Chapter 4
Coffee Industry in Brazil

Abstract This chapter presented the state of the coffee industry in Brazil. Brazil has a great production of coffee and causes a huge amount of waste. In the productive sector, the main residue is coffee husk, obtained after processing of coffee fruits. Information of the coffee processing and refining as well as details about the waste from the coffee production are described.

Keywords Coffee industry · Coffee waste

Brazil has a prominent position in the world coffee production. The country is the world's largest producer and its production exceeds the sum of the production of the other top five of the list, as shown in Fig. 4.1.

According to the Brazilian Institute of Geography and Statistics (IBGE), the national coffee production in the 2011 harvest was approximately 2,668,780 tons of processed coffee. Figure 4.2 shows the percentage of domestic production by state. The state of Minas Gerais is the main coffee producer, with approximately half the national production, followed by the states of Espírito Santo, São Paulo, Bahia, Paraná, and Rondônia.

In Brazil, plants of species *Coffea arábica*, known as Arabica coffee, and *Coffea canephora*, mostly conillon variety, also known as Robusta coffee, are grown. The species Arabica is better adapted to regions of higher altitudes, between 1,000 and 2,000 m in relation to sea level and cooler temperatures, with annual averages between 18 and 22 °C. The species Robusta easily adapts to lower regions, close to sea level areas, and higher temperatures, with annual averages between 22 and 26 °C. The fruit of the Arabica species results in a more refined drink in terms of aroma and flavor, a condition that substantially affects the commercial value of the product. However, Robusta has high contents of soluble solids and therefore is preferred by manufacturers of instant coffee and by pharmaceutical and food industries due to the interest in caffeine as a raw material. Figure 4.3 shows the percentage of state wise domestic production of both species of plants according to IBGE.

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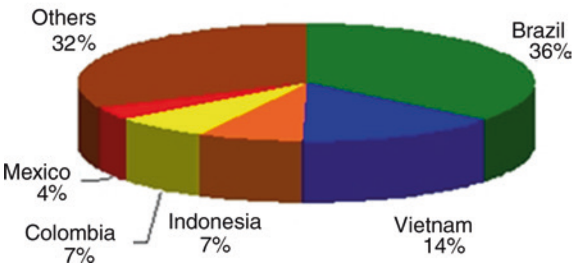

Fig. 4.1 World coffee production. *Source* International Coffee Organization

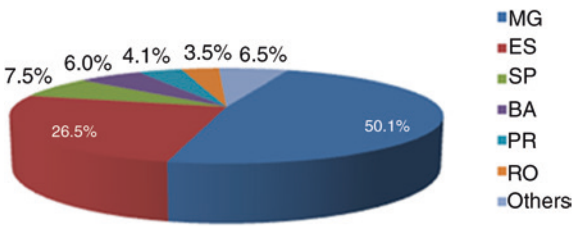

Fig. 4.2 National coffee production by state. *Source* IBGE (2012)

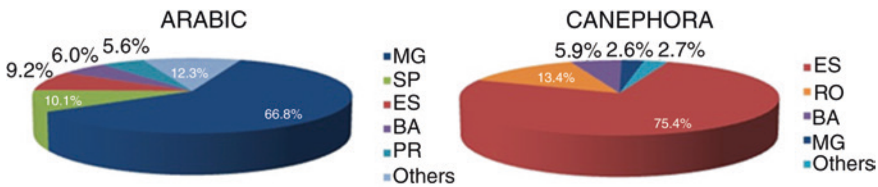

Fig. 4.3 Brazilian coffee production by variety of species—2011. *Source* IBGE (2012)

The state of Minas Gerais, the largest coffee producer in Brazil, figures as the main producer of species Arabica, with approximately 67 % of the national production. The state of Espírito Santo is the main producer of species Robusta, followed by the state of Rondônia. Figure 4.4 shows the main coffee growing regions by species.

In Bahia, of the 160,033 tons of coffee produced in the 2011 harvest, 74.5 % were of the species *Coffea arabica* and 25.5 % were of the species *Coffea canephora* (IBGE 2012). The western, northern, and mid-eastern regions of the state are producers of the species Arabica, while Robusta is grown in the southern coast. According to Bessa (2012), in Bahia, the most significant growth occurred in the Cerrado region (high technology, fully irrigated), with growth rate around 20 %

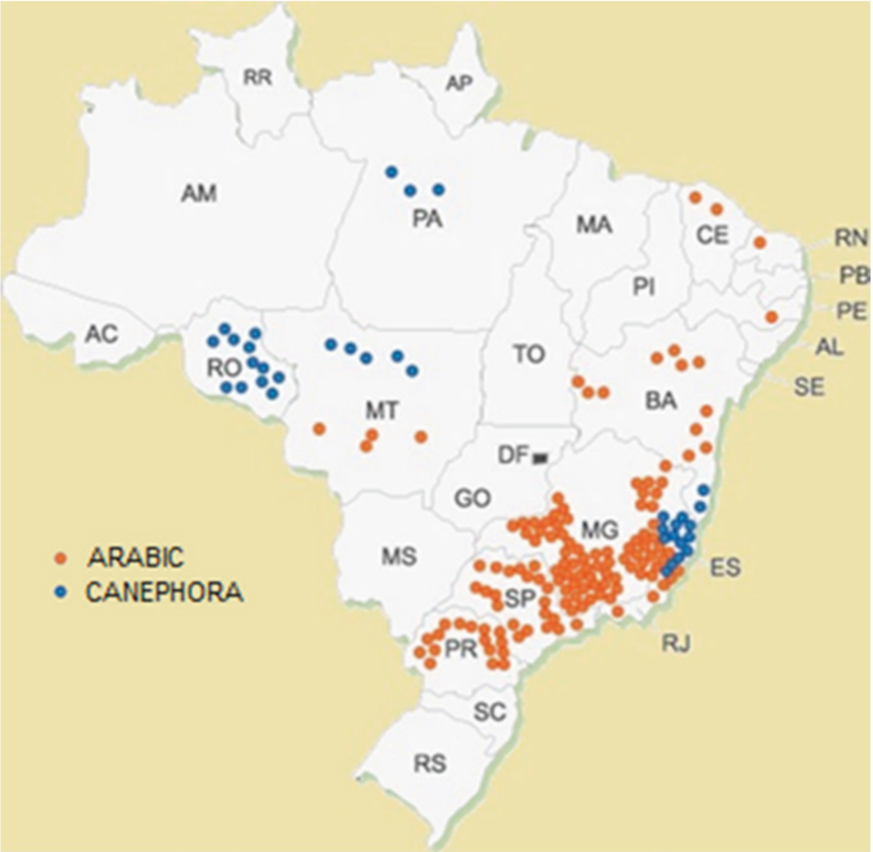

Fig. 4.4 Main coffee growing regions in Brazil by species. *Source* Markcafe

per year. Recently, this growth is also occurring in the Conillon region (Robusta coffee), called "Atlântico," with a growth rate of 10 % per year. Therefore, one could conclude that coffee production in Bahia is currently under expansion.

4.1 Coffee Processing and Refining

After harvest, the coffee fruit undergoes processing for the removal of impurities, as well as bark, parchment, and separation of the grain, which is the commercial product, from unused parts for manufacture of the beverage. Figure 4.5 shows a schematic drawing of the coffee fruit structure.

Coffee processing and refining can be performed by two different methods for drying fruits: wet or dry process. Both begin with the step of separating and classifying the fruit by maturation stage: green, cherry, or dry. Thus, the

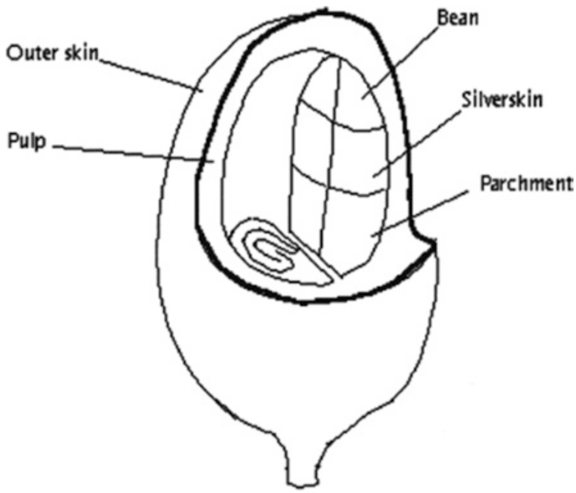

Fig. 4.5 Schematic drawing of the coffee fruit structure (Saenger et al. 2001)

manufacturer has greater control of the processes, since for each maturation stage, there are different characteristics in the drying step.

Drying agricultural grain means improving its condition to be stored at room temperature, maintaining its characteristics with the best cost–benefit ratio. Then, after drying, the moisture content should present the maximum value with which the product can be stored for predetermined periods at room temperature without any damage that could reduce the quality (Palacin et al. 2005).

Drying as a step in processing and beneficiation is considered critical for providing heat stresses, developing undesirable fungi, adding odors from fumes or other contaminants in fruits and grains, depending on the technique used in the operation (Palacin et al. 2009; Oliveira, 1998). Many researchers claim that the drying conditions of the fruit influence the quality of commercial coffee and hence the value of the final product (Machado et al. 2003; Palacin et al. 2009). Drying in yards, with natural air, is possible in environments with low relative humidity and low cloud conditions. The main advantage of this method is energy saving, but it has disadvantages such as requiring large areas and dependence on climatic factors, which are not favorable, slow the process, and compromise the quality of the final product. In Brazil, a predrying step in yards with mechanical dryers for additional drying is common (Machado et al. 2003).

Artificial drying in mechanical dryers has the advantages of reducing the drying time, use in humid regions and periods of rain, reducing the climate influence on the quality of coffee, and allowing the reduction of the area of yards and hand labor, despite requiring better professional qualification. Thus, the literature classifies artificial drying by mechanical dryers as advantageous from the technical point of view due to the reasons above. Still according to the literature, the main disadvantage is the higher drying cost compared with outdoor natural drying. However, due to the smaller influence from climatic factors and the less likely action of fungi and bacteria, and also their influence on the quality and therefore the price of the product, the cost–benefit ratio at the end of processing may be favorable to the use of mechanical dryers.

This review on the use of mechanical dryers is important for it is at this stage, with the use of such equipment, that coffee hush ashes are produced (resulting from burning coffee husks), the residues used in this study. From the point of view of coffee production in Brazil, it is difficult to estimate and quantify the use of mechanical dryers. There are a few studies of regional coverage, for example, carried out by Freitas et al. (2000) which evaluated the characteristics of the production processes of coffee in southern Minas Gerais. In this study, 170 farms classified as small, medium, and large were analyzed. According to the authors, approximately 82 % of farms used mechanical driers in the drying process of grains. Of these, 90 % were medium (with area between 10 and 50 acres) and large (above 50 ha of area), that is, most of the farms that did not use mechanical dryers were classified as small (less than 10 ha). It is noteworthy that this study was conducted over 10 years, and many investments in improvements of processing conditions have been made by small producers, for example, through associations, causing this percentage to be currently higher. In a recent study, (Sater et al. 2011) reported that virtually all drying of the production in the state of Espírito Santo is made with the use of mechanical dryers. After the drying step, the coffee grains are packaged and stored, and later marketed.

4.2 Waste from Coffee Production

Due to their high production, the coffee industry in Brazil generates huge amounts of waste. In the productive sector, the main residue is coffee husk, obtained after the processing of coffee fruits.

Coffee husk is derived from the cleaning of coconut coffee, composed of epicarp (husk), mesocarp (pulp or mucilage), and endocarp (parchment). The pulp is the residue of wet pulping the cherry coffee, composed of epicarp and mesocarp (Matiello 1991). The amount of husks produced in a harvest season is huge. According to several authors, in the processing of coconut coffee, approximately 50 % is grain and 50 % is husk (Badocha et al. 2003; Giomo et al. 2006; Rocha et al. 2006). Thus, in the 2011 harvest season, about 2,668,780 million tons of coffee and therefore the same amount of husks were produced.

A small part of the coffee husks is used in farms as fodder for coffee plants (Badocha et al. 2003). There are differences between authors on the use of this waste as animal feed. So, large amounts are discarded, most often, inappropriately. The inadequate disposal of wastes generate serious environmental problems such as pollution and siltation of rivers, air pollution due to burning, and use of areas for the storage of this material that could be aimed for other purposes, and waste of raw materials entering the industry.

The most interesting use in terms of use of coffee husk is the production of thermal energy from biomass (Vale et al. 2007). Due to the growing world concern to increase the use of renewable energy, wastes of various origins emerge as interesting energy alternatives (Protásio et al. 2012). Studies have shown the excellent energy viability of coffee husk to produce heat (Saenger et al. 2001; Vale et al. 2007; Oliveira et al. 2008; Protásio et al. 2012). This conclusion is mainly based on the calorific value of coffee husk, with values between 3,990 and 4,393 kcal/kg, rated as excellent in terms of biomass residue from agriculture. Vale et al. (2007) compared results of the combustion of coffee husk with *Cedrelinga catenaeformis* residue (shavings) and concluded that coffee husk, despite having lower calorific value than *Cedrelinga catenaeformis* (3,933 and 4,932 kcal/kg, respectively), has higher bulk density (567,965 kcal/m^3 for coffee husk and 470,463 kcal/m^3 for shavings), resulting in higher energy output per unit volume, optimizing the use of burning appliances. The authors emphasize the possibility of manufacturing charred briquettes from coffee husk for the production of thermal energy, with viability for use in thermoelectric power plants. Other studies have also suggested this possibility (Saenger et al. 2001; Oliveira et al. 2008; Sater et al. 2011; Protásio et al. 2012). Coffee husk is an excellent fuel for industries that use furnaces. Many coffee producing farms use this residue as fuel for their mechanical dryer, maintaining energy autonomy in the drying process, as shown in Fig. 4.6. Burning the coffee husks results in residual ash, which is discarded by farmers.

According to Dultra and Acchar (2010), in many cases, the ash is disposed in areas close to producing farms, on roadsides, or near rivers and streams without treatment and may contaminate soil or water. Figure 4.7 shows an example of the improper disposal of coffee husk ashes.

Coffee husk ash, currently of no commercial value, is rich in alkali (K_2O) and alkaline earth metals (CaO and MgO). Dultra and Acchar (2010), concluded that

Fig. 4.6 Coffee husks used as fuel

Fig. 4.7 Improper disposal of coffee husk ashes

Fig. 4.8 Coffee husk ash

it is possible to incorporate this residue into masses for the production of ceramic tiles. In this study, the author evaluated as satisfactory results for water absorption and mechanical strength obtained by ceramic bodies with 10 % added residue, without the use of other fluxes. According to the author, the residue contributed to the formation of liquid phase, or vitrification, improved sintering and, consequently, increased the densification of the ceramic body. Figure 4.8 shows coffee husk ash obtained in a producing farm in Eunápolis—Ba.

The fact is that coffee husk ash comes from coffee cultivation, its offer is submitted to the harvest period, which begins in late March and continues until early October, according to the Ministry of Agriculture. However, if one considers that: (a) the annual production of coffee husks (and its improper disposal) is abundant, (b) the current situation in the search for renewable energy sources, along with policies to encourage the use of residues may contribute so that more industries make use of coffee husks as a source of energy, the amount of ash generated from burning coffee husks tends to steadily increase, allowing the accumulation of strategic reserves of this residue.

A positive factor highlighted by Dultra and Acchar (2010), regarding the use of coffee husk ashes by the ceramic industry is the geographical location of both producers. Coffee cultivation is very strong in the states of São Paulo, Paraná, Minas Gerais, and Espirito Santos (as can be seen in Fig. 4.4), and the major states of ceramic coatings production are Sao Paulo and Santa Catarina, where there is a higher concentration of manufacturers. Thus, geographically, obtaining the residues by ceramic tile manufacturers is facilitated.

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