coffee sector.

By addressing both practical and strategic elements of coffee processing, this guide

serves as a reference for improving quality, encouraging innovation, and supporting evidence-based policy development.

## 3. What is Processing?

**The final cup quality is shaped not only by the coffee variety and terroir but also by the coffee processing method**. While the variety and terroir are the unique combination of altitude, soil, climate, and ecosystem where coffee is grown, coffee processing refers to the series of steps that transform freshly harvested coffee cherries into green coffee beans ready for roasting. It is a critical phase in the coffee value chain, significantly influencing the final cup quality, flavor profile, and market value. Certain varieties may respond better to specific processing techniques, and terroir can amplify or moderate flavor attributes such as acidity, body, sweetness, and aroma.

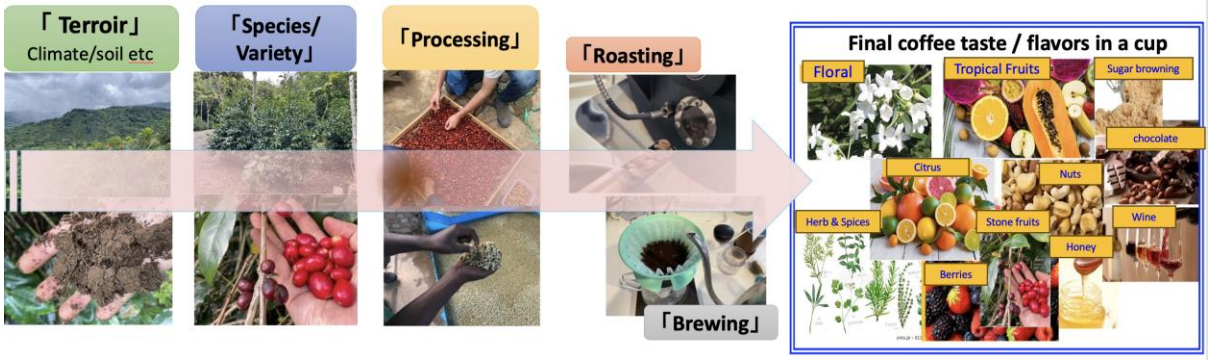



*Figure1: Main factors affecting cup quality*

Processing begins after harvesting and typically includes the following stages:


*Figure2: Processing stages*

1. **Harvesting** (pick well ripen cherries)
2. **Sorting** (remove defects and select ripen cherries),
3. **Pulping** (removal of the outer skin),
4. **Fermentation** (breaking down the mucilage layer),
5. **Washing** (removing the remaining mucilage)
6. **Drying** (applying heat to reduce the moisture from within the coffee bean), and
7. **Storage** (safely keeping and preserving the quality of the parchment)

There are several processing methods, the most common being **washed (wet process)**, **natural (dry process)**, and **honey (semi-washed)**. Each method interacts differently with the coffee bean, depending on the local climate, water availability, infrastructure, and producer preferences.


| | | | | | | |
|---|---|---|---|---|---|---|
| Natural | ✔ | | | | ✔ | ✔ |
| Washed | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ |
| Honey | ✔ | ✔ | | | ✔ | ✔ |

*Figure3. Each stage of processing at washing station*

In Rwanda, **most coffee is processed using the washed method** at wet mills. While this method has the potential to produce clean, high-quality coffees, the outcome depends

greatly on how well each stage is managed. Even slight variations in timing, temperature, and moisture can lead to significant differences in quality.

Thus, understanding coffee processing is not only about knowing the steps—it is about mastering them with precision, consistency, and adaptation to environmental conditions. **A data-driven approach** can help processors make informed decisions that lead to higher quality and better market access.

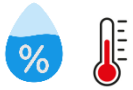
## 4. Key factors in processing

Successful coffee processing depends on the careful management of several key factors. These variables not only influence the efficiency of the post-harvest process but also determine the consistency, cleanliness, and flavor expression in the final cup. The following are the most critical elements to monitor and control:

*Table1: Key factors in processing*

| Category | Key Factor | Indicator | Why it's important | Impact on flavor |
|---|---|---|---|---|
| **Harvesting/ sorting**  | **Cherry Ripeness** | **Brix (sugar content)**  | **Ripe cherries** have the ideal balance of sugars and acidity, which are critical for fermentation to develop flavors in the cup. Underripe/overripe cherries can lead to defects. Ensure only fully ripe cherries are processed by **thorough sorting**. | High sugar levels promote fruitier, more aromatic notes. Overripe or underripe cherries cause imbalance or astringency in flavor. |
| | **Cleanliness of processing facility** | **Frequency of cleaning**  | **Hygiene** prevents contamination from molds, off-flavors, or pathogens that can ruin the coffee's quality and consistency. | Clean processes produce cleaner cups with fewer off-flavors or defects. |
| **Pulping**  | **Pulping machine calibration** | **Damaged beans, unpulped beans**  | **Inconsistent pulping (e.g., damaging beans)** can lead to uneven fermentation, affecting clarity. Calibration must be conducted before the harvesting season. | Well-calibrated pulpers help maintain uniformity and clean profiles. |
| | **Water Quality in floating** | **Visual observation, pH**   | Clean **water** is essential for proper processing. Poor water quality can lead to contamination, and improper amounts can disrupt fermentation or washing, impacting final coffee quality. | Dirty water introduces off-flavors and fermentation defects. |
| **Fermentation** | **Quality of fermentation** | **Brix, food for microbes**   | Microbes don't need just sugar but **an array of compounds.** Proper inoculation (e.g., yeast, bacteria or mold) can be a starter culture to improve flavors. | Different types of food for microbes can create different byproducts, leading to various range of flavors to develop in cup profile. |

| Category | Key Factor | Indicator | Why it's important | Impact on flavor |
|---|---|---|---|---|
|  | | **Temperature**  | Temperature affects **microbial activity** hence **fermentation time.** Too long or short fermentation can lead to undesirable sourness or other defects. | Ideal temperature yields vibrant and clean flavors. |
| | | **Fermentation Time**  | | Proper time enhances clarity and balance; too long can lead to over-fermentation. |
| | | **Oxygen**  | **Aerobic (with oxygen)** encourages growth of aerobic bacteria and some yeasts leading to slower and more controlled fermentation. **Anaerobic (without oxygen)** promotes lactic acid bacteria and anaerobic yeasts resulting in faster and more intense fermentation. | Aerobic fermentation can lead to cleaner, brighter profiles and higher acidity. Anaerobic leads to fruitier, more exotic flavors, often more winey or funky notes. |
| | | **pH**  | In addition to checking texture and smelling of parchments, monitoring pH levels can indicate progress and help avoid over-fermentation (e.g., for washed process, recommended range of pH shall be **between 4.2 and 4.5**). | Balanced pH helps develop clean acidity and structure. |
| **Washing/ Soaking**  | **Removing mucilage** | **Washing time**  | Ensure mucilage is fully removed otherwise over-fermentation occurs. | Incomplete washing may cause sour or uneven flavor. |

| Category | Key Factor | Indicator | Why it's important | Impact on flavor |
|---|---|---|---|---|
| **Drying**  | **Monitoring weather condition** | **Bean temperature**  | Bean temperature affects how quickly moisture is removed from the beans. (e.g., maximum 40°C for parchments, 35°C for dried cherries) | Extreme heat risks “baked” flavors; moderate drying preserves nuance. |
| | | **Humidity**  | Drying humidity affects how quickly moisture is removed from the beans. | Influences risk of mold and drying consistency. |
| | **Drying practices** | **Drying Time**  | **Rapid drying** can lead to **encapsulation** (damaging the bean structure), resulting in poor cup quality, while **too slow drying** can lead to mold development. It is required to (1) manage sunshine exposure by using a plastic sheet, (2) adjust thickness of parchment layer, (3) adjust frequency of mixing parchments. | Proper drying preserves sweetness and aroma; fast drying may flatten flavors. |
| | | **Bean moisture content**  | Uneven drying can result in defects such as musty or moldy flavors. The ideal moisture content is around **10-12%.** Uniformity of moisture content gives consistent quality coffee. | Improper moisture leads to moldy, flat, or sour profiles. |
| **Storage**  | **Storage management** | **Humidity and temperature**  | Humidity in the warehouse is preferably between **55-60%** and temperature are stable and ideally between **4–20°C** for parchment storage (above 60% increases risk of mold and reabsorption of moisture). | Undesirable conditions may lead to mold growth, musty flavors, and cupping defects. |

## 4.1 Understanding Fermentation and Its Importance

In coffee processing at washing stations, flavor development happens at multiple stages, but **the fermentation stage** is widely considered **the most critical for flavor development** in any processes.

- It's the stage where **microbial activity** (bacteria, fungi including yeasts) interacts with the mucilage sugars.
- These interactions break down compounds and release byproducts like acids, esters, and alcohols that directly influence **aroma and taste**.
- It can develop **clean and complex flavors** depending on how it's managed.

The process is influenced by factors such as **availability of oxygen, temperature, food for microbes (e.g., sugar content), duration and pH**. If not properly controlled, it can lead to inconsistent results or undesirable flavors. That is why the fermentation must be supported by good cherry selection, drying, and storage to reach its full potential. Monitoring key indicators, such as fermentation time and pH drop, allows for better control and repeatability, ultimately improving the cup quality.

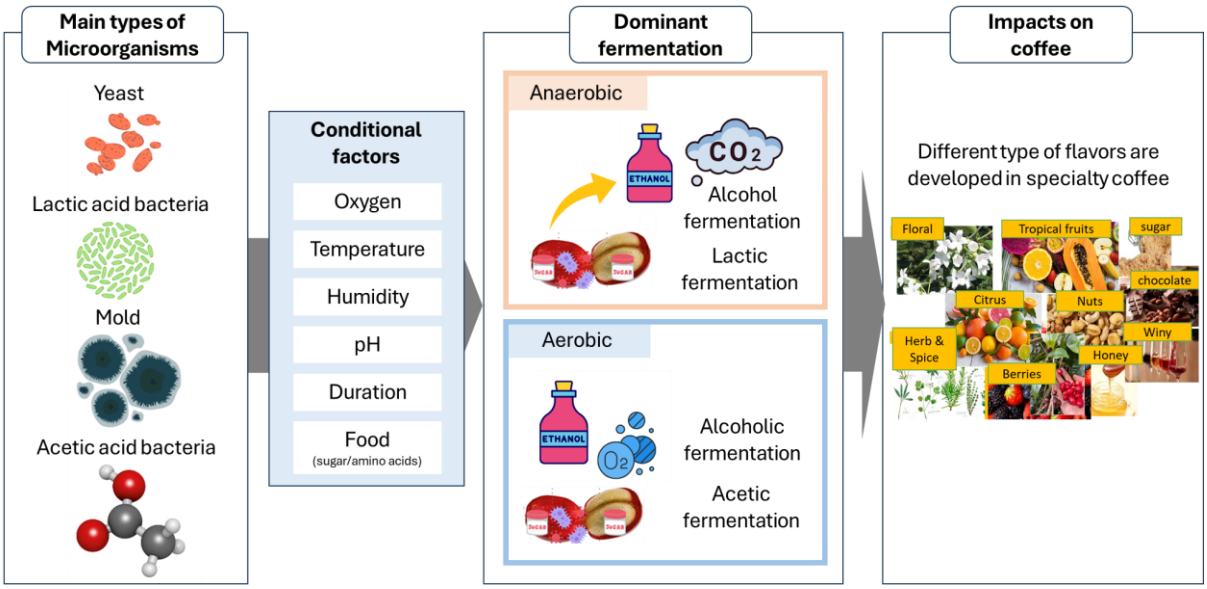



*Figure4. Coffee fermentation mechanism (image)*

**Typical fermentation is that microbes (usually bacteria or fungi) consume sugars and produce alcohol and organic acids.*

# 5. Introduction of traditional processing methods

According to CQI (2025), traditional processing methods are classified as follows:

*Table2: Clarification of processing methods*

| **Classification system** | | **Layers removed prior to full drying** | **Recommended techniques** |
|---|---|---|---|
| Whole fruit | | None | **Natural** |
| Pulped | Remaining mucilage left on parchment | Pulp | **Honey** |
| | (Most of) remaining mucilage is removed mechanically | Pulp & mucilage | Mechanically demucilageed (**semi-washed**) |
| | Remaining mucilage removed via biological processes | Pulp & mucilage | **Fully washed** |
| Hulled | | Pulp, mucilage, parchment | **Wet hulled*** |

** Also known as Giling Basah or Mandheling, is a modified washed process from Indonesia. In this method, parchment is hulled while still semi-wet (at 30–40% moisture) and then dried again to a final moisture level of around 11%.*

This section outlines the processing steps, fermentation mechanisms, flavor characteristics, key advantages, and associated challenges of each processing method.

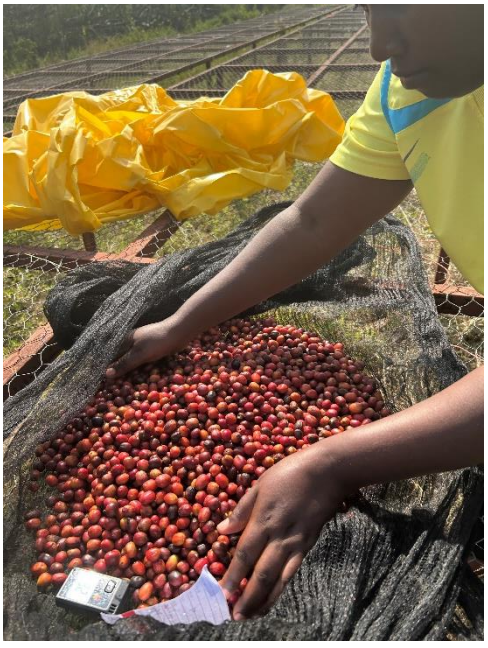
## 5.1 Natural process

*Also referred to as "Unwashed," "Dry Process," or "Sun-Dried".*

**Processing:** The Natural process is the oldest and most traditional method of coffee processing, used long before the development of the washed process. In this method, freshly harvested coffee cherries are dried whole—without pulping—until they reach the target moisture level (10-12%).

**Fermentation mechanism**:

- Fermentation occurs within the whole cherry, under the skin and mucilage.
- It is largely aerobic (exposed to air), especially on raised beds or patios.



- Microbial activity (yeasts, bacteria) is slower and more surface-based compared to washed processes.
- Yeasts are particularly active in the early phase, producing alcohols and esters.
- Lactic acid bacteria may also act in the inner pulp.
- Minimal acetic bacteria activity due to intact cherry and lower oxygen diffusion inside.

**Flavor characteristics:**

- Sweet, complex, and full-bodied, with a pronounced fruit-forward character (e.g., berries, tropical fruits, stone fruits etc)

**Key Advantages:**

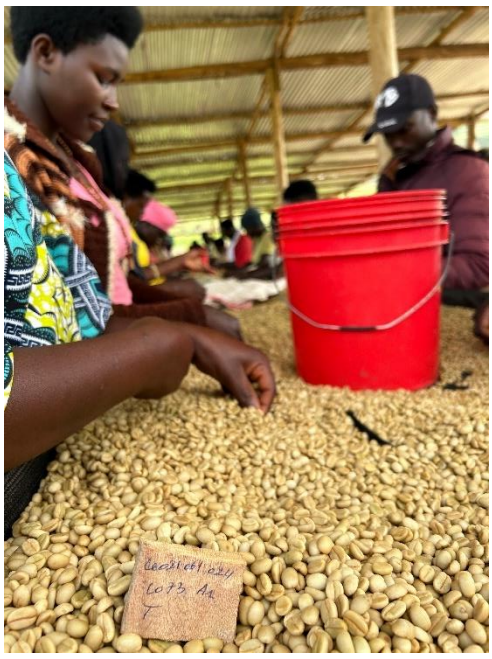
- Offers high potential for complex and distinctive flavor profiles.
- Requires no water, making it suitable for regions with limited water resources.
- Minimal equipment investment is needed.

**Key Challenges:**

- Defect removal is more difficult due to the intact fruit skin during drying.
- Drying takes longer and requires consistent monitoring to avoid over-fermentation or mold.

## 5.2 Washed process

*Also referred to as "the Wet Process ".*



**Processing:** It involves the pulping of fresh coffee cherries followed by the complete removal of mucilage before drying the beans in their parchment layer. Mucilage removal is typically achieved through fermentation—a method referred to as the Washed process. Alternatively, mechanical removal using a mucilage remover machine is known as Semi-Washed.

**Fermentation mechanism**:

- The washed process relies on microbial activity—primarily yeasts, lactic acid bacteria, and acetic acid bacteria—which enzymatically break down the mucilage.
- This microbial activity is influenced by factors such as temperature, water quality, and fermentation time, and can subtly affect the coffee's final flavor profile by contributing to its acidity, clarity, and aromatic complexity.

**Flavor characteristics:**

- Clean cup, bright acidity, well-defined fruity or floral flavors, balanced body, and enhanced sweetness.

**Key Advantages:**

- Reduced risk of defect contamination compared to the traditional Natural process
- Shorter drying times
- Greater uniformity in cup profile

**Key Challenges:**

- High water consumption
- Potential for overfermentation
- Less distinctive flavor compared to the Natural process
- Significant initial investment in equipment

## 5.3 Honey process

*Also referred to as "**Pulped Natural**".*

**Processing:** It involves pulping fresh coffee cherries and then drying the beans with some or all of the mucilage still attached. Originally developed in Brazil to achieve a more distinctive flavor profile, the method has since gained popularity in Costa Rica, where it aligns with environmental efforts to reduce water usage. In modern applications, producers further refine the process by adjusting the amount of retained mucilage, resulting in variations such as Yellow, Red, and Black Honey.

**Fermentation mechanism**:

- Honey Process occurs during drying, as beans retain mucilage on their surface.
- It involves yeasts breaking down mucilage sugars for fruity, sweet notes, lactic acid bacteria stabilizing fermentation and enhancing acidity, and acetic acid bacteria potentially causing overfermentation or off-flavors if not controlled.
- Unlike the Fully Washed process, fermentation is slower and aerobic, influenced by ambient temperature, humidity, and mucilage thickness.
- Careful drying control is essential to manage microbial growth and ensure desirable flavor development.

**Flavor characteristics:**

- Typically have enhanced sweetness, moderate acidity, fruit-forward flavors, a heavier body, and a balanced complexity between Washed and Natural profiles.

**Key benefits**:

- Lower water consumption compared to the Fully Washed process
- Reduced risk of defects compared to the Natural process
- Offers a unique and often fruit-forward flavor profile

**Key challenges**:

- Requires careful control of drying conditions, particularly during the initial stages, to avoid fermentation defects or uneven drying

## 5.4 Wet hull process (not very common)

*Known as "Giling Basah" or "Mandheling".*

**Processing:**

- A variation of the washed process used primarily in Sumatra, Indonesia.
- Parchment is dried then hulled when moisture content reaches 30-40%. After that, it is dried again to 10-12% moisture.

**Fermentation mechanism:**

- Fermentation occurs during the early stages when mucilage is removed, similar to traditional washed processing, but the moisture level is higher at hulling.
- The fermentation is generally shorter, and microbial activity is influenced by the humid environment during the drying process.

**Flavor characteristics:**

- Clean and bright cup, similar to washed coffees.
- Earthy, herbal, and spicy flavors are often present due to the unique environmental factors of Sumatra.

**Key benefits:**

- Faster drying time during the rainy season.
- Efficiency in processing despite adverse weather conditions.
- Offers cleaner flavors while still being resilient to climate challenges.

**Key challenges:**

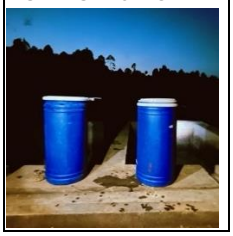
- Inconsistent drying conditions due to unpredictable weather, which can impact flavor consistency.
- Requires careful monitoring of moisture levels during drying to avoid over-fermentation or under-drying.

## 6. Current Trends in Coffee Fermentation Processing

Recently, many coffee producers around the world have been experimenting with various **fermentation techniques** to enhance flavor complexity and increase cupping scores. These innovative approaches aim to add value and command higher prices in the specialty coffee market.

Key fermentation methods include the following:

*Table3: Key fermentation methods*

| Fermentation Method | How to Do | Key control factor | Features in Taste | Requirements |
|---|---|---|---|---|
| **Anaerobic Fermentation**  | Seal coffee cherries or mucilage in an airtight tank to block **oxygen**. During fermentation, microorganisms perform **alcohol fermentation** in an oxygen-free environment, intensifying specific flavors. | **Oxygen** | Intense, fruity, sometimes funky. | Airtight tanks or GrainPro, temperature & pH control, careful monitoring of fermentation duration. |
| **Carbonic Maceration**  | Coffee cherries are placed in sealed tanks and carbon dioxide ($CO_2$) is introduced to create an **oxygen-free** environment. The $CO_2$ helps to bring out fruity, wine-like characteristics during fermentation. After fermentation, the cherries are processed as usual. | **Oxygen** | Clean, fruity, wine-like, sometimes floral. | $CO_2$ supply, airtight tanks or GrainPro, whole cherries, tight oxygen control, detailed monitoring. |
| **Yeast-Inoculated Fermentation**   | Specific **yeast** strains are added to coffee cherries or mucilage to steer the fermentation toward desired flavors. The selected yeast (e.g., Lalcafe products) helps control fermentation, ensuring the development of targeted flavors, such as tropical or floral notes. | **Micro-organisms (Yeast)** | Consistent, targeted flavors (e.g., tropical, floral). | Access to high-quality yeast cultures, controlled fermentation conditions, clean processing tanks. |
| **Nitro wash**  | Ripe coffee cherries are kept at 12°C to trigger embryonic stress. After pulping, beans undergo controlled fermentation in a bioreactor with **selected yeasts, bacteria, and fruit must** | **Temperature, oxygen, micro-organisms** | Unique sweet melon flavors | Airtight sealed tanks or GrainPro, Temperature Sensors, nitrogen gas injector |

| Fermentation Method | How to Do | Key control factor | Features in Taste | Requirements |
|---|---|---|---|---|
| | (likely melon-based), under **nitrogen** injection. | | | |
| **Infusion Techniques**  | Coffee is immersed in external materials such as **fruits, sugarcane or whisky barrels.** The coffee absorbs flavors from the materials over a controlled period. | **Food (sugar & amino acids)** | Unique, infused flavors depending on material. | Careful choice of infusion material, food-safe containers, hygiene, flavor balance, legal review. |

These methods can generate complex and distinctive profiles. However, it is critical to emphasize that **successful fermentation is not accidental**—it requires a clearly defined **goal**, **technical understanding**, and **sensory evaluation skills**. To determine which process to implement, multiple factors must be carefully considered and controlled. These include:

- Desired flavor/taste outcome
- Target consumer segment
- Concept and consistency of the processing method
- Cherry volume and maturity
- Fermentation time and progress (temperature and pH monitoring)
- Availability of equipment (e.g., airtight tanks)

## 6.1 Introduction of anaerobic processing method

On the contrary to the traditional processing methods, the anaerobic fermentation process requires oxygen-free environment to activate different microbes. It is increasingly used in coffee production to create unique and complex flavor profiles by fermenting coffee in an oxygen-free environment.

## 6.2 Anaerobic fermentation

**Processing:** This process involves fermenting coffee cherries in a sealed, **oxygen-free environment**, often using tanks where oxygen is either removed or replaced with carbon dioxide. This differs from traditional natural or washed processes, which ferment in open air, allowing for the development of unique and complex flavors.

**Fermentation mechanism**:

- Anaerobic fermentation promotes the growth of specific yeasts preferring non-oxygen environment (e.g., Saccharomyces cerevisiae) that ferment sugars to produce ethanol and flavor compounds, resulting in fruity, berry-like sweetness and wine-like aromas.
- Lactic acid bacteria contribute to mild acidity and clean cup characteristics, while acetic acid bacteria may also play a role but must be controlled to avoid vinegary off-flavors.
- The process encourages the production of volatile organic compounds (VOCs), such as esters, phenols, and acids, creating spicy, chocolatey, and complex flavor profiles, with selective microbial activity allowing producers to tailor flavors.

**Flavor characteristics:**

- Often feature bright acidity, berry-like sweetness, wine-like aromas, and sometimes spicy or chocolatey notes, creating a complex and distinctive flavor profile highly sought after in the specialty coffee market.

**Key benefits:**

- Allows for the creation of unique and complex flavor profiles, including bright acidity and fruity notes.

- When managed properly, the anaerobic process can produce consistent and high-quality outcomes in terms of flavor.
- Appeals to adventurous consumers seeking high-quality, innovative coffees beyond traditional profiles.

**Key challenges**:

- Requires special equipment (e.g., airtight tanks) and precise control over variables like temperature, pH, and fermentation time.
- Risk of over-fermentation if not carefully monitored, leading to undesirable off-flavors.

## 7. Importance of data-driven approach

As implied in the previous sections, **data tracking** - including reading **data on Brix (sugar content), pH, checking fermentation time, drying duration, moisture content, and ambient conditions** – is crucial. It enables processors to analyze results and replicate high-performing batches. A data-driven approach at this stage ensures consistency, supports traceability, and allows continuous improvement in quality over time.

Additionally, each processing step in every method has **a theoretical indicator as a reference point** according to Coffee Quality Institute (CQI), and identifying and standardizing the optimal approach by carefully adjusting these indicators helps maintain a high level of quality consistency. In this sense, managing the processing workflow while thoroughly reviewing the data becomes critically important.

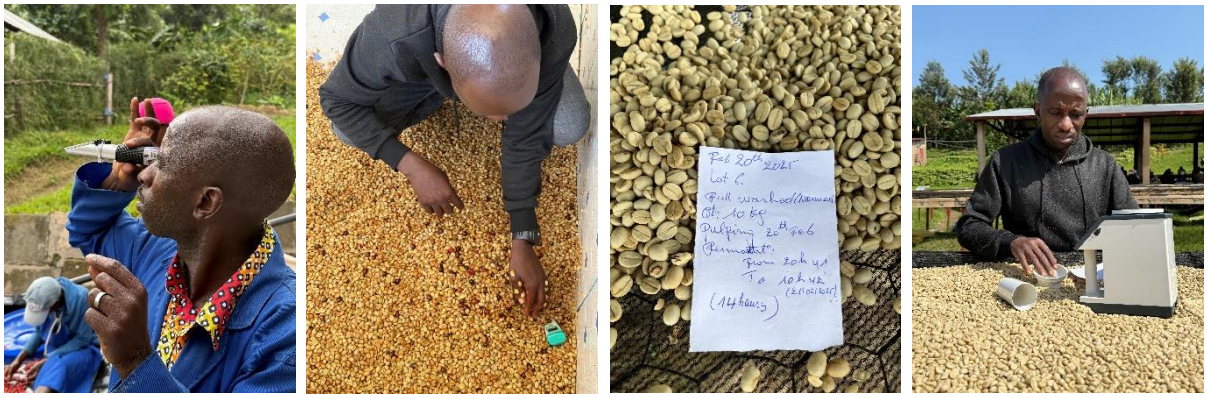


*Figure5: Data tracking throughout the process (Brix, pH, traceability sheet, moisture meter)*

*Table4: Example of target indicators by processing method* ****The figures are examples and are subject to local climate and cherry ripeness.***

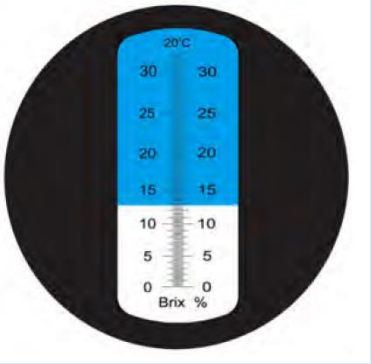
| Processing methods | Target Brix (sugar content) | Fermentation (h)* | pH after fermentation | Guideline drying days* | Thickness of layer (cm) / temperature (℃) / frequency of stirring* | Sunshine exposure* |
|---|---|---|---|---|---|---|
| **Washed**  | > 15.0 | 12 to 18 hours aerobic fermentation | 4.2-4.5 | 15-20 days | 8cm layer / less than 35℃ / stirring every hour by hand | -Open: 8:00-11:00 / 14:00-17:00<br>-Cover with black net: 11:00 - 14:00 / 17:00-8:00 |
| **Honey**  | > 15.0 | - | - | 20-25 days | -First 3 days for 8cm layer / less than 25˚C<br>-After, 4cm / less than 35℃ / stirring three times a day by hand | |
| **Natural**  | > 18.0 | - | - | 30-35 days | -Until 35% of moisture content, 8cm layer / less than 25˚C<br>-After, 4cm / less than 40℃ / stirring three times a day by hand | |
| **Anaerobic Honey**  | > 15.0 | 192 hours (8 days) anaerobic fermentation | 4.0 - 4.5 | 20-25 days | -After anaerobic fermentation, 4cm layer for 1 day under shade4 days<br>-After, 4cm with sundry / less than 35℃ / stirring three times a day by hand | |
| **Anaerobic Natural** | > 15.0 | 72 hours | 4.2-4.5 | 30-35 days | -After anaerobic fermentation, 4cm layer for 1 day under shade4 days | |

| Processing methods | Target Brix (sugar content) | Fermentation (h)* | pH after fermentation | Guideline drying days* | Thickness of layer (cm) / temperature (℃) / frequency of stirring* | Sunshine exposure* |
|---|---|---|---|---|---|---|
|  | | (3 days) anaerobic fermentation | | | -After, 4cm with sundry / less than 40℃ / stirring three times a day by hand | |

## Box 1: How to check sugar content?

**●Brix meter (Refractometer)**

Brix is a measure of soluble solids in a substance that is calibrated to grams sucrose per 100g of solution and thus provide a proxy of the sugars in cherries. Brix meter is a useful tool to check sugar and decide a processing method.

## Box 2: Case study in other countries: Enhance development of flavors

**Costa Rica**

In Costa Rica, the team set out to create the highest quality **"Classic Honey"** coffee for international competition, targeting sweetness, texture, cleanliness, and aftertaste. They studied **differences across farm plots, linking elevation and climate to cup profiles**, and carefully measured cherry ripeness using **Brix values**. During processing, only fully ripe cherries were selected, mucilage was preserved during pulping, and drying **temperature** was carefully controlled **under 35°C**. **Full data tracking** and multiple cuppings guided batch selection, leading to a top placement with a score above 90 points and providing insights to further improve production and processing strategies.

**Indonesia**

In Indonesia, the goal was to develop **a high-quality, "clean" coffee** that still expressed authentic Indonesian character. **Calibration sessions were held with local suppliers** to align on flavor strength versus true quality, aiming to balance clean cups, strong flavors, and **traditional "Giling Basah" (wet hulling) characteristics**. The key strategy was **"honey fermentation × Sumatra method."** After obtaining and evaluating type samples that matched the target profile, the team engaged buyers by proposing on-site processing experiences and exclusive product sourcing. As a result, they secured new partnerships and established long-term business relationships.

**Burundi**

In Burundi, the team experimented with a new fermentation process using 2 types of ***koji*** (aspergillus molds) in collaboration with **a Japanese *koji* producer**. By replicating optimal conditions for *koji* activity—**high oxygen, temperatures between 28–40°C, and 36-hour fermentation**—they tested both natural and honey processes against controls. Cupping evaluations confirmed clear flavor differences, notably creating unique **"umami"** profiles reminiscent of soy sauce or miso, showcasing the potential of *koji* fermentation in coffee.

## 8. Manual for each processing method (indicators be confirmed in June 2025)

**Objectives of this manual:**

- To shift from experience-based practices to data-driven process management.
- To improve coffee quality and processing consistency.
- To inform processors on what to use, how and when to monitor key indicators, and how to control the process accordingly.
- To provide the processing method manuals as reference, based on CQI's processing course for further adaptation to Rwanda's context.

**Key Considerations:**

- **There is no one-size-fits-all method**; environmental factors such as soil and climate have a significant impact on processing outcomes.
- **Processors are encouraged to conduct their own experiments** to identify optimal indicators for quality and consistency in their specific location.
- **The manual provides theoretical benchmarks and critical steps as a foundation**—not as rigid instructions.
- **Users should tailor the manual** and develop context-appropriate methods rather than follow the manual blindly.

**Manuals:**

1. Washed process (classic)
2. Washed process (24 hours aerobic fermentation of cherry) – Test processing
3. Honey process
4. Natural process
5. Anaerobic honey process
6. Anaerobic natural process

### 8.1.1 Washed process (classic)

**Overview**

- **Process:** Pulping → Dry fermentation → Washing& Grading → Drying
- **Key to Success:** Careful maturity selection, precise fermentation control, and gentle drying are crucial to preserve quality and avoid off-flavors.

---

**Step 1: Sorting Coffee Cherries**

**Color Sorting with Maturation Board:**

- **Purpose:** Classify cherries as "green," "immature," "ripe," and "overripe."
- **Target:** Set a Brix target for cherries, typically over Brix 15.0, with at least 98% ripe cherries.
- **Action:** Sort cherries by hand based on color using a Maturation Board (100 holes).

*Photo 1: Maturation board*

*Photo 2: Brix meter*

- **Note:** Measure and record the Brix of each group, then sort until the target is achieved.

**Water Sorting:**

- **Action:** After color sorting, place cherries in water to float off defective cherries.
- **Note:** Green cherries must be manually removed before this step.
- **Consideration:** Water sorting can also help remove less dense cherries, which may indicate under-ripeness.

*Photo 3: Floating cherries*

---

**Step 2: Pulping**

- **Purpose:** Efficiently remove the cherry skin while preserving the beans and removing most of the mucilage.
- **Action:** Use well-calibrated pulping machines that suit the cherry size and maturity. Adjust the gap between the cherry

*Photo 4: Checking pulped cherries*

and the disc to minimize unpulped or damaged beans.

- **Note:** Some machines have built-in water systems to help with mucilage removal during pulping.

---

**Step 3: Fermentation**

- **Purpose:** Fermentation helps remove the remaining mucilage and develop the desired flavor profile.
- **Action:** Adjust fermentation time to local climate and facility conditions. Monitor progress using texture (feel), smell, and pH.
- **Check Points:**
  - **Texture**: Rub parchment beans—mucilage should be gone.
  - **Smell:** Avoid sour or vinegary aroma.
  - **pH:** Should fall to **4.2 – 4.5** by the end of fermentation.

*Photo 5: Checking pH*

*Photo 6: Checking texture*

- **Fermentation methods:**
  - Dry Fermentation: Without water. Faster, bolder flavors, higher risk.
  - Wet Fermentation: With water. Slower, more consistent, lighter flavors.
  - Single Fermentation: Washed directly after fermenting.
  - Double Fermentation: Soaked after fermentation (commonly used in Kenya).

*Photo 7: Dry fermentation*

*Photo 8: Wet fermentation*

---

**Step 4: Washing & Grading**

- **Purpose:** Clean off mucilage fully and sort parchment by density.
- **Action:** Use clean water; the water starts brown due to pectin and becomes clear when properly washed. Grade beans by density (heavier = better quality).

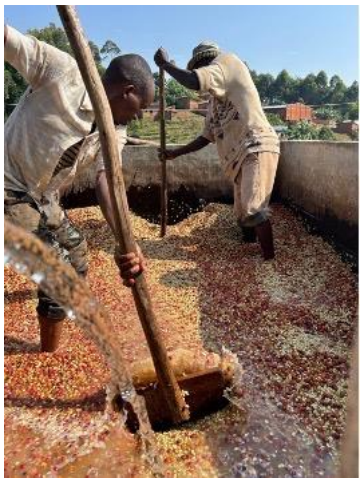


*Photo 9: Washing*

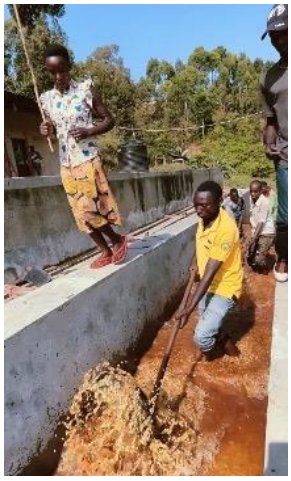


*Photo 10: Grading*

*Photo 11: Separation by grade*

---

**Step 5: Drying**

- **Purpose:** Reduce moisture for safe storage and long-term quality preservation.

**A) Pre-Drying (Skin Dry)**

- **Action**:
  - Hand-sort wet parchment under shade.
  - Identify and remove green or black-spotted beans only visible at this wet stage.

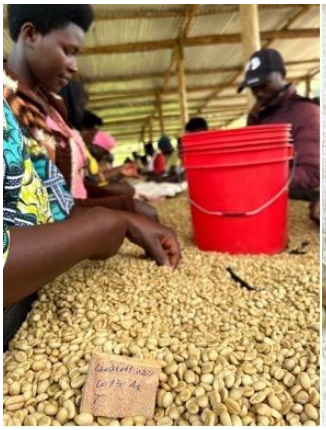


*Photo 12: Sorting*

*Photo 13: Sorted beans*

**B) Outdoor Drying**

**Best Practices:**

- **Duration: 15–20 days** depending on climate. Quick dry may result in off-flavor.
- **Bean Temperature**: Keep under 35°C to preserve embryo viability.
  - Use black nets for shading if needed.
  - Stir beans every ~30 minutes.
- **Ventilation**: Ensure airflow for uniform drying.
- **Moisture Target**: Finish at **10–12%** moisture.
  - Use moisture meter and "bite" test to confirm.
- **Note:**
  - In humid areas (e.g., Sumatra), traditional drying is difficult.

- Mechanical dryers like Guardiola can help when combined with patios, raised beds, or greenhouses.

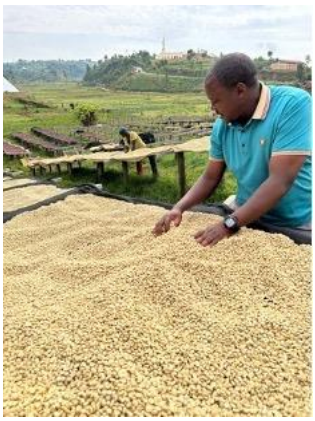




*Photo 14: Moisture meter* *Photo 15: Stirring* *Photo 16: Protection*

---

**Step 6: Storage**

- **Purpose**: Stabilize beans post-drying for export or milling.
- **Resting Period**: 2–4 months in stable conditions before shipment.
- **Ideal Conditions**:
  - Temperature: **15–23°C** (optimal ~18°C)
  - Humidity: **50–70%** (optimal ~60%)
  - Protect from: Moisture, insects, strong light, and excess oxygen
- **Monitoring**:
  - Check temperature and humidity regularly.
  - Decide whether to keep beans bagged or exposed based on storage readings.
- **Risks**:
  - **High moisture**: Risk of mold/fungi.
  - **Low moisture**: Beans crack during dry milling, losing quality and weight.




*Photo 17 & 18: Consistent temperature and humidity inside of warehouse* *Photo 19: Resting*

---

**Step 7: Wastewater Drainage**

- **Purpose**: Address environmental and social impacts of wastewater.
- **Action**:

- Filter and treat water to a safe level before discharge.
- Confirm that final water flow is environmentally safe.

*Photo 20: Example of 4 step-filtered water system*

### 8.1.2 Washed process (24 hours aerobic fermentation of cherry) – Test processing

**Overview**

- **Process:** Sorting Cherries → Aerobic Fermentation (24 hours) → Pulping → Fermentation → Washing & Grading → Drying → Storage → Drainage of Wasted Water
- **Key to Success:** Aerobic fermentation time, proper pulping, and drying stage management to preserve coffee quality and add desirable flavors.

---

**Step 1: Sorting Coffee Cherries**

**Color Sorting with Maturation Board:**

- **Purpose:** Classify cherries as "immature," "ripe," and "overripe."
- **Target:** Set a Brix target for cherries, typically over Brix 18, with at least 98% ripe cherries.
- **Action:** Sort cherries by hand based on color using a Maturation Board (100 holes).

*Photo 21: Maturation board*

*Photo 22: Brix meter*

- **Process:** Measure and record the Brix of each group, then sort until the target is achieved.

**Water Sorting:**

- **Action:** After color sorting, place cherries in a water tank to float off defective cherries.
- **Note:** Green cherries must be manually removed before this step.
- **Consideration:** Some pulping machines now combine floating systems for additional sorting.

*Photo 23: Floating cherry*

---

**Step 2: Aerobic Fermentation (with cherries)**

- **Purpose:** Add specific flavor by aerobic fermentation (24 hours) before pulping. The fermentation time should be adjusted based on the site's conditions.
- **Action:**
    - Place sorted cherries in plastic bags under a roof at the washing station.
    - Wait for 12, 18, or 24 hours (Recommended to experiment with different times to find optimal conditions based on coffee quality, site regulations, and staff availability).
    - Monitor the fermentation process by checking the smell and pH (avoiding sour/vinegar-like aromas).
    - Record pH and use the results to establish site-specific fermentation criteria.
- **Note:** Over-fermentation leads to undesirable flavors, so careful monitoring is essential.

*Photo 24: Aerobic fermentation*

*Photo 25: pH meter*

---

**Step 3: Pulping**

- **Purpose:** Efficiently depulp cherries without damaging the beans.
- **Action:** Use pulping machines suitable for removing the pulp without affecting the beans' quality.
    - Adjust the balance between the cherry and the disc to avoid

*Photo 26: Pulping machine*

unpulped cherries or damage to beans.
    - Consider the maturity of cherries, as it affects the accuracy of the pulping process.
- **Note:** Some pulpers may not be suitable for the Honey process as they use less water during pulping.

*Photo 27: Checking pulped cherry*

---

**Step 4: Fermentation (with parchments)**

- **Purpose:** Remove the mucilage completely without over-fermentation. It typically shortens the required fermentation time due to the 1st aerobic fermentation activity.
- **Action:** Set the fermentation time based on local conditions, such as climate and facility capacity.
    - **Check fermentation completion:**
        - Texture: Rub beans to check if mucilage is removed.
        - Smell: Ensure the fermentation is not overdone (avoid sour or off smells).
        - pH: Aim for a pH of around **4.2 to 4.5** when the fermentation is finished.

*Photo 28: Checking pH*

*Photo 28: Checking texture*

- ***Supplement information: Fermentation Types***
    - **Dry Fermentation:** Faster, stronger flavor but higher risk of over-fermentation.
    - **Wet Fermentation:** Longer, more consistent quality but weaker flavor.
    - **Single Fermentation:** Immediate washing after fermentation.
    - **Double Fermentation:** Soaking after fermentation (common in Kenya).

*Photo 29: Dry fermentation*

*Photo 30: Wet fermentation*

---

**Step 5: Washing & Grading**

- **Purpose:** Wash off remaining mucilage and grade parchment by density.
- **Action:** Use clean water to wash out all mucilage. Initially, the water will be brown due to the pectin in the mucilage; it will become clearer as the washing process progresses.
- **Grading:** After washing, grade the beans by density to separate higher-quality beans from the lower ones.

*Photo 31: Washing*

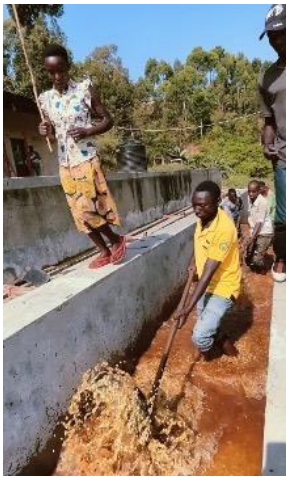


*Photo 32: Grading*

*Photo 33: Separation by grade*

---

**Step 6: Drying**

- **Purpose:** Reduce moisture content and prepare beans for proper storage.

**A) Pre-Drying (Skin Dry):**

- **Action:** Sort parchment by hand under a roof after grading to remove lower-quality beans like

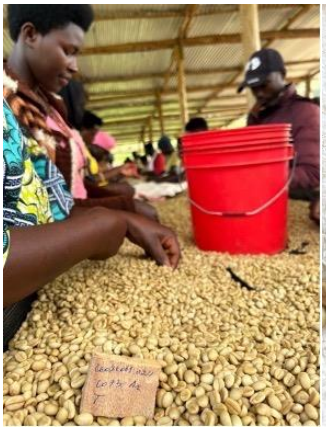


*Photo 34: Sorting*

*Photo 35: Sorted beans*

green or black-spotted ones.

**B) Drying Outside:**

- **Duration:** Typically **15-20 days**, but may vary based on conditions.
- **Bean Temperature:** Keep bean temperature under 35°C to prevent embryo damage.
- **Ventilation:** Ensure proper airflow to maintain consistent moisture levels.
- **Site Conditions:** Adjust drying methods based on facility and weather conditions.
- **Final Moisture Content:** Aim for **10-12%** moisture; check with moisture testers and bite tests for consistency.

- **Example:** In humid regions (e.g., Sumatra), use drying machines like the "Guardiola" in combination with traditional methods (Patio, African bed, Greenhouse) to deal with erratic weather.

*Photo 36: Moisture meter*

*Photo 37: Stirring*

*Photo 38: Covering parchment*

---

**Step 7: Storage**

- **Resting Time:** Allow beans to rest for 2–4 months post-drying.
- **Storage Conditions:**
  - **Temperature: 15-23°C** (optimal around 18°C).
  - **Humidity: 50-70%** (optimal around 60%).
  - **Avoid:** Water, insects, strong light, and oxygen after resting.
- **Moisture Control:** Keep moisture levels between **10-12%.** If moisture increases, risk of mold; if it decreases, beans may break during milling, affecting quality and profitability.
- **Monitoring:** Regularly check temperature and humidity to decide if beans should be kept in bags or remain open to airflow.


*Photo 39 & 40: Consistent temperature and humidity inside of warehouse* *Photo 41: Resting*

---

**Step 8: Drainage of Wasted Water / Fully Washed Process**

- **Purpose:** Treat wasted water after the washing process to address environmental and social issues.
- **Action:** Filter the wastewater until it reaches a safe level for both environmental and human health.
    - **Note:** Ensure the final disposal of the treated water is safe and environmentally responsible.

*Photo 42: Example of 4 step-filtered water system*

## 8.2 Honey process

**Overview**

- **Process:** Pulping → Drying with Mucilage
- **Key to Success:** Proper management of mucilage (sugar/Brix content) and drying conditions.
- **Honey Process Types and Drying Conditions**: Definition of honey processes varies from one country to another. For your reference, the following is an example of various honey processes.

| Type | Mucilage Content | Drying Temperature | Drying Duration |
|---|---|---|---|
| Red Honey | Almost 100% | 21–28°C | 15-20 days, sun-dried |
| Black Honey | Almost 100% | Over 28°C | 22–30 days, sun-dried with plastic sheet cover; results in darker color |
| Gold Honey | About 70% | Less than 21°C | 20-25 days, sun-dried |
| Yellow Honey | About 50% | Not specified | 15-20 days, sun-dried |
| White Honey | Less than 25% | Not specified | 15-20 days, sun-dried |

*Photo 43: Drying parchment with mucilage*


*Photo 44: Different types of honey process*

---

**Step 1: Sorting Coffee Cherries**

**Color Sorting with Maturation Board:**

- **Purpose:** Classify cherries as "immature," "ripe," and "overripe."
- **Target:** Set a Brix target for the cherries, typically over Brix 18, with at least 98% ripe cherries.
- **Action:** Sort cherries by hand based on color using a Maturation Board (100 holes).

*Photo 45: Maturation board*

*Photo 46: Brix meter*

- **Process:** Measure and record the Brix of each group, then sort until the target is achieved.

**Water Sorting:**

- **Action:** After color sorting, place cherries in water to float off defective cherries.
- **Note:** Green cherries must be manually removed before this step.
- **Consideration:** *Water sorting may be skipped in case of excessive rain damage to preserve sugar (mucilage).*

*Photo 47: Floating cherry*

---

**Step 2: Pulping**

- **Goal:** Efficiently remove the cherry skin without damaging the beans while retaining as much mucilage as possible.
- **Action:** Pulp cherries using a pulping machine that balances the space between the cherry and the machine's disc. Adjust the spacing to avoid over-pulping (which could damage beans) and under-pulping (which could leave excess skin).
- **Important:** The machine should ideally use less water to retain the mucilage for the Honey process.
- **Check:** Inspect the parchment after pulping to ensure minimal mucilage loss.

*Photo 48: Pulping*

*Photo 49: Checking parchment after pulping*

---

**Step 3: Drying (Honey Process Specific)**

- **Purpose:** Develop flavors and reduce moisture while keeping the mucilage intact for flavor development.

**Drying Principles:**

a) *First Few Days:*

- **Action:** Lay cherries on drying beds in a thick layer **(8-10 cm)** to allow fermentation to begin naturally.
- **Note:** Avoid stirring too frequently; cover cherries with plastic at night.
- **Sunshine:** Ensure strong sunlight but avoid overheating.

*Photo 50: First day of drying*

b) *Drying Duration:*

- **Time:** Drying typically takes **20-25 days** depending on the climate and the amount of mucilage.

c) *Temperature Control:*

- **Action:** Keep the bean temperature **below 35°C** to prevent over-drying and maintain quality.
- **Tip:** Use black nets to block intense sunlight if necessary.

d) *Ventilation:*

- **Action:** Raised beds are ideal for promoting airflow from both top and bottom, helping with uniform drying.

*Photo 51: After 1 week of drying*

e) *Site-Specific Adjustments:*

- **Consideration:** Tailor drying methods to the local climate (facilities, equipment, weather).
- **Monitoring:** Use thermometers and moisture testers to make real-time adjustments.

f) *Drying Completion:*

- **Final Moisture:** Target moisture content should be between **10-12%.**
- **Check:** Use moisture meters and tactile tests (e.g., bite test) to assess dryness.

*Photo 52: Moisture meter*

*Photo 53: Covering parchment*

---

**Step 4: Storage**

- **Post-Drying Resting:** Store beans for 2-4 months in proper conditions to stabilize flavors.
- **Ideal Storage Conditions:**
  - Temperature: **15-23°C** (optimal around 18°C)

    - Humidity: **50-70%** (optimal around 60%)
- **Monitoring:** Regularly check moisture content, ensuring it remains between **10-12%** to avoid mold and prevent drying issues during milling.
- **Storage Considerations:** Make adjustments based on temperature and humidity in the storage area.


*Photo 54 & 55: Consistent temperature and humidity inside of warehouse*

*Photo 56: Resting*

## 8.3 Natural process

**Overview**

- **Process:** Sorting → Drying Whole Cherries
- **Key to Success:** Proper sorting of cherries, managing sugar content (Brix), and drying conditions.

---

**Step 1: Sorting Coffee Cherries**

**Color Sorting with Maturation Board:**

- **Purpose:** Classify cherries as "green," "immature," "ripe," and "overripe."
- **Target:** Set a Brix target for the cherries, typically over Brix 18, with at least 98% ripe cherries.
- **Action:** Sort cherries by hand based on color using a Maturation Board (100 holes).

*Photo 57: Maturation board*

*Photo 58: Brix meter*

- **Process:** Measure and record the Brix of each group, then sort until the target is achieved.

**Water Sorting:**

- **Action:** After color sorting, place cherries in water to float off defective cherries.
- **Note:** Green cherries must be manually removed before this step.
- **Consideration:** Water sorting may be skipped in case of excessive rain damage to preserve sugar (mucilage).

*Photo 59: Floating cherry*

---

**Step 2: Drying**

- **Action:** Dry cherries whole, with the skin and pulp intact, on raised beds or patios.
- **Initial Days:** Lay cherries in thick layers **(8-10 cm).** Do not stir to allow natural fermentation during drying.
- **Ventilation:** Ensure good airflow with raised beds to promote even drying and

avoid mold growth.

*Photo 60: First day of drying*

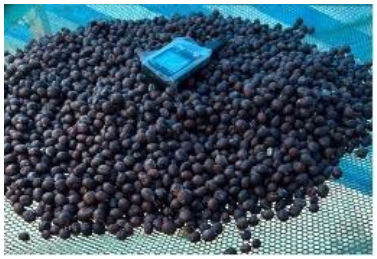


*Photo 61: After one week*

*Photo 62: Reducing layer*

- **Moisture Level:** Stir cherries regularly after moisture content reaches about 30%, but avoid over-stirring. Stir at least 2-3 times daily during drying.
- **Drying Time:** Typically **30-35 days**.
- **Temperature Control:** Keep beans below 40°C during the drying process to preserve flavor and avoid over-drying.

*Photo 63: Moisture meter*

*Photo 64: Covering parchment*

---

**Step 3: Storage**

- **Post-Drying Resting:** Store beans for 2-4 months in proper conditions to ensure stabilization of flavors.
- **Ideal Storage Conditions:**
  - Temperature: **15-23°C** (optimal around 18°C)
  - Humidity: **50-70%** (optimal around 60%)
- **Monitoring:** Ensure moisture content stays at 10-12% to prevent mold and dryness issues.
- **Storage Considerations:** Regularly check temperature and humidity in the storage area.


*Photo 65 & 66: Consistent temperature and humidity inside of warehouse*

*Photo 67: Resting*

## 8.4 Anaerobic honey process

**Overview**

- **Process:** Pulping → Anaerobic Fermentation → Drying with mucilage
- **Key to Success:** Proper fermentation conditions and managing the sugar/Brix content.

---

**Step 1: Sorting Coffee Cherries**

**Color Sorting with Maturation Board:**

- **Purpose:** Identify "green," "immature," "ripe," and "overripe" cherries.
- **Target:** Set a Brix target for the cherries, typically over Brix 18, with at least 98% ripe cherries.
- **Action:** Sort cherries by hand based on color using a Maturation Board (100 holes).

*Photo 68: Maturation board*

*Photo 69: Brix meter*

- **Process:** Measure Brix for each group and sort until target is achieved.

**Water Sorting:**

- **Action:** After color sorting, place cherries in water to remove defective cherries.
- **Note:** Green cherries can't be sorted out in this step, so they must be manually removed earlier.
- **Consideration:** Skipping water sorting might be necessary if a lot of cherries are rain-damaged to prevent sugar loss.

*Photo 70: Floating cherry*

---

**Step 2: Pulping**

- **Action:** Remove the skin of the cherries while retaining as much mucilage as possible.
- **Equipment:** Pulping machines may vary. Ensure the spacing of the pulper is optimal to avoid damaging the beans or leaving unpulped cherries.
- **Goal:** Keep mucilage intact for the Honey process to develop the right flavor.

*Photo 71: Pulping*

- **Consideration:** Some pulpers may use excess water, which is unsuitable for the Anaerobic Honey process.


*Photo 72: Checking parchment after pulping*

---

**Step 3: Anaerobic Fermentation**

- **Action:** Place pulped cherries with mucilage into an airtight plastic tank or GrainPro bag.
- **Goal:** Achieve anaerobic (no oxygen) fermentation for flavor development. Aim for a pH of around **4.0 to 4.5** when the fermentation is finished.
- **Conditions:** Store under a roof where temperature and humidity are stable.
- **Fermentation Time: 192 hours (8 days)**. *Depending on temperature.
- **Monitoring:** Open bags/tanks to check and record pH during fermentation.

*Photo 73: Parchment with mucilage*


*Photo 74: Plastic tank and Grain Pro bag*

---

**Step 4: Drying**

- **Action:** Dry cherries on raised beds with **5-7 cm** thickness.
- **Initial Days:** Avoid stirring too frequently—3 times per day. Cover with plastic at night to protect from dew.
- **Ventilation:** Raised beds provide excellent airflow, ensuring uniform drying.
- **Moisture Level:** Stir frequently when moisture content reaches 20%.
- **Target Drying Time:** Typically **25-30 days.**

- **Final Moisture Content: 10-12%.**

*Photo 75: Moisture meter*

*Photo 76: Covering parchment*

---

**Step 5: Storage**

- **Post-Drying Resting:** Store beans for 2-4 months in appropriate conditions.
- **Ideal Storage Conditions:**
  - Temperature: **15-23°C** (optimal around 18°C)
  - Humidity: **50-70%** (optimal around 60%)
- **Monitoring:** Maintain moisture content at **10-12%** to prevent mold and drying issues.
- **Storage Considerations:** Regularly check temperature and humidity in the storage area.

*Photo 77 &78: Consistent temperature and humidity inside of warehouse*


*Photo 79: Resting*

## 8.5 Anaerobic natural process

**Overview**

- **Process:** Sorting Cherries → Anaerobic Fermentation → Drying
- **Key to Success:** Control of anaerobic fermentation conditions, amount of mucilage (sugar/Brix), and drying stage management.

---

**Step 1: Sorting Coffee Cherries**

**Color Sorting with Maturation Board:**

- **Purpose:** Classify cherries as "green," "immature," "ripe," and "overripe."
- **Target:** Set a Brix target for cherries, typically over Brix 18, with at least 98% ripe cherries.
- **Action:** Sort cherries by hand based on color using a Maturation Board (100 holes).

*Photo 80: Moisture board*

*Photo 81: Brix meter*

- **Process:** Measure and record the Brix of each group, then sort until the target is achieved.

**Water Sorting:**

- **Action:** After color sorting, place cherries in a water tank to float off defective cherries.
- **Note:** Green cherries must be manually removed before this step.
- **Consideration:** In this stage, unripe green cherries cannot be separated, so they must be thoroughly removed during the sorting stage.

*Photo 82: Floating cherry*

---

**Step 2: Anaerobic Fermentation**

- **Purpose:** Promote anaerobic fermentation to develop unique fruity flavors without oxygen. Aim for a pH of around **4.2 to 4.5** when the fermentation is finished.
- **Action:**
    - Place fully ripe cherries into sealed plastic tanks or GrainPro bags.
    - Store under a roof in a location with consistent temperature and humidity.
    - Wait for **72 hours (3 days)**.

- After 3 days, open the tank/bag and check the pH, recording the values.

- **Note:** Stainless steel tanks or tanks with agitators can also be used to control temperature and microbial activity, but here we focus on the anaerobic method.

*Photo 83: Anaerobic tank*

*Photo 84: Pet bottle to check gas*

---

**Step 3: Drying**

- **Purpose:** Develop specific fruity flavors and reduce moisture content for proper storage.
- **Principles:**
  - **First Few Days:** Start with a thicker layer **(5–8 cm)** of cherries to develop fermentation, slightly thicker than Classic Natural. Adjust the thickness depending on the remaining mucilage after anaerobic fermentation.
  - **Sunshine:** Strong sunlight is essential but avoid excessive heat.
- **Drying Duration:** Typically, **30–35 days**, but it can exceed 35 days depending on conditions.
- **Bean Temperature:** Keep the bean temperature below 40°C to avoid killing the embryo.
  - **Example:** Use black nets to protect from strong sun exposure.
- **Ventilation:** Raised beds are ideal for airflow from both top and bottom.

*Photo 85: First day of drying*

*Photo 86: Checking smell*

- **Site-Specific Conditions:** Factors like facility, equipment, and weather conditions must be considered in drying. Adjust the drying method based on these conditions.
    - **Tools:** Thermometers and moisture testers should be used to monitor drying conditions and adjust actions accordingly.
- **Drying Completion:**
    - Target final moisture content**: 10-12%.**
    - Use moisture testers to confirm and perform tactile checks (e.g., bite test for firmness).

*Photo 87: Moisture meter*

*Photo 88: Covering parchment*

- **Example:** In humid areas (e.g., Sumatra, Indonesia), the Natural process is not recommended due to the higher risk of mold.
- **Guardiola Dryer:** A drum-type drying machine can be used in conjunction with traditional drying methods like patio, raised bed, or greenhouse drying, especially in regions with erratic weather.

---

**Step 4: Storage**

- **Resting Time:** Allow the coffee beans to rest for 2–4 months after drying.
- **Ideal Storage Conditions:**
    - **Temperature: 15–23°C** (optimal around 18°C).
    - **Humidity: 50–70%** (optimal around 60%).
    - **Avoid:** Water, insects, strong light, and exposure to oxygen after resting.
- **Moisture Control:** Maintain moisture levels between **10-12%** to avoid mold and prevent damage during dry milling.
    - If moisture content exceeds 12%, the risk of mold and fungus increases.
    - If moisture content is too low, beans may break during milling, resulting in reduced quality and profit loss.

- **Monitoring:** Regularly check temperature and humidity in storage to determine whether beans should be kept in bags or remain open to airflow.


*Photo 89 &90: Consistent temperature and humidity inside of warehouse*

*Photo 91: Resting*

## Appendix 1: Example of time schedule for each processing method

As the drying period is subject to variations in climate and other local conditions, adjustments by each coffee washing station are required.

<table>
<tr><th>Day</th><th>1.1 Fully Washed / Dry fermentation</th><th>1.2 Fully Washed / Aerobic fermentation 24h + Dry fermentation</th><th>3. Classic Honey</th><th>4. Classic Natural</th><th>5. Anaerobic Honey</th><th>6. Natural Anaerobic</th></tr>
<tr><td rowspan="5">Day 1</td><td colspan="6">Picking cherry</td></tr>
<tr><td colspan="6">Continue sorting until cherries meet the target Brix and maturation rate (e.g., Brix >18, ≥98/100), verified using the maturation board.</td></tr>
<tr><td>Pulping cherry,<br>Dry Fermentation<br>(12-18 hours)</td><td rowspan="2">keeping cherry into the bag (don't close for aerobic fermentation for 24 hours)</td><td>Pulping cherry then move to pre drying under shade</td><td>Dry on bed with 8 cm layer keeping 25℃ under shade</td><td>Put into airtight tank or Grain pro tightly sealed</td><td>Put into airtight tank or Grain pro tightly sealed</td></tr>
<tr><td rowspan="2">Day 2</td><td>Check fermentation (rubbing, smell, pH)</td><td rowspan="3">Move to outside drying bed, dry on bed keeping 8cm layer around 25℃ in three days</td><td rowspan="3">Move to outside drying bed, drying on bed keeping 25℃ until 35% of moisture content</td><td rowspan="3">Anaerobic Fermentation<br>(192 hours, 8 days)</td><td rowspan="3">Anaerobic Fermentation<br>(72 hours, 3 days)</td></tr>
<tr><td>Washing & Grading<br>Pre dry & Sorting (cherry pulp, defect)</td><td>Pulping cherry,<br>Dry Fermentation<br>(12-18 hours)</td></tr>
<tr><td>Day 3</td><td>Move to drying bed outside under sun<br><br>Dry 8cm layer keeping less than 35℃.<br><br>- Stirring every hour by hand<br><br>- Covering by black shade net during 11:00 to 14:00 to avoid strong sunshine<br><br>- Checking and</td><td>Checking fermentation (rubbing, smell, pH)<br><br>Washing & Grading<br>Pre dry & Sorting (cherry pulp, defect)<br><br>Move to outside drying bed under sun<br><br>Drying 8cm layer keeping less than 35℃.<br><br>- Stirring every hour by hand<br><br>- Covering by black</td></tr>
</table>

| Day | 1.1 Fully Washed / Dry fermentation | 1.2 Fully Washed / Aerobic fermentation 24h + Dry fermentation | 3. Classic Honey | 4. Classic Natural | 5. Anaerobic Honey | 6. Natural Anaerobic |
|---|---|---|---|---|---|---|
| Day 4 | recording moisture content twice per day (morning, evening) | shade net during 11:00 to 14:00<br><br>- checking and record moisture content twice per day (morning, evening) | | | | Pulling out from the bag, checking pH |
| Day 5 | | | Drying 4cm layer keeping less than 35°C.<br><br>- Stirring 3 times per day (10:00, 13:00, 16:00)<br><br>- Covering by black shade net during 11:00 to 14:00 to avoid strong sunshine<br><br>- Checking and record moisture content twice per day (morning, evening) | | | Dry on drying bed with 4 cm layer under shade. |
| Day 6 | | | | | | Move to outside bed, drying 4cm layer keeping less than 40°C.<br><br>- Stirring 3 times per day (10:00, 13:00, 16:00)<br><br>- Covering by black shade net during 11:00 to 14:00<br><br>- Checking and record moisture content twice per day (morning, evening) |
| Day 7 | | | | | | |
| Day 8 | | | | (reaching to 35% of moisture content) drying 4cm layer keeping less than 40°C.<br><br>- Stirring 3 times per day (10:00, 13:00, 16:00)<br><br>- Covering by black shade net during 11:00 to 14:00<br><br>- Checking and record moisture content twice per day (morning, evening) | | |
| Day 9 | | | | | | |
| Day 10 | | | | | pulling out from the bag, checking pH | |
| Day 11 | | | | | drying on bed with 4 cm layer under shade | |
| Day 12 | | | | | Move to outside drying bed,<br>drying 4cm layer keeping less than 35°C.<br><br>- Stirring 3 times per day (10:00, 13:00, 16:00)<br><br>- Covering by black | |
| Day 13 | | | | | | |
| Day 14 | | | | | | |
| Day 15 | | | | | | |
| Day 16 | | | | | | |

| Day | 1.1 Fully Washed / Dry fermentation | 1.2 Fully Washed / Aerobic fermentation 24h + Dry fermentation | 3. Classic Honey | 4. Classic Natural | 5. Anaerobic Honey | 6. Natural Anaerobic |
|---|---|---|---|---|---|---|
| **Day 17** | Reaching moisture content 11%±1% | | | | shade net during 11:00 to 14:00<br><br>- Checking and record moisture content twice per day (morning, evening) | |
| **Day 18** | Storing warehouse (avoid directly on the ground, water, sunshine) | Reaching moisture content 11%±1% | | | | |
| **Day 19** | | Storing warehouse | | | | |
| **Day 20** | | | | | | |
| **Day 21** | | | | | | |
| **Day 22** | | | | | | |
| **Day 23** | | | | | | |
| **Day 24** | | | | | | |
| **Day 25** | | | Reaching moisture content 11%±1% | | | |
| **Day 26** | | | Storing warehouse | | | |
| **Day 27** | | | | | | |
| **Day 28** | | | | | | |

| Day | 1.1 Fully Washed / Dry fermentation | 1.2 Fully Washed / Aerobic fermentation 24h + Dry fermentation | 3. Classic Honey | 4. Classic Natural | 5. Anaerobic Honey | 6. Natural Anaerobic |
|---|---|---|---|---|---|---|
| **Day 29** | | | | | | |
| **Day 30** | | | | | | |
| **Day 31** | | | | | | |
| **Day 32** | | | | Reaching moisture content 11%±1% | | |
| **Day 33** | | | | Storing warehouse | Reaching moisture content 11%±1% | Reaching moisture content 11%±1% |
| **Day 34** | | | | | Storing warehouse | Storing warehouse |

# Appendix 2: Traceability sheet (example)

| General information | | | | | | | | Fermentation | | | Drying | | | Quality control | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Batch # | Cooperative | Farmer Group | sector | cell | Harvest date | cherry amount(kg) | Processing name | Fermentation time(h) * | Fermentation / from | Fermentation / to | drying days | Drying date / from | Drying date / to | Defect count | Moisture content of Green beans | Cupping score | Comment |
| 001 | Kopakaki | Kayenzi | Bwishyura | Kayenzi | 20-Mar-25 | 300.00 | Fully Washed | 14 | 3/20/25 18:00 | 3/21/25 8:00 | 13 | 22-Mar-25 | 04-Apr-25 | | | | |
| 001 | | | | | | | | | | | | | | | | | |
| 002 | | | | | | | | | | | | | | | | | |
| 003 | | | | | | | | | | | | | | | | | |
| 004 | | | | | | | | | | | | | | | | | |
| 005 | | | | | | | | | | | | | | | | | |
| 006 | | | | | | | | | | | | | | | | | |
| 007 | | | | | | | | | | | | | | | | | |
| 008 | | | | | | | | | | | | | | | | | |