

PRODUCTION PROCESS AND QUALITY TESTING OF ARABICA GROUND COFFEE (COFFEE ARABICA L) SOLOK REGENCY, WEST SUMATERA

Rince Alfia Fadri^{*1}, Kesuma Sayuti², Novizar Nazir², Irfan Suliansyah³

¹Doctoral Program Student Agricultural Sciences, Andalas University, Padang, Indonesia

²Faculty of Agricultural Technology, Andalas University, Padang, Indonesia

³Faculty of Agricultural, Andalas University, Padang, Indonesia

*Corresponding author:

Email: alfiarince@gmail.com

Abstract. One of the types of coffee cultivated in Solok Regency is Arabica Coffee (*Coffea Arabica L*). The quality of the coffee produced can be influenced by the proper harvesting and post-harvest process so as to produce ground coffee with good quality. This research is done by the method of observation, descriptive, and hedonic test. Ground coffee produced in Solok Regency has a semi-mechanical harvesting process while the post-harvest process begins with the release of the skin and meat of the fruit, subsequent drying, and release of the skin of horns, sorting and grading, roasted, milling and packaging. This research aims to study the processing and quality of Arabica Ground Coffee in Solok Regency.

Keywords: arabica, quality, ground coffee, solok regency

1. Introduction

Coffee is one of the superior crops in West Sumatera. Solok Regency is also focused on the development of arabica coffee in order to meet market demand. Arabica coffee production in Solok regency amounted to 657,77 tons with a planting area of 6.630 hectares (Ha), and *robusta* amounted to 1.388 tons with a planting area 16.396 hectares (Ha) (*Badan Pusat Statistic (Central Statistical Institution), 2018*). Arabica coffee developed in high areas with a height of 1,000-1,400 meters above sea level (*masl*), some of them are in the Subdistrict of Lembah Gumanti, Lembang Jaya, and a bit in the subdistrict of Gunung Talang. One of the main professions for most residents of Solok Regency is the cultivation of coffee. The interest in planting coffee on the residents of the Solok Regency is increasing, and this makes the typical coffee of Solok increasingly popular among coffee lovers.

The process of coffee processing will contribute in terms of character, flavor, and quality. The process can be various, and each produces a unique flavor of its own. The harvesting process should pay attention to the age of harvest and how to harvest, while in the process of post-harvest for each treatment should pay attention to the engineering process, the temperature, and humidity. The temperature and duration of storage before roasting can affect the quality of the coffee (Yusri, Mursalim, & Tulisa, 2012). The process of coffee processing done by wet and dry methods. The level of maturity of the coffee fruit is very important to note because coffee berries that are picked red was about 10-11 months will improve the quality of coffee beans produced (Yusianto, 2016). The processing of coffee

should be done immediately when the coffee fruit has been harvested to prevent the occurrence of chemical reactions, which can degrade the quality of the coffee. Sorting the coffee fruit is done based on certain criteria. Coffee berries are picked red, and good post-harvest handling will produce coffee beans with good quality.

The process of processing is carried out greatly affects the quality of ground coffee. The process is done today in Solok Regency, still in the form of a simple. Not all of the people in the Solok Regency that cultivate the ground coffee very well. The quality of the ground coffee is analyzed from the physical properties (texture, color, aroma, and taste), while the chemical analysis that becomes the specific characteristic of the ground coffee is water content, acidity (pH) and chemical content in ground coffee which refers to a quality standard (SNI), in order to be accepted by consumers (Rahardjo, 2012). Consumer acceptance is also inseparable from the process of packaging and storage of coffee. Packaging that is used can affect the quality of ground coffee.

Arabica coffee processed in Solok Regency is one of the main commodities of the area that should be developed and maintained. Therefore, it is necessary to observe and know the process of processing and quality of arabica ground coffee in the Solok Regency. This study aims to know the process of processing and quality of Solok Regency arabica ground coffee.

2. Methods

The research conducted at the place of the producer of arabica ground coffee in Solok Regency. Quality testing is done in the laboratory of processing, laboratory of chemical Agricultural Polytechnic State of Payakumbuh. Roasting is done at farmer groups of Surian and *finds a roastery* Payakumbuh.

The materials used in the research included: coffee berries, ground coffee. Tools used: Hygrometer, pH meter, roaster machine, coffee bean grinder machine, analytical scales, sealer, cups, packaging, pan, camera, paper, newspapers, and stationery.

The variables that will be observed consist of; a) primary data include processing that is performed, which starts from harvesting to post-harvest. b) Secondary Data include the state of the climate of the study site and data processing of the coffee in Solok Regency. c) the Quality, which is observed in the form of color, texture, taste, and aroma as well as acidity levels (pH).

Methods of a descriptive study conducted by interviews using questionnaires and direct observation in the field as well as a Hedonic test. Data analyzed by tabulation and presented in the form of Tables and Images.

3. Results and Discussion

Coffee in the Solok Regency is planted at an altitude of about 1000-1400 meters above sea level between the Twin Lakes and Mount Talang with temperatures between 20-26⁰ C. According to the farmers' group in the Solok Regency (2019), minimal precipitation for the growth and development of coffee is 1000-2000 mm/year, while the rainfall that is optimal for the growth of the arabica coffee plant is an average of 2000-3000 mm/year with an average dry month 1-3 months. The type of soil that is rich in nutrients is good for the growth and development of coffee. The process of cultivation begins with land clearing, create spacing, and then seeding and planting. The important thing to note is weeding and pruning. Weeding and pruning should be noted that the coffee plant can bear fruit well.

Some of the coffee is processed organically and treated with natural fertilizer even without pesticides altogether, this is an added value and make the specific coffee in the region of Solok regency more delicious. The character of the taste of the coffee produced such an assortment of lemon, herbs, chocolate, spice, and spicy. This scent of fresh lemon, herbs, and spicy are the most creamy feel on this coffee. Arabica coffee of Solok Regency is well received by the wider community, not just in Sumatra, but in the whole of Indonesia up to foreign countries. These are the steps of the processing of coffee done (Figure 1).

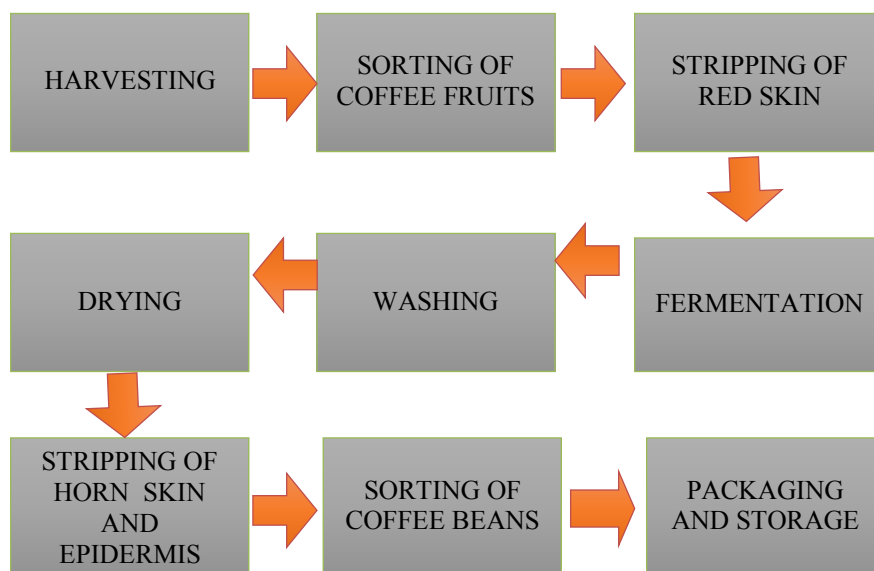


Figure 1. Block diagram the steps of the processing of coffee

A. The Process of Processing Coffee Semi Wet Method

Harvesting/picking of arabica coffee

Coffee fruit that is ripe will generally color reddish yellow to dark red. Picking coffee berries in the Solok Regency is done manually. High-quality coffee was obtained from

coffee beans that are picked when the coffee is red. Arabica coffee requires time flower buds 6 to 8 months. The main part of coffee is the pericarp that affects the flavor of coffee, there are four parts, the skin, the flesh of the fruit, the sap, and the skin on the inside, and the other part is the seed (coffee beans). Before the process of picking is done, it is necessary to understand the structure of coffee, as seen in Figure 2.

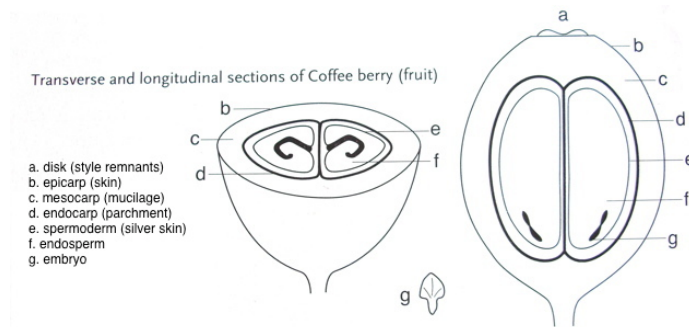


Figure 2. Structure of the coffee

The process of picking is very important to influence the taste and quality of the coffee beans. Usually, the coffee growers in the Solok Regency picking coffee-colored red. There are several criteria of coffee ready to harvest that must be considered by all coffee farmers in the Solok Regency. The coffee plant begins to bear fruit in the age range of 2-5 years. At this age, maybe the fruit just a bit and will continue to grow until the age of five years. The harvested coffee by the farmers in the Solok Selatan Regency (South Solok) can be seen in Figure 3.



Figure 3. *Cherry coffee*

The period of harvest has a frequency of picking every 10-15 days, which lasted for 4-5 months. There are several kinds of the picking done in the Solok Regency, such as a) Picking a selectively performed only on the pieces that have been colored red is full or has been ripened perfectly. The rest is left for the next picking. b) Picking a half-selectively carried out on all the fruit in one bunch. The condition is on the bunch; there are some pieces that have been colored full red. c) Plucking all at once is done against all of the coffee fruit from all bunches.

The criteria of the ripeness coffee are characterized by a change in color. Harvested coffee has criteria such as; a) Green and yellowish-green, usually the beans will be pale and wrinkled, so coffee in this condition should not be harvested because of the aroma that is produced is still very weak. b) reddish Yellow, which indicates the coffee fruit begins to ripen, has the aroma began to improve, and has been allowed to be plucked. c) full Red signifies the coffee fruit has matured and has an aroma as well as taste perfect. d) the Color of the coffee fruit dark red should be immediately picked because it decreases the aroma. The Aroma of the soil (earthy) will be out and make the coffee taste not good if to wait for picking time too long. To harvest the coffee takes quite a long time because usually, the level of maturity of the coffee fruit does not occur simultaneously. Figure 4 looks at coffee plantations are in a state that is clean and has shade, and pruning is often done.



Figure. 4 Arabica coffee Solok regency

The processing of coffee beans

Post-harvest technology needs to be corrected to improve the quality and taste of the coffee, which begins with the process of sorting coffee berries, coffee processing by the method of semi-wet or wet, fermentation, washing, drying. The initial process of harvested ripe red coffee fruit sorted carefully to separate the pieces that are superior (ripe, pithy and one kind) from the fruit of the inferior (defected, black, broken, perforated and pests attacked/diseases) Impurities such as leaves, twigs, soil, and gravel must be removed because it can damage the huller. This sorting is done directly in the garden after harvest is completed. Red seeds (superior) is processed with the method of wet processing in order to obtain dry *HS* coffee beans with a nice look. Fresh coffee fruit sorting results preferably directly processed to obtain optimal results, both in terms of quality (especially taste) and the ease of the next process. Coffee fruit stored in plastic bags or sacks for more than 36 hours will

cause pre-fermentation so that the aroma and taste of coffee beans to be poor and stink. Thus, the physical appearance of the seeds also becomes dull.

Sorting the coffee fruit can be done with two methods (Najiyati & Danarti, 2004) *that is a) manual threshing*, done by immersing the coffee cherries in water, the fruit floats (fruit dry on the tree, and affected by the disease) taken and separated and typically processed with dry processing while the submerged fruit (which is good) used to process the subsequent processing by the wet way. b) *semi-mechanical threshing*, the coffee fruit is put into the tank equipped with a water to remove the floating coffee fruit, while the coffee fruit is submerged directly to go towards the breaker of the skin (pulper). Then it's done washing and continued with the drying process.

Before the process of drying, the fermentation process is carried out on the method of wet or semi-wet to be coffee beans (green beans). The purpose of this process is removing/cleaning the skin and the coffee fruit that still clings to the skin horn of coffee. Furthermore, the skin of the fruit will be released using the pulper, then to put in a bucket/tub of water for 12-36 hours. This at once to the fermentation of the coffee fruit. After soaking, the coffee is washed with clean water for the next drying done by the sun or by using drying machines. If the coffee starts to dry with a moisture content of about 40 %, carried out the disposal of the skin of the horn using a huller or pounded to remove the skin of the horns, which continued with the sorting.

Stripping the skin of berries (pulping)

The process to distinguish between the coffee processing in the wet with the dry is stripping the skin of the wet coffee fruit (pulping). The Processing of wet method, starting with the stripping or separation of the coffee fruit, has reached the level of optimal maturity, while the dry processing method, the red coffee fruit harvested, directly dried to obtain a moisture content of between 12-13%. Skin fruit peeler that is commonly used by growers of Arabica coffee in Indonesia is a skin fruit peeler mechanical type horizontal single-cylinder powered manual drive (hand pulper) or driven by a fuel motor defenseless 4-5 HP (Sri Mulato, 2002).

The stripping process of the skin was using a pulper machine. Pulping aims to separate the coffee beans from the outer shell and *mesocarp* (the meat part). The principle works are removing the exocarp and mesocarp of the fruit coffee. Stripping can be done manually or using a machine. Some types of pulper machine that is commonly used by the farmers are *vis pulper* and *roared pulper*. The difference is that *vis pulper* serves only as a skin peeler,

so the result should be fermented and washed again. While the roared, pulper also serves as a washer, so it does not need to be fermented and washed again but go directly to the drying stage.

The working procedure of the pulper machine that is made in the Solok Regency started from the receipt of raw material the coffee fruit from the garden and farmers groups, then do the weighing to determine the selling price. Coffee berries that have been weighed are brought to the place of the pulper and fermentation and cleaned and washed. Pulper machine is turned on and put the fruit coffee alternately with the water head for the machine is slick and can facilitate the stripping process. After the process of pulping done, it was continued with the process of fermentation. Pulping is only performed each time the coffee comes from the farmers of Solok regency. The Pulper machine used can be seen in Figure 5.



Figure 4. Pulper machine (Vis Pulper)

The fermentation of coffee beans

The method of fermentation is a stage of coffee processing that needs better handling so as not to interfere with the final results of coffee fermentation technology by wet requires more labor, larger capital, and plenty of water. The Fermentation technology of semi-wet is worth doing on the coffee plantation of the people. This technology requires labor, capital, and water needs just a little.

The layer of *mucus* that left on the surface of the skin horn coffee beans after the process of stripping carried out the fermentation. The coffee beans are washed again before going into the other stages with the hope of the mucus that is still attached thoroughly separate from the seeds of coffee. Fermentation on Arabica coffee aims to reduce the bitter taste. The principle of fermentation is the decomposition of compounds contained in the layer of mucus by microbes in natural and assisted with oxygen from the air. Fermentation can also reduce the bitter taste and encourage the formation of an impression of "mild" in

the sense of steeping coffee. The fermentation process can be carried out in a wet (soaked in a puddle of water) and dry (without water bath) (Avallone, S., Brillouet, J.M., Guyot, B., Olguin, E., & Guiraud, J.P . 2002).

The process of processing the coffee using the method of semi-wet starting with the harvested fruit of the coffee is put into a pulper machine. After the peel, immediately dried on the sun to be dried until the percentage of water of 30-35%. Fermentation is still running because the mucus has the sugar content is still inherent in the coffee beans through the levels are not as much as the wet method. Furthermore, the coffee beans go to the milling machine to get rid of the skin of the remaining horns. After it was clean from the skin horns, the second drying portion is done until the percentage of moisture content of 10-12%.

The level of perfection of the fermentation, if the mucus is not sticky, then fermentation is estimated to have been completed. Generally, the time of fermentation of seeds of Arabica coffee ranged from 12-36 hours. The end of the fermentation is marked by the peeling layers of membranes that envelop the skin of the horn. Fermentation time varies depending on the type of coffee, the temperature, and humidity of the environment as well as the thickness of a pile of coffee beans in a bath. The following figures, 6 and 7, show the fermentation bath and fermented coffee beans.



Figure 6. Fermentation water bath



Figure 7. Fermented Coffee

The wet method of coffee processing, have to go through the fermentation process that started with plucking the coffee berries are red. The time between plucking/picking with the fermentation process is cultivated, not more than 6 hours. Coffee berries are soaked for a moment or without soaking with clean water to facilitate the breakdown of the skin, then milled with machine pulper (*vis pulper*). The results of pulping are stored in the container to form a cone. A Cone of the results of pulping closed by sack or plastic, and then it left to stand for overnight (12 – 15 hours). Another alternative to speed up the fermentation process or strengthen the taste is to provide yeast or proteolytic bacterial sold in the market into the fruit already pulped then brooded for 12 – 15 hours. Levels of yeast or proteolytic bacteria given enough 3% only. After brooded, the fruit is next washed with clean water and dried.

The next process, such as the process generally the processing of coffee, to get ground coffee. Fermented Coffee beans have a different color with coffee beans that are not fermented, where the color is more pale compared to the unfermented (grayish-green). In arabica coffee, fermented coffee with proteolytic bacteria has a stronger flavor and preferred more, compared with the use of yeast (Jackels, S.C., & Jackels, C.H. 2005).

The fermentation process aims to help release or remove the layer of mucus that is still remaining on the surface of the skin horn coffee after the stripping process. The principle of fermentation is the decomposition of compounds contained in the layer of mucus by microbes in natural and assisted with oxygen from the air. The hydrolysis of pectin caused by pectinase contained in the fruit or the reaction can be accelerated with the help of microorganisms. This fermentation process can occur with the help of microorganisms *Saccharomyces* called by the process of yeasting and curing. The duration of the fermentation process is influenced by the type of coffee, the temperature, and humidity of the environment, as well as the thickness of a pile of coffee beans. The end of the fermentation is marked by the peeling layers of membranes that envelop the skin of the horn. Fermentasi can be done in a wet way and dry way.

Drying

Drying aims to reduce water content in the seeds of coffee. Method of drying coffee can be done by natural drying, artificial, and a combination of natural and artificial. Natural drying is usually done in the dry season because in the rainy season, the natural drying during the rainy season resulting in a coffee-colored brown, moldy, and smelled musty. Drying in the rainy season should be done by artificial means or a combination of the natural and the artificial. Naturally drying is best done on the cement floor, bamboo matting, or mat. For some farmers, they do drying coffee on the soil. This will cause the coffee to become dirty and infected by fungi, which will affect the taste of the coffee (Najiyati & Danarti, 2004).

Artificial drying is usually carried out in cloudy weather. This method is usually able to dry the coffee for about 18 hours, but sometimes it also depends on the type of device. The working procedure of artificial drying is done through two stages, the heating at a temperature of 65-100⁰ C to lower the moisture content from 54% to 30% performed at an early stage. The next stage is the heating at a temperature from 50 to 60⁰ C for the lower water levels 8-10% (Najiyati & Danarti, 2004).

Other methods that the coffee farmers usually have done are the drying combination of natural and artificial—drying done in the scorching of the sun until the moisture content

reached 30%. Then proceed by artificially drying until the moisture content reached 8-10%. The combination of temperature and time of heating during the drying process on the commodity of grains are made to avoid the occurrence of damage to the seeds. Air temperature, air relative humidity, airflow, the initial water content of the material and content of the final material is a factor that affects the time or the duration of the drying (J.S, De & Friends 2015). Coffee beans that have been washed contain 60% water, by way of drying the water content can be evaporated, so that the water content in the coffee reaches 8-10 %. After drying, then proceed with the treatment of the breakdown of the horns.

They were drying in the Solok Regency done on the floor of the drying or drying tool with the thickness of the expanse of the coffee beans about 6-10 cm layer of seeds (Figure 8). Reversion is carried out every 2 hours during the time the coffee is still wet, long drying time around 7-15 days. The good Way of drying the coffee is spread on the floor with a maximum thickness of 1.5 cm or about two layers. The expanse of the coffee to be inverted by using a tool resembling a rake or wood so dry evenly every 1-2 hours. When sun scorching is well, the drying usually lasts for 10-14 days, and then when the sky is cloudy, the drying usually takes three weeks (Najiyati & Danarti, 2004).



Figure 8. Drying

The working procedure of the drying stage in the Solok Regency starts from the grain, which has been done the fermentation process dried by spreading the grain using a rake on the wall or put the grain in a solar *dryer dome*. Drying on the floor carried out for three weeks. The drying will be stopped when the water content already or reached 12 % and for drying using the solar dryer dome performed for 4-7 days. Drying using solar dryer dome is much faster than using the drying manually because the solar dryer dome was absorbing the heat. The use of a solar dryer dome in the process of drying the coffee more effective and efficient because it does not need to be inverted. Sanitation during the drying process can be maintained, but storage capacity is not too large so that it is done drying manual. Sanitation

in the drying manual looks like has not awake because on the floor, there is still sand, and sometimes it could be entered by animals.

Hulling

Hulling or husking the skin of the horn using a machine peeling (huller) or can also be done manually. Stripping the skin of the horn using a huller, coffee beans that have passed through the drying process, carried out cooling (tempering) at least 24 hours (Figure 9).



Figure 9. Hulling

The procedure of work done in the Solok Regency is started from the grain that has been dried, which is characterized by a moisture content of 12 % inserted into the sack and then carried out the process of transporting to the shelter at the top of huller the machine. Huller ignited and heated for 8-10 minutes, and then the grain is put into the funnel of huller. Coffee beans that have been separated from the skin of the horns are accommodated with a sack to continue the process of sorting. Each member of the group to do this process should ensure the huller condition is clean, able to function normally, clean the remains of coffee, and the skin that is still wet, which left behind up, free from harmful ingredients that may cause cross-contamination in the processing of coffee beans. After the process of hulling is completed, the coffee rice immediately dried. Furthermore, to do the process of grading and temporary storage. Avoid storing the coffee beans is still wet because it can be attacked by the fungus, which can damage the coffee beans both physically or flavor, and can be contaminated by mycotoxins (ochratoxin A, aflatoxin, etc.).

Grading

Criteria the quality of the coffee will be determined by the grade coffee and the classification of green beans. Systematic assessment of the grade coffee and the classification of green beans is different in each country, will not be universal because every country has a different culture. The development of coffee is strongly influenced by the culture of each country. Coffee processing is also different in each region, develop an appropriate culture planting system and processing to every coffee plantation and processing unit results. Each country coffee producers to develop a systematic classification of green

beans and graphs grade coffee that is often used for the determination of the minimum standard of export.

Indicators used for the classification of green beans based on the size of the coffee bean, factors include the level of the height of the coffee plants. The height of the planting provides the texture of the seeds are dense, and coffee beans tend to be larger when compared to coffee grown at the height of planting low. The condition of coffee beans will affect the roasting, and generally, coffee grown at the height of planting optimum will evolve in a slow but generally has a flavor profile that best. We need to study relationships that are mutually related in between the size of the coffee bean, density, and quality of taste. The standard procedure applied in each country in determining the grade and classification of green bean is disability green beans, which affects the level of risk of contamination. The assessment system will align the disability of such. Indonesia carried out a policy that refers to the quality standards of the Indonesian government. There are six classifications of coffee quality of the system the disability of seeds: Grade 1 with a value of defect 0-11, Grade 2 with the value of the defect 12-25, Grade 3 with the value of the defect 26-44, Grade 4a with the value of the defect 45-60, Grade 4b with the value of the defect 61-80, Grade 5 with the value of the defect 81-150, Grade 6 with the value of the defect 151-225 (SNI, 2008).

The process of grading done in the Solok Regency started by taking the sample randomly on the bottom, middle, and up from each selected sack so that the obtained coffee beans as much as 10 kg. Selected samples are evenly mixed, then taken the sub-sample of 200-300 g to the determined type of quality of coffee beans. Grading is done manually using sieves hung have holes of diameter 6 mm. The random seed is input into the sifter and sifted until the random seed is small (sized below 6 mm) falls and is separated from the random seed according to size grade and put into sacks, and continued with the process of sorting coffee beans (Figure 10).



Figure 10. Grading Tool

Sorting Coffee Beans

Sorting is the process of separation of materials that have been cleaned in a fraction range of quality based on physical characteristics (water content, shape, size, density,

texture, color, foreign objects/dirt), chemical (the composition of a material, the smell, and taste of rancidity) and biological (type and amount of damage by insects, the number of microbes and the power of growing in particular on the material of the agricultural-shaped grains). The process of sorting that can be done is wet sorting and drying sorting (Widyastuti, 1997). The process of sorting is done to separate the physical size of coffee beans and foreign objects, like splinters of leaves, wood, or skin of coffee that get carried away when the coffee beans are dried.

The process of sorting coffee beans based on the physical (defect system) divided into two, namely manual sorting and mechanical sorting. Manual sorting coffee beans performed with the use of the hands of workers for the classification process while the sorting mechanically using the help of machines. Working procedures for the process of sorting in the Solok Regency started from randomly coffee that has been done the grading continued with the process of sorting by the manual way to put the coffee above the white table and choosing the coffee beans and separate the coffee beans that are broken, perforated and black. Then coffee beans that have been sorted to be inserted into the sack. Proceed with the weighing process of the good coffee beans (green bean/specialty) to be marketed or continued to the roasting process.

Sorting of coffee beans by size is usually done with the help of a sieving machine single cylinder rotating type. The table shakes while sorting coffee beans based on the color difference and the look, the way can be done with the help of electronic sorting machine (sorter) (Widyotomo et al., 1998). The process of sorting is done so that coffee beans that have been dried can be sold at high prices. Basically, the working principle of coffee beans sorting machine is the same, to use a few levels of the sieve, which moves to separate the quality of the coffee beans. The sieves have been arranged in such a way that they can deal with particular power. Coffee beans sorting machine types of shakes on the market have a three-level sieve with the hole size of sieve shaker, which is 5.5 mm, 6.5 mm, and a 7.5 with the third sieve are arranged in series (Figure 11).

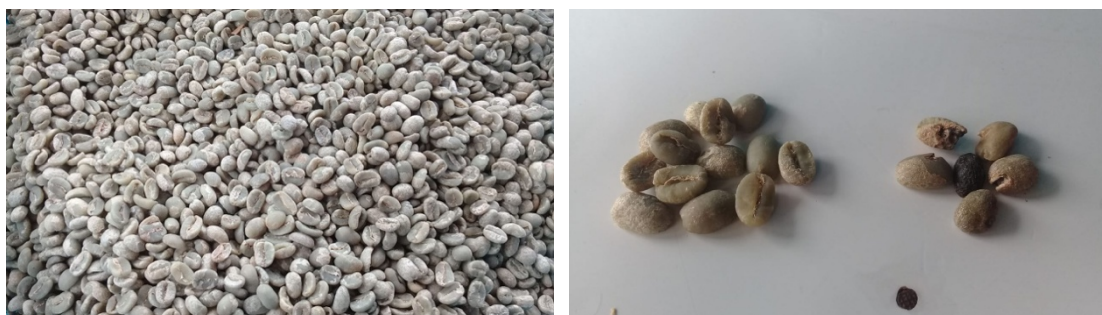


Figure 11. Sorting of Coffee beans

Roasting

The process of crucial roasting determines the coffee flavor that will be enjoyed compared to all the stages of coffee processing. Coffee flavor is able to vary according to taste, depending on the process of roasting done. Roasting is the process of cooking a coffee to put out of water in coffee, drying, and developing seeds, reducing the severity of the provide aroma in the coffee. When the coffee is cooked, there is a chemical reaction that accompanying so that the character of the coffee beans changed. Longer the coffee beans cooked, the more chemicals that change its characteristics.

The stages that need to be considered in the process of roasting is to make sure the green bean to be roasted has a moisture content of 12% and the water content remaining to 4% after the roasting process. Recognize the characters of coffee will be roasted and determine the best flavor of coffee that can be produced by the green bean. Avoid all the things that are considered disturbing in the taste of coffee, for example, the taste of earthy, grassy, astringent, carbon, woody, or taste disturbance other so that the roasting is not too long, so that the coffee does not burn. Enter green bean or raw coffee beans to the roaster. Do the roasting of green bean till the coffee changes the color gradually from green to yellow, then brownish-yellow, continuous light brown, dark brown, blackish brown, until the latter become black. Feel the change in the aroma of coffee beans at every minute of the roasting process and make sure that happens twice a burst, i.e., the first (*first crack*) and the second burst (*second crack*).

Coffee turned into a brown color when roasting. The combination of temperature and time in the roasting is a unique art in creating the best coffee taste. The difference in the use of temperature and duration of roasting are important factors that must be considered by the roastery, although the tool and method of roasting also a measure that is important also. The process of roasting coffee on a percentage basis has the effect of up to 30% in donations aroma and taste. This figure is obtained from the assumption of 55 percent the formation of aroma and taste on the coffee in the "garden" (the climatic conditions, the height of planting, varieties of coffee, the process of post-harvest, etc.) and 15% of the process of coffee brewing.

During the process of roasting, raw coffee beans (raw green beans) which have the characteristics of soft, "grassy" smell and little/nothing at all a sense of change (transform) into a roasted bean that has a unique characteristic flavorful and rich in taste. Coffee will also be changed from absorb heat (endothermic) become generate heat (exothermic) during the process of roasting. During the process of roasting coffee beans, undergo two processes,

evaporation of water at a temperature of 100⁰C and the reaction of pyrolysis at a temperature of 180-225⁰C. This reaction is a decomposition reaction of hydrocarbon compounds, among others, carbohydrates, hemicellulose, and cellulose that exist in coffee beans. This reaction generally occurs after the temperature of the roaster above 180⁰C. At the stage of pyrolysis, the coffee undergoes chemical changes, among others, composing coarse fibers, the formation of volatile compounds, the evaporation of acidic substances (evolution of CO₂ gas in the amount of a lot of space of roasted white-colored), and the formation of the substance a distinctive smell of coffee. Change the color of the coffee beans are initially greenish, becoming brownish, then to black with an oily surface is the physical changes caused by the roasting process. The time of roasting is needed to reach the stage of roasting point greatly varies from 7 to 20 minutes, depending on the water content of the rice coffee beans and the quality of ground coffee desired.

One of the benchmarks the process of roasting changes the color of the coffee beans roasted. The roasting process is stopped at the time when the color sample is closer to the color standard. There are three colors: light brown, brown, rather dark, and dark brown to blackish. The temperature range of the roasting is 190-195⁰C for the level of lighter roasting (light brown color), the temperature of 200-205⁰C for the level of medium roasting (brown color rather dark), and temperatures above 205⁰C for the level of dark roasting (the color of dark brown rather black). After the process of roasting is complete, coffee beans are cooled while stirring so that the roasting process does not continue (over-roasted).

The roasting process in the Solok Regency started by to make sure the coffee beans which have been sorted, prepared with a moisture content of 11-12 %. The roaster machine is turned on and heat until it reaches a temperature of 200⁰C. The coffee beans are put into the roaster machine, and the temperature of the roasting is maintained 150⁰C up to the level of maturity desired. The maturity level of light, coffee will be issued at the time of 1-2 minutes after the onset of the burst of the first (first crack). The level of maturity of a medium coffee is issued at the time of 1-2 minutes after the onset of the second burst (second crack). The level of maturity of a dark, coffee is issued at the time of 3-4 minutes after the onset of the second burst (second crack). Blower/culling is turned on, and coffee is issued in accordance with the level of maturity desired, and the coffee left in the blower for 4-5 minutes (Figure 12).



Figure 12. Roaster Machine

Milling/Refining

The process of milling roasted coffee beans aims to facilitate the drinking of coffee because at this stage will be generated coffee in ground form. The grinding process can be performed manually or using a milling machine. Roasted coffee beans are smoothed with a smoothing tool (grinder) is equipped with means of regulating the size of the coffee particles so that automatically the ground coffee that is produced sized as desired or until the obtained granules of the ground coffee with a certain fineness to be easily brewed and give a flavor and aroma sensation that is optimal.

Yield the result of processing (roasting and grinding) is the ratio between the weight of ground coffee obtained by the rice coffee beans weight that is processed. Yield getting down on the degree of roasting that darker. The highest yield is 81%, obtained at roasting degrees is light, and the lowest is 76% with the degree of dark roasting. Yield is also affected by the shrinkage of the weight of the coffee beans during roasting. The higher the seed moisture content and the longer the time of roasting causes the yield to be smaller.

The level of the size of the coffee grinder should be adjusted by the method of makers that are used in order to obtain an optimal sense. Because coffee that has been ground will be stored in the container, the faster the change, the aroma, and the taste compared to store the whole coffee beans—grinding coffee just before brewing can to maintain the freshness as well as the character of the taste and aroma of the coffee. Consistency is key when grinding coffee. Scale coffee grinder will follow the method makers that will use. To grind the coffee according to the recommended size for the limited method makers, this means that consistently will get a cup of coffee that is most fitting for sensory.

Brewing a glass of coffee is important in determining the level of consistency of the particles in a powder of the coffee that has been ground in accordance with the desired method. The more subtle scale mill the coffee, then more and more particles will be exposed and, in theory, will make the coffee more extracted due to the high intensity of water flowing

on the sidelines of the coffee particles. This has an impact on the coffee flavor, strong and intense. On the contrary, the more coarse-scale mill of the coffee, then the coffee extraction the less because of the low intensity of the water flowing on the sidelines of the particles in the coffee. Before determining the scale of the mill that best suit the method of brewing that will be used.

Arabica Ground Coffee Quality

The process of cultivation and post-harvest from upstream to downstream, as well as the type of coffee, will determine the quality of the coffee produced. The quality of coffee can be seen from the physical and chemical, the characters of physical and chemical to the color, texture, aroma, taste, and acidity (pH) of coffee. The results of the hedonic test on the Arabica coffee Solok Regency production can be seen in Table 1.

Table 1. The results of organoleptic tests on the Arabica ground coffee from the Solok regency

Ground Coffee	Characteristic		Physical	
	Color	Taste	Aroma	Texture
Ka	Brown	Neutral	Rather Coffe Flavor	Rather Smooth
Kb	Brown	Coffee Characteristic	Coffee Characteristic	Rather Smooth
Kc	Blackish	Coffee Characteristic	Coffee Characteristic	Smooth
Kd	Brown	Neutral	Rather Coffe Flavor	Not Smooth
Ke	Blackish-brown	Neutral	Rather Coffe Flavor	Not Smooth

Description: Coffee a (Ka); Coffee b (Kb); Coffee c (Kc); Coffeed (Kd); Coffee (Ke)

The best Ground Coffee that can be obtained is ground coffee (Kc) because it has the characteristic flavor of coffee with the aroma of coffee and smooth texture, the color is blackish, as shown in Table 1. The color is very decisive for the attractiveness, as an identifier and attributes on food commodities. Color is the quality factor that most attracts the attention of consumers and gives the impression of preferred or not preferred (Soekarto, 1985). The color on the coffee beans to change in the process of roasting, the formation of color on the ground coffee due to the Maillard reaction, condensation occurs between amino acids or proteins with the amount of sugar (Jing & Kitts, 2002).

The color of the ground coffee is usually at the level of a brown color, rather black to the black, while without fermentation and two days fermentation, the color of the ground coffee at a level not black until slightly black. The color formation is first determined by the process of fermentation, where the fermentation process occurs due to the activity of microorganisms and the reaction enzymatically. The difference in the level of the blackish color of the coffee grounds occurs due to the presence of browning reactions in enzymatic along with the length of fermentation; the longer the fermentation then the coffee color will

be browner. Next, coffee beans that have been chipped will change the color becomes slightly browned (browning) due to the oxidation of polyphenols.

In addition to color, the aroma is a factor that determines the quality of ground coffee. The Aroma of coffee started to fill the air in the roasting process. Coffee from *Aia Dingin* Solok Regency (Kb and Kc) is a coffee with a distinctive aroma in accordance with the organoleptic test. Soekarto (1985) stated that the scent of a product in many ways determine the smell of whether or not a product, even the scent or the smell is more complex than the taste. Next on the Sulistyowati (2001) writes that the results of the study, the aroma of good coffee with a score of 7-8 (based on SNI 01-2907 - 1992) obtained from the fermentation of wet with the time of fermentation 12-36 hours.

Furthermore, the aroma of ground coffee will appear maximum when the process of roasting is done. In the process of roasting will happen a Maillard reaction in which a reaction occurs chemical reaction forming the character of a coffee that is distinctive (Sulistyowati. 2001). Until now, this has been detected more than 800 compounds of the volatile and non-volatile combine to form the aroma of coffee. According to Yusianto & Mulato (2002), that the compound of volatile furan, phenol compounds, may cause the aroma in the ground coffee. Pirazin Components is a component of the aroma which was formed due to the roasting on the material. The number of components of pyrazine produced was determined by the composition of the components of the precursor, such as free amino acids, peptides, and decrease the enzymatic sugar formed during the fermentation process. In addition to the compounds of phenol and pyrazine, there are compounds of benzene formed during the roasting, where the compound of benzene is a compound of aromatic smelling class like the scent of almonds and other (Janzen, S.O. 2010).

The degree of acidity or pH is an indicator to see the quality of the coffee. The pH is determined by looking at the numbers on the pH meter. The ground coffee is brewed with water (pH = 7) and then measuring the pH. The measurement results were seen in Table 2.

Table 2. The pH of the ground coffee from Solok regency

Arabica Ground Coffee	pH (%)
Ka	5,3
Kb	6,1
Kc	5,6
Kd	5,1
Ke	6,1

Description: Coffee a (Ka); Coffee b (Kb); Coffee c (Kc); Coffee d (Kd); Coffee e (Ke)

Coffee is a drink that is synonymous with the bitter taste, is also identical with a sour taste. The level of acidity in coffee is only traded at a pH of 5, and this means that the acidity

in coffee is still safe to be consumed. On the coffee sour and the acidity is described in terms of such different notes and after taste. In Table 2 is seen that the pH of the most acid is on the coffee K4. This can be said of the time of harvesting coffee is less precise. The process of post-harvest coffee also has a long span of time, over more than 10 hours. In addition, the acidity of coffee is affected by the process of fermentation. The principle of fermentation is the decomposition of compounds contained in the layer of mucus by microbes in natural and assisted with oxygen from the air. The fermentation process can be carried out in wet (soaking the coffee beans in a puddle of water) and dry (without water immersion) (Yusianto et al., 2013).

The time of roasting also affects the degree of acidity of coffee. The value of acidity increased along with the height and duration of the roasting process. The level of acidity of arabica coffee from Solok Selatan Regency at the temperature of 170 °C for 16 minutes which is 5.94 %, 18 minutes is 6.03 %, 20 minutes is 6.19 %, while at the temperature of 180 °C for 16 minutes, the level of acidity is 6.1 %, 18 minutes is 6.09 %, and 20-minute is 6.5 %, while the level of acidity at the temperature of 190 °C for 16 minutes is 6.63 %, for 18 minutes is 6.72 % and for 20 minutes is 7.11 %.

4. Conclusion

Post-harvest handling of Arabica coffee in Solok Regency consists of harvesting, stripping, drying, roasting, milling, packing, and storage. Ground coffee that has a brownish-black color with a smooth texture and flavored coffee with a distinctive flavor of coffee and pH is not too acid.

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