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# TECHNOLOGICAL TRAINING IN THE BRAZILIAN ROASTED AND GROUND COFFEE INDUSTRY¤

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**ABSTRACT:**

Brazil possesses a roasted and ground coffee industry (R&G) with great number of small companies and a high concentration, with the production of 13 million bags in about 1500 units.

The objective of the research is to analyze the technological profile of the Brazilian R & G coffee industry and its domestic and foreign competitiveness possibilities. The *survey* method was used to raise data from the companies.

Traditional and family companies are not very concerned with planning but they have reasonable technological knowledge. On the other hand, large and middle-sized companies are striving to reach better quality, niches for differentiated products and possible market earnings.

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## INTRODUCTION

Technological innovation is the main tool for change in the world nowadays.

Indeed, the economic and social progress of several countries and the success of the industries and companies depend on the effective and efficient production of technical and scientific knowledge and subsequently incorporated into products and services available for the community. In the last years, the technological innovation ceased to be a mere academically interesting phenomenon to become an element of real survival in a fast changing world. However, the gap that separates Brazil from more industrialized countries, its regional differences and the difficulties to bring together institutional players are obstacles still to be overcome. (Sbragia, Marcovitch and Vasconcellos, 1994).

Most large industrial companies in southern and southeastern Brazil have been updating products and processes. However, it should be explained that this updating primarily resulted neither from direct investments in R&D, nor from learning processes and/or the development of internal competencies. In reality companies have employed intense transfer technology to enable fast innovation. This strategy would be likely be maximized should it be followed by an internal effort to complete the "absorption cycle' of the imported technology."

R&D as a percentage of GDP (gross domestic product) it is the most universal indicator of the scientific and technological effort of a country (Landi, 2002). Recent information appear, however that Brazil managed to raise S & T expenses (from 0,6%) to the current 0,9% of GDP in the last 2 years, adding into the budget of the Ministry of Science and Technology (MCT) resources from sectorial funds to finance the scientific and technological research in strategic sectors. (Izique, 2002).

As world leader in coffee production Brazil possesses a wide grinding industry characterized by a large number of small companies and a high concentration of few larger industries (Nogueira Junior & Moricochi, 2001).

The industrial segment of roasted and ground (R&G) accounts for the processing of about 13 million bags destined to internal consumption. That volume is processed by more than 1,500 coffee roasted houses , 489 out of which are now affiliated to the Brazilian Coffee Industry Association (ABIC).

The national industry, herein discussed, presents great heterogeneity, ranging from modern plants to rudimentary factories, the latter almost unable to compete abroad and even internally due to the globalization increasingly attracting the interest of foreign companies in the large consuming market the country has available.

Given the historical-economical importance of that segment in the development of the country, and also considering that little it is known about the technological structure of the R & R coffee industry, the present work proposes to bring some more knowledge on a few structural variables that address the sector. This will be studied under a twofold viewpoint, namely, of competition in the internal market and of the country's possibilities to conquer space abroad. Thus the main objectives of this research are to analyze the technological profile of the Brazilian R & G coffee

industry and to study other variables related with its competitive insertion not only domestically, but also its possibilities in the external market.

## COFFEE-ROASTING AND GRINDING TECHNOLOGY PROCESSES

This chapter on coffee roasting and grinding industrial technology was grounded on the text by Illy & Viani (1995) and complemented with information obtained from grinding companies and machines and equipment manufacturers.

Roasting is one of the main steps in the determination of the aroma of the drink (coffee) and it is a complex stage involving a series of hardly distinguishable chemical reactions. The grinding quality depends on a range of factors, some of which linked to the raw material.

Grinding is roughly a three-phased process: drying, with the elimination of the humidity; with the transformation of the precursors (the quality of the grain) in components of the toasted coffee through a series of pyrolitic reactions; and, finally, cooling, which restores coffee to room temperature.

During the drying phase the color of the grain changes from “green” (raw) for brown, also modifying the taste.

During grinding gas evaporation occurs just as it happens in the explosion of popcorns: when the explosion ends the product is ready. The ideal average temperature for coffee -roasting is around 240° C. According to Clarke & Macrae (1987), the liberation of gases start at 160 °C and peaks at 210°C, although it could extend up to 250 °C.

In Brazil coffee roasting can last up to 40 minutes. Longer period make coffee bitter and worsens the quality., but the higher volatility thus achieved allows for the use of a smaller amount of grain. The time varies according to the equipment, in some cases being only 3-4 minutes. It is worth bearing in mind that very short periods of coffee roasting may be insufficient for the accomplishment of all pyrolitic reactions causing undesirable organoleptic characteristics in the coffee.

Industrial toasters have developed greatly. The first equipment used heat by contact and were replaced by transport processes. The oldest toasters used pots, metallic balls or cylinders with hot surfaces.

Inasmuch as coffee is a poor conductive, a lot of energy is lost and the edges of the grain are burned, thus harming the quality of the final product. The advent of the fuel gas brought improvement to the coffee roasting process, in the form of a mixed system using transport and convection.

The fast development in coffee-roasting processes was facilitated by the increase in energy costs and in the environmental concerns, including the recirculation of gases and removal of undesirable particles. Thermal residues of energy can still be used for cooling.

The market has both conventional oven roasters and continuous roasters, their capacity varying according to the purpose. The most widely spread are those with rotating cylinders and flow techniques (air mattress).

The color changes progressively during the coffee roasting process turning from the greenish yellow tone of the raw coffee to darkish and brownish tones, and finally almost black . The color of the roasted coffee is therefore correlated to the final temperature of the coffee-roasting process and the bitter/acid relationship of the drink. The darker, the bitter it is in the cup, particularly in the traditional process.

The most important structural change caused during coffee roasting regards the hardness of the grain: the operation makes the coffee is brittle, facilitating the grinding - the subsequent stage of coffee roasting house, and that it requests less mechanical energy in relation to the green grain.

The first coffee roasting patent was granted in 1847 and the process has been widely progressing ever since. The proof is that between 1864 and 1914 the process lasted a whole 30 minutes, decreasing to a mere 5 minutes already in 1942 (Sivetz & Foote, 1963).

To be consumed, coffee needs to be triturated after it is roasted. This process receives the technical name of grinding, and its main objective is to allow the extraction of the soluble solids and emulsifiable substances that, after the mixture with water, give the characteristic flavor of the drink.

The very formation of the grain, involving not only an elliptic shell, but also several forms and compositions of cells (sugars, proteins, acids chlorogenic acids and lipids) makes grinding a complex process. In practice, coffee is ground in two ways–by impact and by gap.

In the first case the impact is caused by a series of cutting sheets rotating at high-speed. This process is used in small scale because it leaves undesirable residues. The thinness of the powder will depend on the duration of the operation.

On the other hand, in the gap process, cutting cylinders that contain holes through which the grains usually penetrate in free fall makes trituration.

The main types of cutting pairs are: cylinders with opposed parallel axes (of great industrial application); cutters, with a male cone that turns co-axially by pressing a cavity in which the grain to be ground penetrates by gravity; and flat cutters with conical cavities. These cutters are mainly used for high quality coffees.

Grinding takes place through the pressure in the wall caused by the rotation of the cylinder, being the ground powder expelled by centrifugal force.

Two phases are usually considered in grinding: a pre-grinding and a final one when the already smaller portion are fragmented into the desirable thinness. The tuning of the equipments will answer for the several types of coffee powder. The larger residues resulting from the first stage are usually eliminated. The homogenization of the mixture is very important, given its influence in the final product.

The adjustment of the precise distance between the cutting sheets that will grind the grain requires delicate and complex operations, which make these mechanisms very costly.

Blend formulation is another complex phase in grinding, since coffee is an agricultural commodity and, as such, it is subject to the natural variations of climate, soil and development of the plant.

It is worth noticing that grinding, like roasting, can also cause physiochemical modifications in the grain due to both a raise in temperature and attrition with the tools (sheets and cylinders). Besides, it can also liberate gases (CO2 and CO, mainly) , in addition to the oil that emerges to the surface of the powder, modifying appearance and aroma of the final product.

Every food has its sensorial characteristics modified during the storage by force of microbiological, enzymatic, chemical or physical activities. Those processes alter the composition and the physical aspect of the product and can provoke deterioration and even health damage.

The packing is the protection warranty for the aroma of the product for a certain period of time. However, the time should be limited so that the coffee does not lose its quality.

Once submitted to the high temperature of roasting, the coffee becomes a sterile product with reduced risks of microbiological and enzymatic degradation. Physical changes, however, with gains or losses of volatile products can happen, mainly because coffee is a product rich in hygroscopic volatile components.

The excess of oxygen is the main cause for deterioration in roasting, bringing an aged taste to the product. The tenor of oxygen becomes critical soon after roasting. Thus it is necessary for the coffee to " rest" at least for 8 hours before packing. The non-compliance with this procedure reduces shelf life by about 40%. The incidence of light also affects the useful life of the powder.

The coffee bean is sensitive to the oxidation because the grinding removes the CO2 barrier almost completely, while it increases the air/oil contact thus increasing oxygen. Lipids, an important fraction found in roasted coffee, rust easily during storage. Special techniques should be used for coffee conservation considering all the chemical transformations happening in the coffee roasting and grinding processes.

The materials for packing should be water, moist and atmospheric oxygen proof; they should preserve the aroma; prevent the entrance of strange odors and to allow the carbon dioxide to exit. In addition to that, they should be practical, cheap, ecologically friendly, hygienic - since they contain food - and chemically inert.

Packings are usually made of alluminum/polimer (films), leaf-of-flandres, paper card and glass. The most widely used are those in poymer/alluminum.

The packing techniques for roasted coffee are: vacuum, inert gas; air and pressurization.

Air packing is the simplest technique consisting of the moist proof natural packing. Its high level of oxygen accounts for a long shelf life and it is called cushion.

Vacuum packing eliminates practically all the oxygen and makes use of flexible materials, so that the product is totally adhered to the packing, with the format of a brick. It presents great earnings in relation to the previous process.

Inert gas packing immediately or gradually expels the air from the packing, through the placement of a pill of liquefied gas (nitrogen or carbon dioxide). The air then leaves through an aromatic valve

and evaporates in contact with air. It is superior in quality, when compared to the previous processes.

The pressurization process is practically the same, except that the internal pressure is higher than the atmospheric pressure, thus oxygen is expelled. The packing here has to be more resistant –leaf-of-Flanders or aluminum – but the durability of the product increases 10 to 15 days as compared to the other processes.

The choice of the technique will depend, above all, on the desired shelf life, on price and on time, i.e., distribution and consumption logistics foreseen. In this case it is worth noting that coffee is almost always consumed well after having been picked and thus requires special care in packing to keep its original quality.

Of the three analyzed stages, the packing is the one showing the greatest technological progresses.

**METHODOLOGY**

The survey method was considered appropriate for this research since it answered questions like , "What is happening?" or "Why or how is this happening?." This research has an exploratory purpose because, based on the *status quo*, it aims to discover new possibilities and dimensions of the population of interest, as emphasized Freitas et al. (2000).

The basic data for analysis came from forms sent to 511 companies – the vast majority of which registered in 2001 in the Brazilian Coffee Industry Association (ABIC) - and located in several states of the Federation. The companies headquartered in São Paulo, Minas Gerais, Bahia and Paraná represent 68% of the total.

Also, interviews were carried out with representatives of leading roasting companies and with manufacturers of coffee-roasting and grinding and packing machines and equipment. As a result, a form was drawn up with the additional institutional support from the Sectorial Chamber of Coffee, the Sao Paulo state Coffee Industry Union and Brazilian Coffee Industry Association (ABIC) whose central office is in the city of Rio de Janeiro. This joint support facilitated the engagement of this compound segment of the productive coffee chain.

The forms contained questions broken into four blocks, i.e., 1) company characterization; 2) managerial training; 3) productive and technological performance; and 4) competitiveness.

The interviews allowed a priori detection of the current conditions of the segment, highlighting threats and opportunities, many of them of crucial importance for the survival of the coffee roasting and grinding industry in Brazil.

A complementary objective of the procedure adopted was the updating of previous diagnoses carried out mainly by ABIC, emphasizing, however, technological innovation, considered as limiting factor to (almost) the whole Brazilian industry including the coffee agribusiness. It also moved forward in issues regarding competitiveness, the main focus of the work, which has worsened due to the opening of markets brought about by globalization.

## RESULT ANALYSIS

Industrialization is the second stage in coffee processing, the first being improvement or peeling. It includes two very different forms: roasted and ground (R & G) and soluble coffee.

The first product aims the domestic market and has a large grinding industry and the second has a small number of industrial units and mainly addresses the external market (Vegro, 1993).

The results here presented refer exclusively to the R & G coffee, considered the most traditional industrial segment in the productive chain and historically facing larger problems.

In the R & G coffee industry family companies and family managed by companies with hired management prevail. Those two types represent 89% of the total companies and answer for 91% of the production. Specifically in the case of the family companies with contracted management, the respective percentages are 19% and 55%, respectively.

Due to the industry characteristic of small aggregation of value, there is a larger concentration of jobs in the sales and production/distribution areas to the detriment of administration and technology.

The industries, whose productions are above 2300 monthly bags, answer for 76% of the supply to the retail equipment. In the other end, companies producing up to 100 monthly bags answer for about as little as 1,5%.

The degree of idleness of the industries increases as the production strata decreases, i.e., it begins with 42% in the strata above 2300 bags and it finishes with 79% in the strata with up to 100 monthly bags. The weighted average is 65%.

About 26% of the interviewees have a sound knowledge of the technology available in the company. However, 64% showed a low knowledge on the subject. Only 4 companies have the ISO 9000 certificate.

Most of the companies is reasonably engaged in training employees. On average, 57% invested in training in the last 5 years, being this concern greater in the family companies with contracted management.

The first priority of the companies is the quality of the final product and the second is the consumer's demand. Price and raw material readiness appear respectively in 3rd and 4th place in order of importance.

Entrepreneurs know other makes of main existing equipment in Brazil and abroad. Thus the reason why they do not have direct access to it is a subject that needs to be best analyzed. This may be caused by a lack of a line of specific credit, a hypothesis reinforced by the fact that almost 67% of the interviewees found the investment credit lines provided in the country inadequate.

76% of the companies invested in equipments in the last 10 years, more concerned with the modernization of the equipment (62%) than with the enlargement of the industry (43%).

Only 15% of the interviewees alleged to have made direct import of machines and equipment in the last 10 years, although 68% of the respondents have knowledge on what exists in terms of best coffee industrialization technology coffee in the world.

14% of the respondents exported coffee, of which 67% in the form of roasted ground coffee and 56% in the form of roasted coffee grain. The *Capuccino* had a participation of 11%.

The average yield in the green x industrialized coffee is 79%, but it is more common in the strip of 80% - considered, in practice, the ideal value.

26% of the interviewees use the high vacuum system and 22% the valve packing system. However, a large part of the trade is still in the cushion system (92%), which does not allow long shell life. Regarding the packing material, the most common types are: aluminized without valve (73%), polyester and aluminized with valve (46% and 23%, respectively).

As for the grinding type, hammer system still prevails (75%) followed by the plane roll (27%) and conical roll (7%). That is a negative verification, because once the hammer system provokes very high temperatures, it tends to harm the quality of the final product. Regarding the roasting type, the most usual system is that of convection (flow of hot air) with 58%, followed by the contact system (25%) and that of irradiation/conduction (11%).

92% of the respondents are concerned with the development of new products, which is one of the strategies suggested by specialists to increase coffee consumption.

A favorable general concern is verified with the competitiveness of the companies. However, research-like, although 55% have answered positively to that subject, the larger emphasis is on prices follow-up (86%). Research on new products and new technology is a smaller concern, 60% and 45% respectively.

In terms of age of the capital goods, there is an outstanding differentiation: in the coffee roasting process older equipments prevail (over 10 years); in grinding they have up to 5 years; and in packing the strip is also up to 5 years is the most representative, although in a larger proportion than the previous. This picture has to do a lot with the recent adoption of new technologies in the last industrial phase, mainly with the introduction of vacuum packing, an innovation interviewees are fully acquainted with.

The situation here portrayed has changed little in relation to other previous studies on the coffee industry. The work coordinated by Zylbersztajn (1993) already pointed idleness between 45,5% and 75,1%, inversely proportional to the company size. A wide diagnosis was accomplished on the coffee agro industrial chain, although it has considered only a few technological variables.

Vegro, Moricochi and Johnson (1997) also pointed to the traditional and concentrating aspects of the coffee industry, although it is now going through strong restructuring with technological advances, moreover in the packing phase of the product, in which the shelf deterioration process can be retarded and the product kept attractive to the consumer. The authors also tell that the quality of the Brazilian coffee is controversial. The sector is coming around to the need for improvements to increase the acceptance of the drink and to develop technology for that.

## CONCLUSIONS

As a leading coffee producer, Brazil possesses a wide industrial park for coffee roasting and grinding, characterized by great number of small companies and a high concentration of the production in few larger industries.

The internal market still predominantly supplied by low-quality coffee, although differentiated coffees like the gourmet, organic, of controlled origin, etc., already exist at higher prices.

The grinding industry (here meaning roasting, grinding and packing) is backed by a quite developed industry of capital goods, comparable to the best of the world.

In the coffee roasting and grinding segment of the productive coffee chain, a large part of the units are small-sized companies, with only a relative concern with planning and technological/managerial progress.

By and large, those companies are mainly concerned with selling coffee, without much regard to quality, the conquest of new markets and product differentiation. On the other hand, the medium and large-sized companies reach for and market niches for differentiated products and possible advances in market share

The hindrances to higher competitiveness have been low prices in force in the last years, the high cost for acquiring of state-of-the–art technology, and the difficulty to “win over ” sectorial markets due to several barriers.

The companies of external capital would have, in principle, better conditions, but the market “reservation” of other company branches located in strategic geographical points hinders any initiatives.

In this sense, the domestic market still comes as an alternative for the placement of products of proven quality, and that is already happening in a relatively accelerated rhythm.

By its turn, the factibility of external embarkments of expression of roasted and ground coffee requires a joint strategy, involving marketing, opportunities, wide government support and participation of all the segments of the productive chain.

Potentially, the Brazilian industry is technologically fit to compete and also to participate in export programs of R & G coffee, taking into account not only the sector upstream, but downstream as well, once Brazil is the second consuming market in the world The technological level of the main national industries of equipments almost reaches that which is considered state-of-the-art status abroad, especially in Germany and Italy. A few obvious adjustments must be made so that the export program can be triggered in a significant scale, both at the organizational level of the sector itself and at the level of technological (physical) and institutional support (adequate credit and economic diplomacy, for instance).

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