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Brazilian Coffee Quality: Cultural, Microbiological and Bioactivity Aspects

Sára Maria Chalfoun, Caroline Lima Angélico, Mário Lúcio Vilela de Resende

Abstract **–The Brazilian coffee industry attentive to the regrouping of the consumers in relation to the notion of quality of the coffee and that this is depends on multiple determinants one must consider factors that involve the steps from pre-harvest to storageundergoes a deep transformation in all coffee chain. Good practice programs, applied along the productive process has repercussion on the microbiological, physical and chemical characteristics translated by the quality of the final product regarding the sensorial and safety standards. Research has been progressively pursuing the improvement of quality techniques and producers have been proactive in all stages of productivity and industrialization, readily absorbing the new technologies generated by the research. Thus, production standards have been designed according to the world demands of quality in a holistic way that involves in addition to the quality of the final product, the quality of the activity by socio-environmental aspects.**

Index Terms: **Improvement, good agricultural and processing practices, bioactive compounds, microbiota.**

I INTRODUCTION

The quality of coffee beans is influenced by factors as coffee production conditions as well as post-harvest operations, such as processing, drying and storage conditions[1].

Between the components of quality there are physical characteristics and the chemical composition of the coffee that are influenced by factors of diverse natures, among them the genetic, environmental, nutritional factors, crop management, harvesting, preparation, etc. Factors another than the genetic and environmental can be controlled after the implantation of the crop, not only in the management in the field by the adoption of Good Agricultural Programs , when all thedisposabletechnologies is employed to obtain the maximum in quality until harvest point as well as in the coffee harvestingandpost-harvestingphase, in which the preservation of quality is sought [2].

However, it is important to consider that aspects related to the sustainability of the crop covering social, economic and environmental aspects of the activity, in a holistic vision, are part of the demands of a growing part of the consumers, which should also be considered taking in account that coffee quality is mainly defined such as meeting of consumer demands.

The present review looked at to present the state of art of the Brazilian coffee sector in improvement the step by step conduction of the coffee operations in pre and post-harvest aiming to reach the excellencein the operations execution as well the available toolsto measure the quality and reach the awards of the participation in the market of differentiated coffees.

Sára Maria Chalfoun Researcher, DSc.EPAMIG Sul, Lavras, Minas Gerais State, Brazil
Caroline Lima Angélico, Fellowship, DSc - INCT do Café, Universidade Federal de Lavras, Lavras, Minas Gerais State, Brazil
Mário Lúcio Vilela de Resende, Professor, PhD - Universidade Federal de Lavras, Lavras, Minas Gerais State, Brazil, CoordinatorINCT do Café

II PRE-HARVEST, HARVEST, POST-HARVEST AND COFFEE BEANS QUALITY

Production conditions, as well as post-harvest operations, such as processing, drying and storage conditions can influence the quality of coffee beans [1].

The Pre-harvest phase is of primordial importance in the management of the coffee activity and has a definitive hole in quality. Consists of making a forecast of the time and duration, definition of the method of collection, collection of material and financial resources; design and revision of the infrastructure and machinery for the processing of the type of final product to be obtained (pulp, peeled cherry, etc.) [2], [3].

Chalfoun, Azarias& Martins [3], warn that good harvest planning starts with the clearing of the loose soil, as well as leaves, weeds, remaining fruits from the previous harvest and other debris.

Techniques such as weeding, weed control, as well as foliar sprays based on fungicides or products that act as preventives in the appearance of pathogens are important measures before the harvest, since they guarantee the productivity, sanity as well as efficiency in harvesting [4] [5].

The coffee harvest period in Brazil, generally begins in april and go on until august or in some cases september. Factors such as climate, amount of coffee in the plant or fallen on the ground interfere with its beginning and end of processing [6].Its important to observe that late harvest can coincide with the beginning of the rainy season with risk to quality commitment.

There are three types of harvesting for coffee: manual, carried out manually which requires a large amount of labor, semi-mechanized, where manual and mechanized harvesting operations are used, and mechanized, with all harvesting operations performed mechanically,so the application of adequate harvesting techniques is extremely important factor for producers, thus contributing to higher economic returns. The type to be used may vary according to the local topography, slope, spacing, alignment and height of the plants [6] thus, the producer based on these data should choose the type of harvest that best suits your crop. By this way any type of harvest technique, if properly executed, shall ensure the coffee quality preservation.

It has been observed that fruits in the cherry stage have better drinking patterns, this being due to this phase corresponds to the ideal point of maturity of the fruits, in which the bark, pulp and seed are with a suitable chemical composition to provide the fruit its highest quality, with

volatile compounds, which are responsible for the characteristic flavor and aroma of coffee, and are present with very low sensory values in green fruits, increasing gradually with maturation, assuming optimal values in cherry fruits [7].

Cherry coffee will provide the best type of beverage, provided that it is properly processed, however, because crop concentration occurs at the same time, there is a tendency for some growers to opt for their anticipation when the percentage of green fruit is above 5% recommended [3].This practice results in great economic loss to growers since there are reducing weight and commercial devaluation due to worse quality pattern. In addition, the fruit of coffee in the cherry stage presents a smaller detachment force which facilitates the harvesting operation [8],[9].

Promotion ofblossoming synchronisation andgreater maturation uniformity has beenchallenge for the coffee sector and a procedure that is sure to in terms of quality. Itsimportant to note that the suitability of the species/cultivar to the best cultivation site, followed by adequate cultural treatmentsand climatic conditions in the growing year can change the number of flowering plants, which will impact directly into this desired maturation uniformity [7].

Harvest with the majority of the fruits in the cherry stage, along with other factors, is essential for obtaining a coffee with adequate chemical composition, minor undesirable chemical modifications and detrimental to the quality of the product. As it is directly related to the various physical, physical-chemical and chemical constituents, which are responsible for the appearance of the roasted bean, flavor and aroma characteristic of the drinks and, among these compounds, the volatile constituents, phenolic (chlorogenic acid), fatty acids, proteins and some enzymes whose presence, contents and activities confer to the coffee a peculiar flavor and aroma [10], [11], [12]; [13].Selective harvesting, coffee separation and well-conducted drying can produce good quality coffee [14], [15]. When economically feasible is the best solution to unevenness of maturation.

In the post-harvest phase, processing and drying are importants steps, since they directly influence the final quality of the product. There are two differents processing methods: the dry and the wet method. A further mode is the process known as the semi-dry process, a wet process process variable [16],[17],[13].

Similar to harvest technique choice, the method of coffee processing is decisive in the profitability of the coffee activity and will depend on several factors, such as: climatic conditions, capital availability, technology and equipment, consumer market requirements regarding product characteristics, water availability and technology for the treatment of wastewater [18].

Regardless of process used, after the harvest the coffee fruits must be processed and spread in the shortest possible time, never being crowded or in the carts waiting for the discharge, since the humidity and temperature conditions in the coffee mass are a highly favorable to the development of microorganisms that accelerate the fermentation process [7], [11].

In the dry processing, the cherry coffee is dried in yard, pre-dryers or mechanical dryers, completely, without the removal of the bark, giving rise to coconut coffee. Although this type of processing is the most used in the Brazilian coffee, the oldest and simplest coffee processing method, wet preparation has been considered a viable alternative to obtain higher quality coffees in some regions mainly due to environment conditions with high relative humidity [19], [20].

Wet preparation is the process by which, after passage through washers, the exocarp and/or mucilage of the fruit is removed, reducing the risk of fermentation and allowing faster drying, which generally results in good quality [18]. It is a common practice among producers in Mexico, Colombia and Kenya, but in Brazil the pulp is still little used. It is indicated for areas where the post-harvest period occurs under conditions of high relative humidity [20].

For many years, the pulping occurs by spontaneous fermentation in concrete tanks, removing the remaining mucilage adhered to the parchment, a suitable substrate for the development of microorganisms that can cause fermentations that are detrimental to the final quality of the product. The coffee will remain in these tanks with water for a period of 12 to 36 hours, aiming to eliminate the mucilage. After this period, the beans are washed until no sign of this mucilage is detected and conducted for drying [18], [21], [20].

In the semi-wet process, in order to obtain the dehusking cherry coffee the ripe fruits are mechanically husked and part of the mucilage remains adhered to the fruit parchment. This operation performed on dehusking machines is based on the difference in resistance to pressure of green fruit and ripe fruit [18].

The operation of mechanical demuciling is realized by machines after the pulping occursfriction between beans and beans with the metal cylinder. In this equipment, the water is added in small quantities for the lubrication and cleaning of the mucilage [18]. The main advantage of using this equipment is the removal of part of the mucilage without the use of the fermentation tanks, besides facilitating the work of movement and drying in the yard, since the beans do not form agglomerates as in the pulped natural cherry process [19].

Coffee drying is one of the most important operations among post-harvest practices, aiming at reducing the water content of the product and, consequently reducing the risk of infestation by microorganisms, the occurrence of enzymatic fermentations preserving quality and nutritive value, besides ensure the germinative power[22],[23].

The high moisture content of the fruits at the time of harvest, 60% to 70%, is a factor the differs coffee from other products difficulting the dry operation[22], [24]. In Brazil, basically three types of drying are used: drying in yards (natural drying), mechanical dryers (artificial drying and combined drying(natural and artificial drying)[25].

Regardless of the drying method used, the following points should be emphasized in order to be successful in the post-harvest process of coffee: to prevent coffee from fermenting before and during drying and excessively high temperature during drying, since coffee tolerates the drying

air temperature of about 40°C for one or two days; 50°C for a few hours and 60°C, for less than one hour without damage; dry the beans in the shortest possible time, up to 18% bu and seek to obtain a uniform coloration product [22].

Processing is an operation carried out after the drying of the coffee and constitutes the separation of beans, bark and impurities in order to peel the coffee in coconut and separate the bark and parchment, eliminating the maximum of impurities. This stage must be conducted correctly and carefully, otherwise impurities remain in the middle of the beans benefited, which is considered a defect, impairing classification by type. Resorting has been increasingly used, mainly, by cooperatives and companies that market coffee. Such a process is adopted for the purpose of classifying and improving quality by eliminating defects. This process is based on bean size and shape, specific gravity, magnetic properties and color [26].

Coffee beans are traditionally storage in jute bags with a capacity of 60 kg of coffee benefited; storage in big bags that have the capacity to store 1,200 kg of coffee with the advantage of adaptation to the mechanized handling, reduction of the losses in the operations of loading and unloading of the coffee, besides the decrease of the workmanship. Advances has been observed in the green coffee packing aiming the quality preservation through mechanisms that allows the atmospheric control.There is also the form of bulk storage in which there is no use of bags, and the coffee is stored in silos [27]. In relation to the bulk storage, the traditionally storage in bags, presents the advantage of the facility in identification and removing the bags that show deterioration.

III CLASSIFICATION OF COFFEE IN BRAZIL

The classification consists of the separation of the beans into categories, subcategories, groups, subgroups, classes and type, according to the sensorial characteristics. According to the category, coffee is classified in *Coffeaarabica* L. or *Coffeacanephora* P. and in the subcategories in boring beans (with normal development) or mocha (beans with ovoid shape, due to the absence of fertilization of one of the ovules), being separated according to the different sieves of the sieves: round screen for flat beans and oblong screen for moca beans. When the sorting does not take place by sieve or when the beans fall into four or more sieves, coffee is obtained called Bica Corrida [28].

According to the aroma and flavor, the raw coffee beans will be classified into two groups, being defined by means of the cup test in Group I (Arabica) and Group II (Robusta) and will be classified into subgroups. Arabica: Strictly soft: coffee that, together, presents all the requirements of aroma and "soft" flavor, but more accentuated; Soft : coffee that has a pleasant and sweet aroma and taste;Softish: coffee that has slightly sweet and smooth taste, but without astringency or roughness of taste; Hard: coffee that has an acrid, astringent and rough taste, but does not have strange palates, besides the considered phenic beverages that are: Rioy: coffee that has a light taste, typical ofiodoform; Rio: coffee that presents typical and accentuated taste of iodoform; Rio Zone: coffee that has a very accented aroma and taste, similar to iodoformor phenoic acid, being disgusting to the palate. The classification of the Beverages of Group II - Robusta are: Excellent: coffee that has a neutral flavor and medium acidity; Good: coffee that has a neutral taste and a slight acidity; Regular: coffee that presents a typical robust flavor without acidity; Abnormal: coffee that presents a non-characteristic flavor to the product [28].

In relation to the class, the beans can be classified according to their coloration that varies according to the drying processes, air exposure, storage, damage suffered during pulping and processing, among others [29].

The classification of quality based on the appearance, type and classification of the beverage by the cup test could be complemented by the adoption of physical, chemical and physico-chemical methods that would facilitate the evaluation, making it less subjective [30],[31].

IV SPECIALTY COFFEES

The segment of specialty coffees represents, today, about 12% of the international market of the drink and 15% in Brazil. Coffee quality attributes cover a wide range of concepts, ranging from physical characteristics such as origins, varieties, color and size, to environmental and social concerns such as production systems and the working conditions of the coffee labor force. The current sales value for some differentiated coffees has an overprice ranging from 30% to 40% more than conventionally grown coffee. In some cases it may exceed the 100% barrier. For the differentiation of specialty coffees, physical and sensorial attributes such as the quality of the drink must be based on the quality of the beverage, which must be higher than the standard. The main categories of specialty coffees are: coffee of certified origin (related to the regions of origin of the plantations, as some of the quality attributes of the product are inherent to the region where the plant is grown), gourmet coffee (Arabica coffee beans with a sieve of more than 16 and high quality, differentiated product, almost free of defects), organic coffee (produced under the rules of organic agriculture) and Fair trade(Coffee consumed by consumers concerned with the social and environmental conditions under which coffee is grown). In this case, the consumer pays more for the coffee produced by small farmers or shaded production systems, where the crop is Associated with the forest) [32].

The specialty coffees are obtained from defect-free beans (black, green, burnt and green black), with the final beverage becoming clean, sowithout undesirable defects, fermentation and bitter taste. Obtaining a pleasant aroma, flavor and aftertaste for a long period (SCA, 2017) [33].The specialty coffees are those that do not present primary defects such as sticks, stones, etc., presenting a flavor that differentiates them from other beverages such as floral, citrus, chocolate and other flavor, adding value to the product [32].

V CHEMICAL COMPOSITION OF BEANS ASSOCIATED WITH COFFEE QUALITY

The quality of the coffee drink is closely related to the taste and aroma, promoting great satisfaction to the

consumers who taste it. It is obtained commercially by the physical characteristics of the beans and sensorial of the beverage [34], [35].

The definition of the quality of coffee as a beverage is quite broad, being dependent on the chemical composition of the beans, determined by genetic, environmental and cultural factors; harvesting, processing and storage methods; roasting and preparation of the beverage. In order to obtain superior coffee, harvesting care and post-harvest management have become fundamental in the commercialization and increase of the coffee grower's profit [36],[9]. Therefore, it is indispensable that the harvested coffee be prepared and then submitted to drying to avoid the development of fermentation processes and damages to the quality of the beverage [37],[38].

To evaluate the quality of the beverage, there are parameters considered as efficient markers of soluble solids [39]; [12] total sugars content [40],[41], electrical conductivity and potassium leaching, [42],[43], total titratable acidity [7],polyphenoloxidase activity [44], [11], as well the official beverage classification (cup test), according to the CNNPA Resolution n ° 12, 1978, and the official classification by the drink (cup test), according to the CNNPA Resolution n°12 of 1978, and the polyphenoloxidase activity [44] and classification by type, which obeys the Official Table for Classification, according to impurities and defects found in 300g of coffee [28].

The roasting of the coffee is a process considered of great importance in the quality of the final product, since this process consists in heating the beans under high temperatures (180ºC to 240ºC) promoting physical and chemical changes in the beans as color and aroma [45]. Physical changes promote volumetric expansion and changes in bean texture and color. As a result of the heat transfer, pyrolytic reactions occur that cause the formation of several volatile and non-volatile compounds, mainly from the Maillard reaction, hydrolysis and condensation of compounds and caramelization of sugars. These compounds are responsible for numerous sensory characteristics such as fragrance, aroma, acidity, body, sweetness and residual taste [41].

In the light roasting, there is a predominance of a certain acidity due to the presence of chlorogenic acids, citric, malic and tartaric, whose concentrations decrease with the increase of the roast degree, emphasizing greater tactile perception of oiliness and viscosity in the mouth, coffee beverage and aroma (olfactory perception caused by gases released from roasted and ground coffee after infusion preparation). In the medium roast, the body and the aroma are more prominent and in the dark roasted, the flavor of burned is caused by the carbonization of some components of the coffee [46]. The roast degree is measuread through a color scale (Agtron).

VI IMPORTANCE OF QUALITY PRESERVATION FOR THE MAINTENANCE OF BIOACTIVE COMPOUNDS IN COFFEE

The usual diet provides, besides the macro and essential micronutrients, some chemical compounds, present mostly in fruits and vegetables, that exert a potent biological activity proven by several studies. These compounds are called bioactive compounds and may play several roles for the benefit of human health, being extranutritional constituents and typically occur in small amounts in foods [47].

The bioactive compounds found in consumed coffee are associated with numerous beneficial effects to health. The main ones are chlorogenic acids that are responsible for a series of volatile compounds important for the flavor of the beverage; the caffeine, an odorless substance that has a very characteristic bitter taste, contributing with an important bitterness to the taste and aroma of the coffee beverage and the trigoneline that during intense roasting, undergoes severe thermal degradation, generating a series of volatile compounds important for the taste and aroma of the beverage and an important vitamin for human metabolism, niacin [34].

Epidemiological studies carried out worldwide suggest that the daily intake of the beverage is capable of exerting influence in reducing the risk of developing non-communicable chronic diseases, such as cardiovascular diseases, metabolic disorders, cancers, neurodegenerative diseases and inflammatory diseases e in addition to improving alertness [48]; [49], [50]; [51].

VII MICROBIAL PARTICIPATION ON SENSORIAL AND SAFETY COFFEE QUALITY

As previously reported in this review, there are different kinds of coffee beverages in consequence of differences in chemical,physical and chemical physical compounds that confer different nuances in terms of body, aroma, acidity and astringency[34],[35]. The action of microrganisms are between the many factors that influence the final beverage [52], [53]. The microbial metabolites produced in this period can diffuse into the grains and influence the beverage final quality. The microbial diversity in this process is high and several species of bacteria, yeasts, and filamentous fungi have been identified [54], [55].

In extreme cases, when the fruit ripening period takes place under very favorable environmental conditions for microorganisms, undesirable fermentations can start in fruit, still in plant. As example of these extreme case are the plantations near to water bodies, were the relative air moisture at the coffee development is high. In this case no investment in post-harvest operations will not restore the quality of the final product already committed in the plant [21].

The fermentation process by the action ofmicroorganisms such as bacteria, fungi and yeast, degrade the beans membranes [56]. However, if the phenomenon is stopped after the loss of mucilaginous layer of fruit, the endosperm is not compromised and beverage quality is preserved. The continuity of the process involves breaking the walls and cell membranes, cell layers degradation and alteration of chemicals of the bean and beverage, resulting in unpleasant taste and odor [57], [66].

Pre-harvest injury such as infection of the fruit still on the plant by microorganisms; insect attacks, mainly coffee fruit borer(*Hypothenemus hampei*) causing injuries in the plant facilitating infection by micro-organisms [58]

development of soil microorganisms in the fallen fruits beneath the canopy (sweeping coffee); adverse weather conditions that cause injury to the fruit (frost, hailstorms) and fruits very mature in the tree (in which senescence has already started) are factors that explain the difference in quality from one coffee region to another. In places where worse beverage coffees are produced, weather conditions such as high relative humidity in the ripening, harvesting and processing of coffee and high temperatures favor the further development of microorganisms [52].

Coffee is processed in one of ways: dry, wet and natural pulped processing, the last processing method developedin Brazil. The dry process is the predominant process used for Arabica coffees in Brazil, Ethiopia and Yemen, as well as for practically all Canephora coffees worldwide. The wet process is predominant method for Arabica coffees in Colombia, Costa Rica, Guatemala, Mexico, El Salvador, Kenia and recently a small percentage of Canephora coffees [59].

Microorganisms can be naturally present in all coffee post-harvest and influence the final quality of the beverage, or by degradation of compounds present in the beans or the excretion of metabolites. The effect of microorganisms is primarily when there is a sample of a mixture of different stages of maturation and processing by dry method. The wet wet coffee processing, submitting ripe fruit to the rapid elimination of fermentation source may result, if well conduced, in good quality coffee [21].

The dry process refers to methods where the fruits are fully dried to yield coffees known as unwashed or natural, immediately forwarded to drying after harvesting and hydraulic separation. The hidraulic separation is of fundamental importance once the fruits are separated in two fraction; one is the unripe and ripe fruits, more dense, and other that are less dense due to different factors as biotic (bored fuits) and abiotic injuries, fruits dried in the plant and are known as floaters[60].

The wet processing refers to various methods in which the beans are separated mechanically peeling fresh fruit (pulping) before drying and may or not include a fermentation step.The decision on which method to adopt depends on economic factors or environmental factors such as areas subject to high relative humidity during the harvesting and drying the coffee. One should also consider the requirements and preferences of markets intended production [1].

The vast majority of Brazil coffee beans are still processed by the dry method since Brazil is one of the few countries in the world that has the appropriate weather to do so successfully. The Brazil's distinct dry and wet seasons, allows Brazilians to harvest coffee via the strip picking method and/or mechanically. The under-ripe and overripe cherries are also harvested, careful processing will easily remove these coffee cherries[21].

Coffee beans have all the precursors needed to generate typical flavor and aroma during the roasting operation but the natural microbiota during the fermentation/drying step confer special flavor in the coffee beverage. The microorganisms naturally present in the production environment use sugars in the pulp and mucilage and excrete organic acids and other metabolites that may affect the final sensory characteristics of the beverage. In addition, coffee fermentation and drying must be managed in order to control the growth of filamentous fungi that can produce off flavors and mycotoxins [57].Although the control of coffee fermentation is not a new idea, in recent years we can see an increase in the interest of researchers in the selection of microorganisms that can be added to the fermentation medium, reducing the randomness of this process.

The production of natural coffee, traditionally known as the dry method, is the oldest and simplest coffee processing method and it consists in drying the entire coffee fruit. It is largely used in tropical regions where the dry season coincides with the harvest period [60]. In some cases, depending upon the some factors as the plantation size, the occurrence of rain at the harvest period, the cherries are machine dried after being in the sun a few days. However under the coffee quality point of view, the presence of all fruit tissues like the exocarp or skin and pulp containing the mucilaginous layer, may predispose the beans to microorganisms infection including the toxigenic ones.

The dry process has more microbial species than the other processes (pulped or dehulled) because the whole fruits are processed and it is known that in dry method the deteriorative microorganisms, present superficially in the skin, has more opportunity to penetrate in the pulp and reach the beans. On the other hand, in the wet process, the skin and pulp are full or partially removed, and consequently, the epiphytic microorganisms are mechanically removed [61].

The presence of organic acid from fermentation (acetic, lactic, butyric and propionic acids) confirms the microbial action in the fermentation process for natural coffees. In the beginning of the process, the bacteria species predominate over yeast andfilamentous fungi, but this changes when the water activity and physical-chemical conditions alter in the medium and the final phase of the fermentation[55].

Silva et al. [54], studying the succession of fungal and bacterial communities during the fermentation of natural coffee (*Coffeaarabica* L.), found that *D. hansenii* and *Pichia* were the most frequent among the yeasts, but were still present in smaller population that fungi and bacteria. However, yeasts identified in this study have been reported as inhibiting the mycelial growth of filamentous fungi and may thus potentially be used for the biocontrol of filamentous fungi. Other researches has been developed to test the improvement of coffee beverage quality by using selected yeasts strains during the fermentation in dry process, with promising results about the use the selected yeasts as starters in the coffee fermentation process [62]; [63].

According Silva [57], the microbial diversity of coffee beans in wet processing is smaller compared with that in dry processing, because the fermentation time is shorter (up to 48 h) and there is a more rapid pH decline from 6 to 4.3.This microbiota comprises few bacterial and yeast species. There is no report of filamentous fungi involved in wet fermentation. The mucilage adhered to the substrate beans is used by bacteria and yeast during fermentation [64].

About the role of yeast in the fermentation of the beans depulped, some researchers do not believe the yeast action on the mucilage degradation. However, pectinolytic yeasts have been isolated during the wet processing of coffee in both robusta and arabica coffees. Pereira et al., [53]; Pereira [63] used a selected yeast starter culture, *Pichia fermentans*YC5.2, originally isolated from wet processing and selected through specific characteristics suitable to drive the fermentation process, viz., coffee fermentation-associated stress tolerance and flavor-active ester compound production

The pulped natural method consists of pulping a coffee, but emitting the fermentation stage to remove the silverskin. The microbiota of the natural dehuled coffee processing is still not well known. The great diversity of prokaryotes and eukaryotes was detected using polymerase chain reaction-denaturing gradient gel electrophoresis (PCR-DGGE) in addition to conventional techniques. PCR-DGGE allowed the detection of species not isolated from conventional techniques, such as *Enterobacter cowanii, Lactobacillus plantarum, Pantoeaagglomerans, Bacillus macerans*, and an endophytic bacterium that could not be cultivated and the yeasts *S. cerevisiae and H. uvarum*. The presence of filamentous fungi was detected with populations below 10^3 CFU $^{g-1}$ and only in recently harvested fruits, washed fruits, and fractions in the skin and pulp portion.

The filamentous fungi species found were:*Aspergillus sp.,A. chevalieri*, *A. foetidus, A. niger, A. ochraceus, A. tubingensis, A. versicolor, Cladosporium sp., C. cladosporioides, C. macrocarpum, Cylindrocarpon sp., Eurotiumchevalieri, Fusariella sp., Fusarium sp., F. chlamydosporum, F. lateritium, F. nivale, F. solani, F. sporotrichioides, Geotrichum sp., Mucorhiemalis, Penicillium sp., P. brevicompactum, P. commune, P. decumbens, P. fellutanum, P. implicatum, P. roqueforti, Phoma sp*., and *Ulocladium sp.* [57],[21].

Stringent regulation on food safety standard may arise from particular importers, country specific bodies and world standard organization. It is increasing also, among the consumers, the concept that one of the most important components of quality food is good safety. Coffee contains a set of molecules that can exert an effect on health, some of them are naturally present in coffee beans, while others are derived from biochemical reactions that occur during roasting. Still others such as ochratoxin A and pesticideresidues are external compounds independent of coffee chemical composition.

According Djossou et al., [65] fungi, including toxigenic ones, can infect and develop in the beans in the field, during harvesting, drying and storage. The factors that favor this development and the production of mycotoxins are classified into three categories: physical, chemical and biological. They are related to the bean itself conditions and the environment that surrounds it. The most important among them are: bean moisture content, relative humidity and air temperature, strain the contaminant fungus and microbial competition. The storage period, impurities (plant debris, dust, bark and bits of bean), light, insects and mites, beans conditions (beans with mechanical and / or visually altered damage), microclimate (oxygen), fungicides, composition substrate, resistant varieties and the degree of contamination can promote the proliferation of fungi and formation of mycotoxins.The possibility of biological control of spoilage micoorganisms is considered as a feaseble alternative[66].

Three species or groups of species, all of the genus Aspergillus, are of significance: *A. niger* complex is undoubtedly the most common, particularly in *Coffeacanephora* (robusta), but OTA production is rare and usually feeble. A study revealed only one producer of seventy isolates tested; *A. ochraceus* and related fungi are well distributed in the coffee production systems and a common producer of air (about 80% of the isolates readily produce OTA), forming the group of most important species of this mycotoxin production; *A. carbonarius* is usually rare, but there is some evidence that it is relatively common in certain places. Many isolates seem to be capable of producing OTA in significant quantities, although in a restricted range of environmental conditions. None of the species producing OTA of the genus *Penicillium (P. verrucosum* and *P. nordicum*) has been isolated from coffee. *P. brevicompactum* is common in coffee and is in the same group the two producing species, but it is not a producer of OTA [64].

Ochratoxins are a group of potent renal mycotoxins that widely contaminate the agricultural commodities, such as corn, wheat, oats and dried beans. There are four ochratoxin homologues — A, B, C and D Ochratoxin A (OTA) is the most prevalent and, together with ochratoxin C, most toxic. Initial symptoms of ochratoxicosis observed in all species include anorexia, polydipsia, polyuria and dehydration, and are associated with renal damage[69].

Upon absorption, ochratoxins enter the circulatory system, bind tightly to serum proteins and accumulate in the kidneys, where they disrupt protein synthesis and other pathways in proximal tubular cells. This results in the degeneration of the proximal tubules and interstitial fibroses [67]. OTA is also known to bind with DNA molecules and induce renal tumors in animal models, although its carcinogenic mechanism remains controversial[68], [69].

The European Community, in order to control the presence of OTA in coffee beans and derivatives has recommended maximum tolerance levels of 5 µg/kgfor ochratoxin A in roasted and ground coffee and 10 µg/kg in instant coffee for marketing (in force since April 2005). Brazilian legislation establishes a maximum tolerable limit of 10µg/kg of mycotoxin for both (ground and whole bean) and soluble coffee as approved by resolution RDC N^o 7 of the National Health Inspection Agency (Agência Nacional de VigilânciaSanitária or ANVISA) on February 18, 2011[69].

CONCLUSION

The present review demonstrates that, undoubtedly,in last decades, Brazil is investing hard to improvement of comprehension of the parameters affecting the coffee quality and the chain actors have been a proactive behavior in all steps of the productive and industrialization, readily absorbing new technologies generated by the research. So we can say that,definitively, Brazil joined in the market of

differentiated and high quality coffee as well maintaining its leadership in coffee commodity production.

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