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Good coffee harvesting and post-harvesting practices.

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Introduction

Brazil produces a third of the world´s coffee production and has maintained its position as the largest producer for over 150 years. As the world's largest exporter, it has one of the best and most advanced technologies for coffee production, in addition to being the second largest consumer of the product (MATIELLO et al., 2020). Coffee is the second most consumed beverage in Brazil, second only to water. It is estimated that this consumption grows even more, not only in Brazil but also worldwide (RODRIGUES et al, 2016).

However, Brazilian coffee is recognized in the international market as a product of inferior quality, while countries such as Colombia, Costa Rica, Guatemala and Kenya are recognized for producing better quality coffee. The specialty coffee segment has achieved great prominence in the world market, with greater growth in demand than commodity coffee, becoming a market niche that is being widely explored by Brazilian coffee growers (BOREM, 2008).

To produce specialty coffee, there are several factors that influence the final quality of the coffee: soil and climate characteristics, cultivars, conduction and management of the crop, **harvest, type of processing, drying and storage** (BOREM et al, 2008).

What is considered specialty coffee?

According to BSCA (*Associação Brasileira de Cafés Especiais* [Brazilian Association of Specialty Coffee]), Specialty Coffee have beans that are free from impurities and defects that have unique sensory attributes. These attributes, which include a clean and sweet beverage, balanced body and acidity, qualify your beverage at a score of over 80 points in the sensory analysis. In addition to intrinsic quality, specialty coffee must have certified traceability and respect environmental, economic and social sustainability criteria at all stages of production.

To this end, the coffee must be submitted to a tasting system by a qualified Q-Grader taster, who makes their evaluation using the SCAA (Specialty Coffee Association of America) methodology, where the coffee is classified using scores from 0 to 10 in the attributes of Fragrance/Aroma, Uniformity, Absence of Defects (Clean Cup), Sweetness, Flavor, Acidity, Body, Finish, Balance, and Final Evaluation, also containing the evaluation of the taster on the sensorial characteristic of the coffee (Figure 1).

Figure 1. Flavor wheel used in sensory evaluation of coffee. SOURCE: Portal do café

Harvest: when?

Many details are important to determine the start of the coffee harvest. Attention should be paid to separating the areas by maturity scale (early, normal and late), as variety, altitude and sun exposure are some of the many factors that can change the maturation degree of the coffee (BORDIN et al., 2017).

We recommend starting the harvest, whenever possible, with 10 to 15% of green coffee (Figure 2A), as the green fruits directly affect the quality of the coffee beverage, generating greater astringency, weight loss due to not being mature and, consequently, a reduction in the price of coffee.

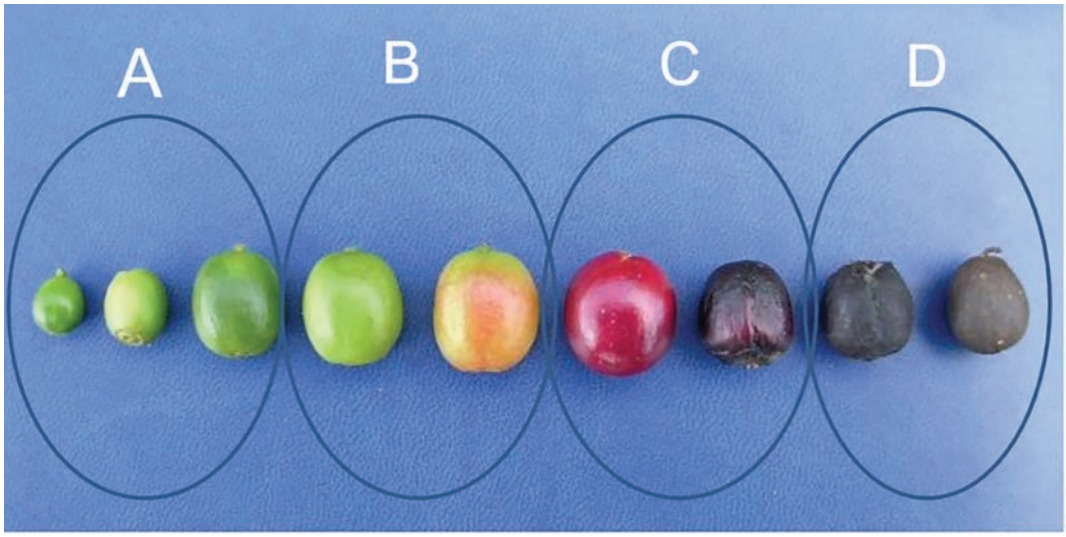

Figure 2. Coffee maturation levels: A - Green, B - Cane green, C - Mature and D - Dry.
SOURCE: Academia do campo.

For harvesting, there are several methods, such as selective manual harvesting (bean-by-bean harvesting), which are focused on harvesting only the mature fruits; semi-mechanized harvesting using manual harvesters; manual harvesting, which represents a large part of the reality in coffee farming, and mechanized harvesting, using coffee harvesters. All types of crops have their pros and cons, where management, technical and operational factors are always needed to choose the best alternative for the plantation (SAATH et al., 2012).

When harvesting with harvesters, the harvest can be used in a single sweep or more, prioritizing increase of the removal of the largest possible volume of cherry coffee and reducing the amount of coffee remaining on the plant and sweeping, generating a reduction in operational costs in the harvest process. (Santinato et al., 2015).

According to FREITAS-SILVA et al. (2001), after harvesting, the coffee should not spend more than 4 to 5 hours waiting to be processed, because unwanted and uncontrolled fermentation can occur, causing losses in coffee.

After the harvesting process is finished, the coffee must be sent to the post-harvesting processes. In Figure 3, we can clearly see that the coffee can have two pathways, being taken directly to drying on a patio or even a stationary dryer, a process that does not have operational expenses or investment in infrastructure (in the case of the patio), being a more economical alternative; or be processed, causing the coffee to be sent through a pre-cleaner and washer. This method will retract coffee impurities such as leaves, branches, stones and impurities, preventing these unwanted materials from remaining in the coffee and thus avoiding possible physical losses in the future evaluation of the coffee (BORN, 2008).

Another great advantage in sending the coffee through the washer, is that through it, the coffee is separated into two groups, the green and mature coffee is separated from the floaters (coffee that has already passed the point of maturation and is already in the process of drying). This separation leads to standardization in drying, as these two types of coffee are

already at different moisture levels, thus generating savings when drying and reducing the amount of breakage when cleaning (BOREM, 2008).

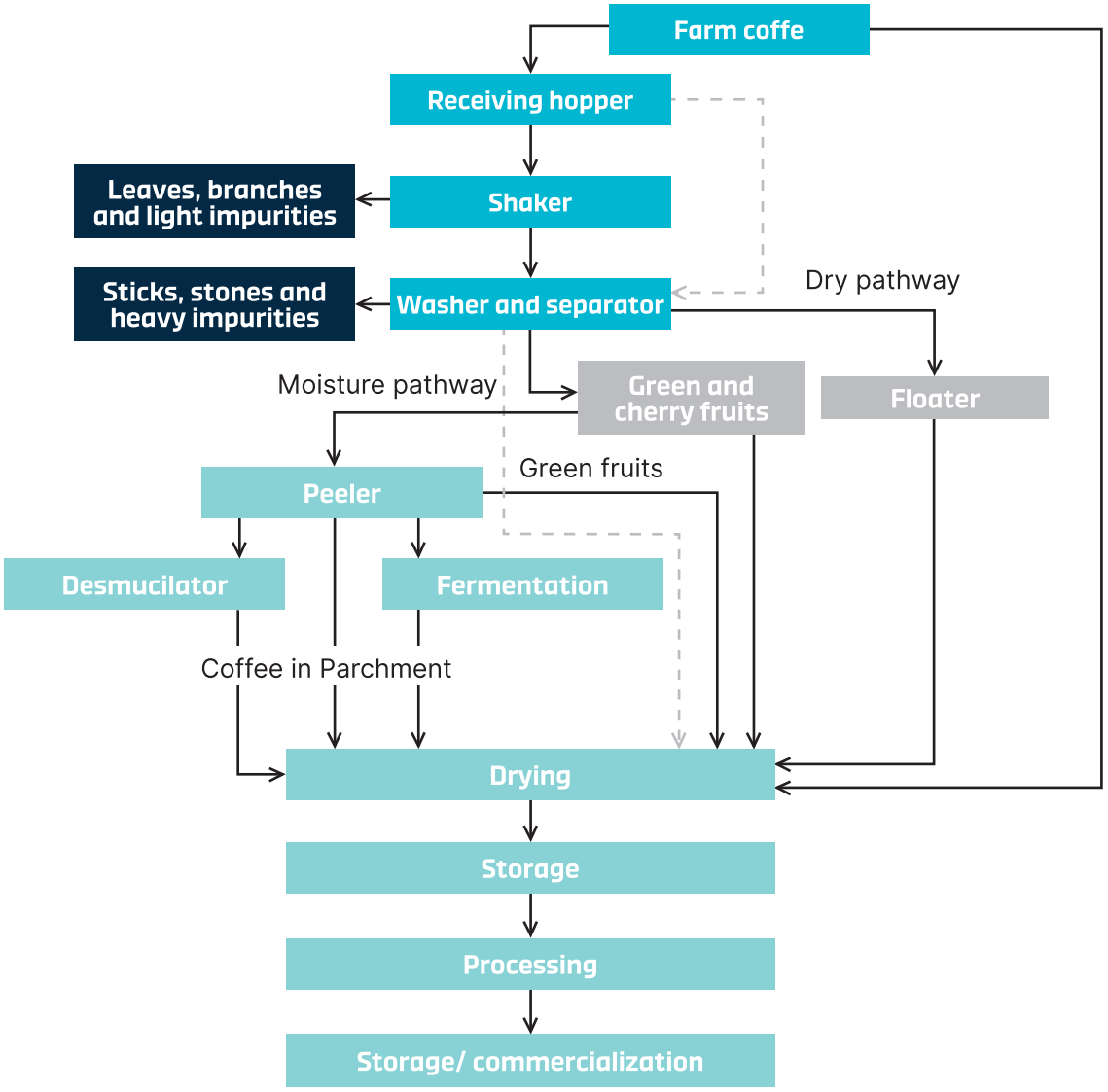

Figure 3. Flowchart of the coffee post-harvesting process. SOURCE: Academia do campo.

Note:
-The washer must be cleaned and the water changed at least twice a day. Water with too many impurities becomes denser and the coffee that should sink due to density ends up being dragged with the floater;
- Disinfect (SPRAY) the washer with 0.5% bleach every 10 days;
- Use 100 ml of benzalkonium chloride per 100 liters of water in the washer.

Hulled and Natural Cherry Coffee

There are currently two methods for processing coffee, using the moisture method (Hulled Cherry - CD) or by the dry method (Natural). The Natural Process consists of drying the coffee completely, including the hull. This type of coffee tends to present greater body and sweetness sensory characteristics, as it concentrates higher mucilage content (Pulp) inside the bean, where the ackars contribute to the sweetness of the beverage and is considered one of the attributes of the most desirable flavor in specialty coffee and participates in important chemical reactions such as the Maillard reaction, originating compounds responsible for the formation of color, flavor and peculiar aroma of the beverage (SANTOS; PAULA, 2007)

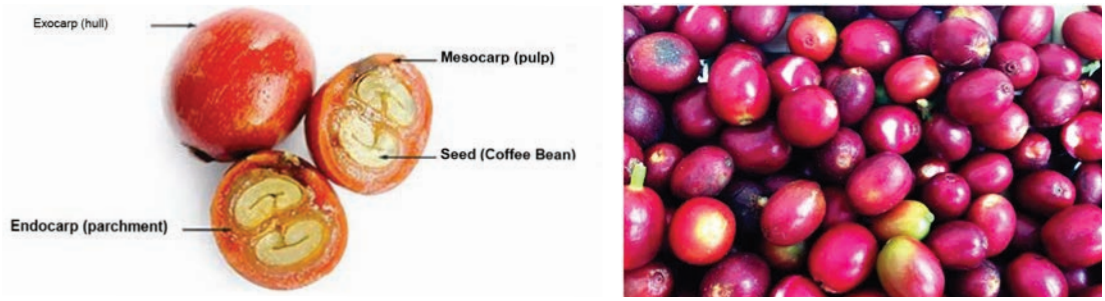

Figure 4. Demonstration of the fruit structures of natural coffee. SOURCE: Jardins Café.

The Hulled Cherry process, also known as the moisture pathway, consists of sending the coffee that came out of the washer into a huller. In this process, the coffee beans that are ripe are hulled, thus separating the mature coffee from the green coffee. The hulls are removed from the mature coffee, generating a significant reduction in space and time for drying (Figure 5). Hulled coffee has soft sensory characteristics, with striking notes and pronounced acidity (SANTOS; CHALFOUN; PIMENTA, 2009).

Figure 5. Hulled cherry coffee.

Fun fact:
Hulled cherry coffee (CD) has a specific market, where, due to its characteristics, it presents premiums in the range of 10 to 15% in the sale price.

Drying

In Brazil, drying is carried out in patios, in mechanical dryers or combining patios and dryers (BOREM, 2008), with the patio method being the most used by coffee growers in at least one of the stages of the drying process. According to Reinate and Borem (2006), this process consists of removing part of the water, found in the coffee after physiological maturity. The desired final water content corresponds to the maximum value at which the product can be stored, for predetermined periods, at room temperature, without deterioration and/or quality reduction occurring (SANTOS; PAULA, 2007; SANTOS et al., 2009). For coffee, this value varies between 11 and 12% moisture base (bu) (BOREM, 2008).

Did you know?
Coffee has approximately 300 chemical compounds present in bean processing and around 850 compounds originate after roasting and these determine the flavor and aroma of the coffee beverage, i.e., its quality (FLAMENT, 2002).

In relation to the patio, there are many types of pavement, which can be paved using asphalt mud, concrete or no paving at all, placing them directly on the ground. According to Reinate et al. (2012), the type of pavement can influence the final quality of the coffee (Table 1).

Code	Identification	E.M.	Soft	A. soft	Hard	Riado	Rio
RFLA RFLA	Roça Fino Lama Asfáltica [Thin asphalt mud]	0	0	2	4	0	0
RGLA	Roça Grosso Lama Asfáltica [Thick asphalt mud]	0	0	0	6	0	0
RFC	Roça Fino Concreto [Thin concrete]	0	1	1	4	0	0
RGC	Roça Grosso Concreto [Thick concrete]	0	0	0	4	2	0
RFTR	Roça Fino Terra [Thin ground]	0	0	0	5	1	0
RGTR	Roça Grosso Terra [Thick ground]	0	0	0	2	4	0
CFLA	Cereja Fino Lama Asfáltica [Cherry thin asphalt mud]	0	0	0	6	0	0
CGLA	Cereja Grosso Lama Asfáltica [Cherry thick asphalt mud]	0	0	0	4	2	0
CFC	Cereja Fino Concreto [Cherry thin concrete]	0	0	0	6	0	0
CGC	Cereja Grosso Concreto [Cherry thick concrete]	0	0	0	2	4	0
CFTR	Cereja Fino Terra [Cherry thin ground]	0	0	0	4	2	0
CGTR	Cereja Grosso Terra [Cherry thick ground]	0	0	0	4	2	0
BFLA	Boia Fino Lama Asfáltica [Floater thin asphalt mud]	0	0	0	6	0	0
BGLA	Boia Grosso Lama Asfáltica [Floater thick asphalt mud]	0	0	0	4	2	0
BFC	Boia Fino Concreto [Floater thin concrete]	0	0	0	6	0	0
BGC	Boia Grosso Concreto [Floater thick concrete]	0	0	2	2	2	0
BFTR	Boia Fino Terra [Floater thin ground]	0	0	0	4	2	0
BGTR	Boia Grosso Terra [Floater thick ground]	0	0	0	2	3	1
CDFLA	Cereja Desc. Fino Lama Asfáltica [Hulled cherry thin asphalt mud]	1	2	3	0	0	0
CDGLA	Cereja Desc. Grosso Lama Asfáltica [Hulled cherry thick asphalt mud]	0	0	0	6	0	0

CDFC	Cereja Desc. Fino Concreto [Hulled cherry thin concrete]	0	3	1	2	0	0
CDGC	Cereja Desc. Grosso Concreto [Hulled cherry thick concrete]	0	0	2	3	1	0
CDFTR	Cereja Desc. Fino Terra [Hulled cherry thin ground]	0	0	0	6	0	0
CDGTR	Cereja Desc. Grosso Terra [Hulled cherry thick ground]	0	0	2	4	0	0

Table 1. Result of beverage quality with the variation of patio pavement, coffee layer thickness and type of processing. SOURCE: Reinato et al. 2012.

In the same table, the treatments that dried in a thin layer of coffee are shown. Drying in thin layers makes the coffee dry more uniformly and more quickly, avoiding unwanted passive fermentation. In this case, for CD coffee, there is a need for intense turning of the coffee (more than 16 times a day) and for Natural coffee, it is not turned in the first few days, as it can cause damage. Also note the great availability of the best beverage (Soft Beverage) of the Hulled Cherry coffee.

After the coffee becomes “semi-dry” (close to 25% moisture), the coffee layers should thicken, using the “heap” system at the end of the day, to preserve temperatures during the night (BOREM, 2008).

Drying

Another option used for drying are dryers, which can be of different models. They are responsible for speeding up the drying process of the coffee and placing it at a moisture where it can be stored. They must be placed in homogenous batches, so that drying is uniform. If you need to complete a load with different batches, we recommend mixing batches with similar quality and with a maximum of 2 days difference in the patio.

With the coffee in the dryer, the temperatures in the coffee mass of 45°C for natural coffee must be respected; 40°C for hulled cherry coffee and 35°C when there is only green coffee, as higher temperatures can degrade the bean and consequently have significant losses in final quality (MARQUES, el al. 2008).

Coffee should be unloaded with 12% moisture in the beans so that at the end, when it is at room temperature, it can reach approximately 11%, ideal moisture for storage (BOREM, 2008).

Interaction nutrition and quality

The mineral nutrition of the coffee tree plays an essential role in the quality of the beverage, either directly when it acts on the plant’s metabolism, accumulating desirable quinine compounds, or indirectly when it acts by producing compounds that are unfavorable to microbial development in the bean (Martinez et al, 2014).

ICL America do Sul, as a leading company in the plant physiology and nutrition segment, offers the **Supera Nutricional Program**, which has the pillars of balanced nutrition, physiological stimulation and stress reduction.

In order to evaluate the quality of the beverage x **Supera Nutricional Program** x Arabica Coffee (Natural and Hulled Cherry) processing, properties in the Forests de Minas Gerais were selected, as shown in table 2.

All bean processing, sensory and statistical analyses were performed at Incaper's laboratory in Brejetuba (ES).

	Variety	Altitude (m)	Treatment	Processing**	Average
Area 1	Catuaí 144	870	Producer	NT	82,90c*
			ICL	NT	85,45a
			Producer	CD	82,95c
			ICL	CD	84,10b
Area 2	Catuaí 144	1112	Producer	NT	83,50b
			ICL	NT	85,55a
			Producer	CD	83,30b
			ICL	CD	83,15a
Area 3	Catucaí 2SL Yellow	890	Producer	NT	83,12b
			ICL	NT	85,35a
			Producer	CD	83,30a
			ICL	CD	84,05a

Table 2. Average coffee scores evaluated using the SCAA methodology for standard farm treatment versus the **Supera Nutricional Program** in different processing methods.

*Averages followed by the same letter do not differ statistically from each other, upper case letters in the column and lower case letters in the row, using Tukey's test at 5% probability.

****NT** = Natural; CD = Hulled Cherry.

We at **ICL** offer several technologies for soil and foliar applications that meet all phases and demands of the coffee tree and these products have been validated by the **Innovation Center**, **ICL**'s research center, located in Iracemapolis-SP that has more than 50 highly specialized professionals, with experimental protocols in plant physiology and nutrition. In addition to top research institutions, such as UFLA, EPAMIG, Fundacio Procafe and ESALQ. We increasingly seek to move and create solutions to increase productivity, combined with better coffee quality, generating greater profitability and sustainability for coffee farming. To find out more, contact our technicians in your region.

Profol Exclusive

Complete nutrition in one product.

Product developed using different sources of nutrients, for better absorption and use by plants. It contains a high concentration of micronutrients, in addition to high solubility and plant response. **Profol Exclusive** combines the balance between nutrients directly linked to photosynthesis and fruit production and the different sources of these nutrients, providing complete nutrition throughout the crop cycle.

Benefits:

- Complete nutrition in one product, highly concentrated in nutrients
- Solid product of high solubility, eliminating the need to transport water to the farm
- High concentration of nutrients
- Increased photosynthesis and production
- Practical 4 kg packaging

Concorde

The solution for a dverse situations

Complex of selected amino acids for the best development of plants. Accelerates recovery from abiotic stresses (high and low temperatures, "hail and phytotoxicity"). Concorde supplies plants with the necessary amino acids when their natural production is neglected due to stressful situations. In addition to 17 essential amino acids, **Concorde** has 9 balanced nutrients in its formula, to favor plant growth, in addition to increasing the size and weight of grains or fruits.

Benefits:

- Increases plant metabolism
- Increases the absorption rate and translocation of nutrients within the plant
- Quick recovery after Indian summers
- Reduces the phytotoxicity of agricultural pesticides
- Increases fixation of flowers and fruits

Energy

Activate the energy missing for your crop to produce more

The vegetative phase consists of the definition period of the productive potential. More energy on this phase contributes to better crop formation and preparation for some productivity sites. **Energy** is ideal for boosting your profitability.

Benefits:

- Nutritional balance
- Increases chlorophyll formation and photosynthetic activity
- Provides energy for developing roots and leaves
- Increases vegetative development and biomass production by plants, preparing them for the reproductive/flowering phase
- More energy in the phase where productive potential is defined

Triplus Perenes

Increase profitability and production with triple strength

Triplus Perenes is a new management concept to increase flowering and final fruit retention. All-in-one product that offers a balance between the physiological and nutritional effects, reducing energy expenditure in the reproductive period and consequently, floral abortion.

Benefits:

- Nutritional balance
- Greater retention of flares and fruits through three modes of action
- Mode of action 1: Bioregulator - Stimulates the differentiation of dormant buds
- Mode of action 2: Retention - Increases flower life, improving nutrition
- Mode of action 3: Nutrition - Greater fixation and formation of fruits

Translok

For higher profitability, you must act at the right time

It has exclusive technology that helps the plant manage the fruit filling process, a process that is decisive in crop productivity. It helps the plant manage the fruit filling phase, with greater availability of energy to translocate sugars.

Benefits:

- Provides a balance of specific nutrients for the fruit filling phase
- Helps to increase the translocation of reserves in the maturation phase of the accumulation organs
- Reduces stress, ensuring much more energy for the plant
- Conversion of the energy produced during the entire crop cycle into heavier and more uniform fruits

Helper Perenes

Anti-runoff technology in high volume applications

Adjuvante Helper Perenes, specific for high volume spray applications, has exclusive technology in its composition to increase droplet retention on waxy leaves, reducing runoff losses, keeping them moist for longer and, with its superior affinity cuticle increases the absorption of active ingredients by three, offering efficiency and optimization of the applied products. In addition to standardizing the drops with a spray drift reducer.

Recommendation: 0.01% to 0.03% VN (10mL to 30mL for 100L of spray mixture

Benefits:

- Reduction of spray mixture runoff - Greater retention of drops on the leaves
- Improved absorption of applied products - Affinity with the leaf cuticle
- Drop standardization - Greater area of coverage and penetration inside plants
- Greater application volume on target - Spray drift reducer

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