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FRENCH BREAD PRODUCTION: A CASE STUDY IN A SMALL COMPANY

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ABSTRACT

French bread, for many years, has been one of the essential foods on the table of citizens. In bakeries it is the main product, which makes it even more important to develop its production process. Thus, the objective of the present study was to analyze the production process of French bread in a small bakery located in a municipality in the midwest of Minas Gerais and to verify possible bottlenecks throughout the process. The study was carried out through a qualitative research, of descriptive character, which used the case study method, and the data collection was done through on-site observation. It was possible to detail the entire production process of French bread, its distribution and logistics, also analyzing the compliance with the specific legislation of the product by the bakery. In the end, bottlenecks were found that allowed us to suggest improvements to make the production process of French bread more effective in the bakery in question.

Keywords: Breads. Production process. Bakery. Bottlenecks.

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INTRODUCTION

Historically, it is possible to see that bread is one of the oldest foods present in man's diet. Until the present century, this is the most consumed food around the world. Consequently, the bakery industry moves a considerable volume of resources and generates a huge number of jobs in the most varied countries (PINHO, 2021).

Panificadora ADG (fictitious name given to the company studied in order to maintain business secrecy) is a family business, founded in 2020 in a municipality in the midwest of Minas Gerais, with the intention of offering products in the bakery segment with quality and good price. Its main products are French bread, bread, doughnuts, cakes and cookies, but it also covers a varied line of greengrocers, snacks and confectionery. It has its own production, not outsourcing any product from the bakery area. It also has a diversified line of drinks, ice cream and snacks. Seeking to adapt to the needs of customers, the bakery, in 2021, also started to have a mini-grocery store, selling mainly food products such as rice, beans, pasta, among others. The flagship products of Panificadora ADG are French bread, bread and biscuits in the package. Approximately 900 French breads are sold per day in the bakery, being the most manufactured product and responsible for a large part of daily sales, which is why it was the focus of this study.

According to the Brazilian Association of Bakery and Confectionery (ABIP, 2020), French bread is the main product of bakeries, even with all the innovations and diversification of the *mix* of products and services. In addition to being cheap, when consumed in moderation, the product is a great option for the daily diet, offering energy, fiber, vitamins and minerals. There are also options such as wholemeal, with less sugar and carbohydrates.

According to Augusto Cezar de Almeida, a specialist and historian on bread, in an interview with Agência Brasil, from the beginning wheat grains were consumed raw. Some historians say that the loaves were formed in a paste made of porridge chewed in the mouth, and that, by accident, they fell on top of a hot stone from a fire and, from there, a baked dough was generated. Before, there was a lot of rejection of what fermented because they thought it was spoiling. Louis Pasteur (1822-1895), a French scientist, was the one who managed to control and understand the fermentation process, leading this fermentation action to spread in a more controlled and industrial way (CRUZ, 2019). In an interview conducted by the Union of the Bakery and Confectionery Industry of the State of Mato Grosso (SINDIPAN – MT), Arthur Benevides, regional commercial manager of mills at M.

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Dias Branco, says that with the arrival of Italians in Brazil, at the beginning of the 20th century, the bakery activity spread and bread became essential on the Brazilian table, being his favorite food to this day, given its versatility. After all, bread can be consumed with butter, as a complement to soups, as a sandwich, among several other ways in which it is used throughout Brazil (SINDIPAN - MT, 2021).

According to SINDIPAN – MT (2021), 76% of Brazilians consume the traditional French bread for breakfast. According to ABIP, there are more than 70 thousand bakeries spread throughout Brazil (BINY; CARAVAGGI, 2021). According to ABIP (2020), the bakery sector has been strengthened year after year in Brazil. With the implementation of new technologies, preparation and execution techniques and investments in improvement courses, professionals in the sector have achieved increasing results for the Brazilian economy.

The Covid-19 pandemic slowed down trade in 2020 and caused revenues of R$ 95.08 billion in 2019 to fall to R$ 91.94 billion in 2020. At the beginning of 2021, the revenue of bakeries and confectioneries was 18.64% higher than in the same period of 2020. With the return of people to the streets, the companies' business increased, generating more sales. For 2022, sales are expected to be 25% higher than in 2021 (AMIPÃO – SINDICATO E ASSOCIAÇÃO MINEIRA DA INDÚSTRIA DE PANIZAÇÃO, 2022).

In 2021, the bakery and confectionery market earned R$ 105.85 billion in the country, a growth of 15.3% compared to 2020. About 2.5 million workers are part of the bakery sector, 920 thousand of whom have direct jobs and 1.6 million indirect professionals, according to 2020 data. It is estimated that 41 million Brazilians enter bakeries every day to buy bread (BINY; CARAVAGGI, 2021).

Thus, the objective of the present study is to analyze the production process of French bread in this bakery and verify possible bottlenecks throughout the process. This study may bring contributions in the academic field and allow a better and more adequate management of the production of the organization studied.

THEORETICAL FRAMEWORK

In recent years, the bakery sector has made great progress and expansion in the domestic market. As a result, it has been increasing its revenue annually and, consequently, its contribution to the GDP (Gross Domestic Product). With the growth of the

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sector, internal controls are a tool that can help in the routine of companies, regardless of their size, they need methods and procedures to maintain and protect assets. Improvements in inventory, quality and processes are fundamental factors for the growth of companies (MONTEIRO, 2014).

For Maximiniano (2000[5] *apud* FLORIANO; LOZECKYI, 2006), there is strategic, administrative and operational control: the first has the purpose of analyzing the company's performance both internally and externally, the achievement of goals and the factors that are influencing the company; the second has the function of controlling the functional sectors of the company, such as human or productive resources with the intention of supporting decisions; the third focuses on activities and resource consumption, using schedules and budgets as planning and operating tools.

PRODUCTION MANAGEMENT

Production Management is the activity of managing scarce resources and processes that produce and deliver goods and services, aiming to meet the needs and/or desires of quality, time and cost of its customers. Every organization, whether it aims at profit or not, has within itself a production function, because it generates some "value package" for its customers that includes some composite of products and services, even if, within the organization, the production function does not have this name. It can be said that production management is, above all, a practical matter that deals with real problems, because everything that is worn, used, and even food, goes through a production process in some way (PASQUALINI *et al.*, 2010).

According to Vitorino Filho (2012), organizations need planning in the differentiation of their products/services in relation to their competitors, in addition to other external threats such as market trends, new technologies, competition, political situations, legislation, etc. Nowadays, it is observed that strategic planning is an essential management tool for companies, and is currently one of the main topics of discussion in management, highlighting a growing number of companies in the most varied segments of activity, which contribute to the improvement of economic, social and political aspects.

[5] MAXIMINIAN, A. C. A. **Introduction to administration**. 5. ed. São Paulo: Atlas, 2000.

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FRENCH BREAD PRODUCTION CHAIN

According to Neves and Rossi (2004), there are several ways to define a "production chain". It is probably the easiest to say that the production chain of a good or service is a group of economic entities that have relevant parts of their business in the production of that specific product or service. In short, any company or entity that can profit from it, grow or lose its weakening, is part of a production chain.

The production chain is the process of converting inputs into final products. When we talk about agribusiness, let's look at a practical example: the production chain is the transformation of an input, such as seed, into food, which the consumer has at home. For this, it is necessary to carry out several steps, from the extraction of the raw material to the distribution of the product. For this, it is necessary to carry out several steps, from the extraction of the raw material to the distribution of the product. Following the examples already mentioned, the extraction of the raw material will be to find seeds and the distribution, to sell the product in supermarkets, where the consumer can buy it (EASYFARM, 2022).

As it is a food, the bread production chain has characteristics similar to the other chains of the foodstuff, with regard to care with hygiene, packaging, packaging, storage, transportation, distribution, as well as the specific characteristics of its production (CUNHA, 2012).

According to Baruffaldi and Oliveira (1998[6], p. 27 *apud* CUNHA, 2012), any production chain begins with the raw materials, which, in the case of bread, are flour, water, yeast and other ingredients that make up a recipe. At various stages of the production process, new substances emerge that are not present in the raw materials. Thus, French bread is made with baking powder, and after fermentation, the dough rises and is ready to bake. Still on the raw material of bread, the most common and used to make bread is wheat, 75% of which is converted into flour. The other 25% is used in animal feed (SEBRAE, 2008[7] *apud* CUNHA, 2012).

[6] BARUFFALDI, R.; OLIVEIRA, M. N. de. Main Operations and Utility Processes. *In*. **Fundamentals of food technology**. v. 3. São Paulo: Atheneu, 1998. p. 27-61.
[7] SEBRAE – BRAZILIAN SERVICE OF SUPPORT TO MICRO AND SMALL ENTERPRISES. **Homemade breads, non-industrialized**: market study. SEBRAE; ESPM, 2008.

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FRENCH BREAD PRODUCTION PROCESS

The methods of producing bread vary, but they can be condensed into twelve stages according to Vianna (2020). The **1st stage** begins with the recipe, through the technical sheet, which will present all the ingredients, steps and quantities necessary for production and must be adjusted to the production needs before starting. This step is fundamental for the standardization and quality of the product. After mastering the list of ingredients and utensils provided for in the technical sheet, the **2nd stage begins**, which is the *layout* of the place, that is, separation and organization of the work environment, the ingredients are separated in the exact quantities that will be used, the availability of utensils, machines are checked and, finally, an inspection is carried out, to check for possible forgetfulness. The **3rd step** is mixing and kneading/laminating, which according to the authors can be done by four different methods: regular direct, fast direct, standard direct and indirect (VIANNA, 2020).

The regular direct method, also called the traditional direct method, was used until the 1970s and required great effort from the workers, as all the work was done manually in the trough, which facilitated the handling of the dough. With the introduction of baking machines, the traditional method was abandoned. The quick direct method, also known as the *Chorleywood* method, involves mixing all the ingredients in the recipe at once in a quick mixer that has a high speed and quickly forms the gluten into the dough in about 3 to 4 minutes, then on the counter there is a short resting and final fermentation period, which takes about 2 hours to complete the process. This method is little applied due to the need for strict control of the process, such as dough temperature, overheating due to friction with the mixer, in addition to not allowing adjustment and visualization of the dough development during mixing (VIANNA, 2020).

In addition to these disadvantages, the final product has a weaker taste and aroma, which leads bakeries to a standard direct method, which can be done with a two-speed kneader or a low-speed kneader and cylinder, adding the dry ingredients first, then the liquid, and finally the fat. The ingredients are simply mixed at low speed and then fed into the cylinder or at high speed until the shading point is reached. As the development of gluten occurs gradually, the amount of liquid can be adjusted throughout the process, which takes about 3 hours from start to finish (VIANNA, 2020).

Production methods can be classified as indirect production methods when there are two or more stages of dough production, either those started with the preparation of pre-

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parts such as sponges and *pooling* or those maintained for variable times during the autolysis process, which is the process of mixing water and flour, leaving it to rest for a variable time before the dough rises. This first step can be done in a slow dough mixer or manually, and for the last step, gluten growth, a quick dough mixer or cylinder is required. The process as a whole can take about 4 to 24 hours, depending on the formulation. The longer the dough preparation time, the better the quality of the breads (VIANNA, 2020).

The **4th stage** of production is resting, which lasts from 10 to 40 minutes depending on the bread to be made where, generally, all the dough is formed into a large ball and placed on the countertop, covered with plastic to prevent it from drying out. At this point fermentation begins and the gluten chains relax, which allows the dough to become more elastic in **the 5th step** which is dividing and portioning (also known as pre-forming), dividing the dough into standardized portions based on the weight of each loaf, using the volume scale or divisor 15, being then rounded up. Finally, there is a new short rest on the countertop, lasting about 10 minutes to promote gluten relaxation again (VIANNA, 2020).

The **6th step**, modeling, can be done by a suitable machine (*shaper*) or by hand. In this step the bread is shaped and, once shaped, the **7th step begins**, where the bread is placed on a greased baking sheet. The joints of the dough, known colloquially as "seam", should be placed under the bread with at least 4 to 5 cm of space between each unit. Then the **8th stage begins,** the final fermentation. For this, a fermentation chamber with controlled temperature and humidity is used, or an enclosed cabin without temperature control. The fermentation time is variable and must be adapted to each recipe, depending on the amount of yeast and the temperature of the dough (VIANNA, 2020).

Also according to Vianna (2020), the dough when it reaches the ideal fermentation point moves on to the **9th stage**, where it is finally finished, in some cases even cutting with a blade on the surface (this will open the eyelashes in the oven) or sprinkling it with flour, seeds or other finishes so that the product dough is immediately sent to the oven for the **10th stage**, which is baking, where the yeast is inactive and dies, and the vapors and gases inside expand, causing the bread to rise and the gluten network to solidify.

The **11th stage** can be divided into three: the first happens in the first few minutes, steam is injected into the oven, especially for poor pasta, this delays the heating of the pasta, allowing more carbon dioxide to be produced. Yeast until it dies at 60°C. Then there is the expansion of the gas inside the bread, the gelatinization of starch and the coagulation of gluten, which determine the final size of the bread. The third stage is where skinning

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(peeling) and color enhancement occurs. The baking temperature of bread and the steam stream depends on several factors, such as the type of bread and the type of oven. And after baking, finally, in **the 12th step**, the bread must cool before being sold (VIANNA, 2020).

Good French Bread Manufacturing Practices and Industry Regulations

According to Sebrae (2017), in addition to the legislation and inspection common to all companies, such as labor and tax, companies in the bakery segment must follow specific legislation on health, food and labeling. Table 1 provides for these legislations.

Table 1 - Regulations involved in baking

Law 14.223/26/09/2006 and Decree: 47950	They provide for the placement of menus outside and for the obligation of advertisements.
Law No. 10.273, of September 5, 2001	It is the decree prohibiting the use of potassium bromate, in any quantity, in flours, in the preparation of pasta and in bakery products.
Law No. 12.560 - From January 8, 1998	Which provides for the use of filtered water in the making of bread dough, and provides for other provisions.
Law No. 12.389 of October 11, 2005	Provides for the donation and reuse of foodstuffs and food leftovers and provides for other provisions.
Ordinance No. 003 of the National Institute of Metrology, Standardization and Industrial Quality of January 10, 1997	Provides for the commercialization of French bread, or salt, by weight (weighing in the presence of the consumer) or units of defined nominal weight.
Ordinance No. 42 - CVS/MS of 01/14/98 (Federal Legislation)	Provides for the Labeling of Packaged Products.
Ordinance No. 146 / 2006 – INMETRO	Provides for the sale of bread by weight.
Ordinance SVS/MS No. 326, of July 30, 1997	Approves the Technical Regulation on "Hygienic-Sanitary Conditions and Good Manufacturing Practices for Food Producers/Industrializers".
RDC No. 90, of October 18, 2000	Approves the technical regulation for establishing the identity and quality of bread.
RDC Resolution No. 91, of May 11, 2001	Approves the Technical Regulation: General Criteria and Classification of Materials for Packaging and Equipment in Contact with Food contained in the Annex to this Resolution.
Resolution No. 105, of May 19, 1999	Approves the Technical Regulations: General Provisions for Plastic Packaging and Equipment in Contact with Food. Resolution of the Collegiate Board of Directors.
RDC Resolution No. 216 of ANVISA, of September 15, 2004	Effective March 15, 2005. Provides for the Technical Regulation of Good Practices for Food Services.
RDC Resolution No. 275, of October 21, 2002	Technical Regulation of Standard Operating Procedures applied to Food Producing Establishments and the Checklist of Good Manufacturing Practices in Food Producing Establishments.

Source: Adapted from Sebrae (2017).

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DISTRIBUTION

Hiremath *et al.* (2013) portray distribution as the steps taken to move and store a product from the manufacturer to the customer in the supply chain. That is, due to the similarities between these tasks and the concept of logistics itself, the understanding of the term becomes confusing. According to Santos *et al.* (2012), physical distribution encompasses the processes of storage, transportation, control, data exchange and monetary flow, enabling the transportation of products from the manufacturer to the final consumer. Ballou (2006) mentions as key activities: 1- Transportation; 2- Inventory management; 3- Customer services; 4- Information flows; and 5- Order processing. In this way, it is possible to see that decisions regarding logistics are extensive and decision-making must be based on appropriate indicators, based on accurate information, thus favoring a competitive advantage for the company.

Everaert *et al.* (2008) say that the need for information with a greater degree of detail and precision regarding costs would increase in the future, especially in the area of logistics, due to competition, with a focus on the rationalization of procedures.

According to Carneiro *et al*. (2009), if the organization is not aware of the function of logistics, the final price of a product will tend to increase in the same proportion as its competitiveness will tend to decrease, thus causing the authors to show the need to measure logistics costs. This measure is made based on the application of an appropriate costing method.

METHODOLOGY

The present research is qualitative, descriptive and uses the case study method. For Cruz and Ribeiro (2004), research is an attempt to understand and explain phenomena that occur in the universe perceived by man. The goal of research is not the accumulation of data, but the understanding of the data. Therefore, it is believed that the understanding of how these phenomena are treated and their structure and function is a preponderant factor in the acquisition of knowledge.

Qualitative research is not concerned with numerical representation, but deepens the understanding of social groups, organizations, etc. Researchers who employ qualitative methods reject the hypothesis of maintaining a single research model for all sciences, because the social sciences have their peculiarities based on their own methodology (GOLDENBERG, 1997). According to Gil (1999), the main objective of descriptive research

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is to characterize a certain population or phenomenon, or to establish relationships between variables.

The character of this study is descriptive in that it describes, documents, analyzes and explains processes with regard to the production of a product (LAKATOS; MARCONI, 2002). For this, a logistics analysis was used, through evaluation of the production process through an on-site observation, as a qualitative technique. Gil (2007) conceptualizes case study as an in-depth study of objects, which can be individuals, organizations, groups or phenomena, and can be applied in the most diverse fields. According to Gil (2007), case studies allow the object of study to maintain its unity even though it is imbricated with the context in which it is inserted; formulates hypotheses and theories; and it allows you to explain variables even in complex situations.

Data collection was carried out through on-site observation (within the company) of the French bread production process, where each stage of the process was observed in detail, such as the determination of the amount of bread produced per day, its distribution, logistics, compliance with the specific legislation of French bread. It was also possible to record photos of each stage of production, count the time of each one and reproduce the flowchart and the physical arrangement/layout.

RESULTS AND DISCUSSION

Panificadora ADG was founded after a market analysis carried out by the management. In the neighborhood where the bakery is located there were no bakeries, only supermarkets. The owners then talked to some residents and they all really liked the idea of having a bakery close to home. They decided to seize the opportunity and in 2020 they inaugurated the ADG Bakery. The company's biggest difficulty was the arrival of the Covid-19 pandemic in the municipality shortly after opening. It was necessary to readjust the bakery to the new reality and some measures, such as removing consumption on site and restricting the entry of customers into the establishment, reflected negatively on sales. Being an essential trade was what allowed them to move forward with the bakery. As the bakery became known, sales began to increase again and it ended up being very well accepted by customers.

The bakery has three attendants, two bakers, a bakery assistant, a kitchen assistant and a cleaning lady, with the owner responsible for the management and delivery of the products, accounting for 9 employees. The main products sold by the bakery are

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doughnuts, cream doughnuts and cheese doughnuts, cakes, cake in a jar, fried and baked cookies, broas, cheese bread, especially stuffed ones, fried and baked snacks, with the flagship being salt bread, kneaded bread and package cookies. The bakery intends to further increase its range of products.

FRENCH BREAD PRODUCTION PROCESS

At the ADG Bakery, approximately 900 French breads are produced per day, 200 of which are made in the morning for sale in the afternoon and 700 made at night for sale in the morning. To determine the amount of bread that will be produced, a forecast is made based on the demand of the previous days. The surplus or lack of bread at the end of the day is taken into account. If there are too many loaves of bread, the production for the next day is reduced in order to avoid the accumulation of stale loaves and a consequent loss. In the case of a lack of bread, the manager keeps the quantity for the next day trying to verify if there has really been an increase in demand. If the next day is also missing, he increases production.

In the morning (from 4 am) only baker is responsible for production. As there are fewer breads, the dough manufacturing process is carried out only once and lasts 50 minutes. The time for bread fermentation varies according to the temperature of the day. On warmer days (above 25°) the fermentation time is shorter and on colder days (below 25°) the time is longer. Since French bread is the first product to be produced in the morning, the internal temperature of the bakery also affects the bread fermentation process. While the bread is resting, which takes an average of 6 hours, in the bread cabinet (which has a maximum capacity of 500 loaves), the baker manufactures the rest of the products (doughnuts, donuts, packaged cookies and greengrocers in general). Therefore, the more products are baked, the more heat is generated and the faster the breads ferment. Therefore, the morning baker must always be aware of these two variables (temperature of the day and external temperature of the bakery), so that the fermentation does not occur all at once and the dough dies, and so that the fermentation is not too slow and the breads take too long to rise, delaying the departure of the afternoon breads, and the average time for this process usually varies between 5 and 6 hours.

At night (from 7 pm), a baker and a bakery assistant produce the breads. The manufacturing process is done twice, because, as much as the dough mixer has the ability to mix the dough for the 700 loaves at once, the mixture would be very heavy, causing

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unwanted wear and tear on the machine. In addition, the process must be quick so that the dough does not heat up and start to ferment at the table. As the production of French bread occurs in stages, if the mixture was made at once, the dough would have to be broken into 4 parts to be discharged without forcing the cylinder and without being too heavy for handling. After the entire mass has been cylindered, it would be cut into 1.9kg pieces, which would be rounded and divided, one at a time. After division, the dough would be placed on the table and until all the pieces passed through the modeler, it would take a long time. Therefore, in order not to risk compromising the machinery or the dough itself, the baker chooses to divide production into two parts. In this way, 350 loaves of bread are manufactured and, soon after, another 350 loaves of bread. The process of making each dough at night is 44 minutes, with 1h28min being spent to produce the dough of the 700 loaves. Manufacturing ends every day until 8:30 p.m. Fermentation takes place overnight and the loaves are baked at 4:15 a.m. the next day. No product is manufactured in this range, so the interior of the bakery follows the temperature of the environment. The night baker needs to be aware of only this variable to calculate the yeast necessary for fermentation to occur within the stipulated time.

In the bread manufacturing process, 8 pieces of equipment are used: mechanical scale, digital scale, dough mixer, cylinder, divider, modeler, bread cabinet and oven. It is possible to observe the arrangement of each machinery through the physical arrangement of the ADG Bakery, shown in Figure 1.

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Figure 1 - Physical arrangement of the ADG Bakery

Source: Survey data, 2022.

The flow through the ADG Bakery for the production of French bread is presented by a process flowchart, shown in Figure 2.

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Figure 2 - Flowchart of the French bread production process

Source: Survey data, 2022.

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The **first step** of the process, as shown in the flowchart, is the weighing of the raw material, where the baker weighs the amount of each ingredient that will be used to produce the dough according to the amount of bread to be made. The ingredients used to produce the bread are: wheat flour, salt, sugar, baking reinforcer, yeast, bread emulsifier, ice and water. The water is mixed with ice, as the dough must be as cold as possible to prevent it from heating up and drying out during the process, and the two together are measured in a measuring bucket, the flour is weighed on a mechanical scale, and everything else on a digital scale. This stage lasts 5 minutes. The **second step** is the dough mixing (Figure 3), where the dry ingredients will be added first, and then the liquid, in a dough mixer, to be mixed until a consistent dough is formed. There is then a stop in the process to wait for the completion of this step, which takes 12 minutes.

Figure 3 - Mixing the dough

Source: Survey data, 2022.

The **third stage** is the cylindering, where the dough formed in the dough mixer will pass through a cylinder with two rollers that will be responsible for removing the air from the dough, leaving it completely uniform and smooth. This dough will then be rolled to make it easier to carry out the next step. The cylindration process takes 7 minutes and is represented by Figure 4.

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Figure 4 - Clindragging

Source: Survey data, 2022.

The **fourth step** of the process is the cutting of the dough, where the dough will be cut into standardized pieces of 1.9kg, which will then be rolled manually. This step lasts 5 minutes and can be seen in Figure 5.

Figure 5 - Cutting the dough

Source: Survey data, 2022.

The **fifth step** is the division of each portion of rolled dough, where, with the help of a divider, each one will be divided into 30 equal pieces. It is a quick process that takes 3 minutes. This step is shown in Figure 6.

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Figure 6 - Mass division

Source: Survey data, 2022.

The **sixth step** is modeling, where each piece of dough will be passed through a modeler responsible for thinning and rolling the dough. These rolls will be placed on mats and will be in the bread cabinet for fermentation. There is a time difference for carrying out this step in the two production periods. In the morning, fewer breads are produced, with 200 units. But as the baker works alone, it takes him 18 minutes to pass all the dough through the modeler and place it on the mats. At night, each production is 350 loaves of bread, but the baker works with an assistant. In this way, the assistant passes the dough through the modeler and the baker places the modeled dough on the conveyor belts, taking 12 minutes to complete this step. The modeling process can be seen in Figure 7.

Figure 7 - Modeling process

Source: Survey data, 2022.

The **seventh step** is fermentation. All the mats are placed in a closed cabinet so that the dough rests and fermentation takes place. In the morning production, this waiting time

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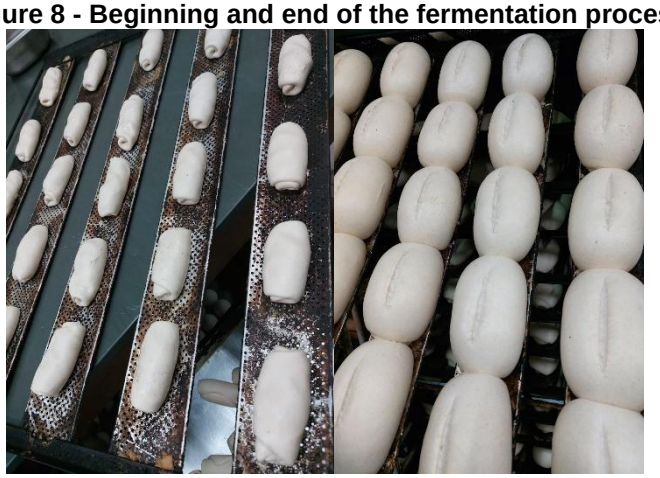
can vary between 5 and 6 hours. In evening production, the fermentation period is always 9 hours. This step can be seen in Figures 8.

Figure 8 - Beginning and end of the fermentation process



Source: Survey data, 2022.

After the fermentation of the breads, the **eighth stage** begins, which is the baking process, shown in Figure 9.

Figure 9 – Supplying

Source: Survey data, 2022.

First the oven is heated to a temperature of 180°. This preheating takes 12 minutes. Meanwhile, the baker prepares the loaves to be baked, making a slight cut on their surface with the help of a blade. Then the bread mats are placed in the oven. The ADG Bakery has two ovens, both with a capacity for 8 conveyors. Each conveyor belt contains 25 loaves of bread, so 200 loaves are baked per batch, each lasting 17 minutes.

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DISTRIBUTION OF FRENCH BREAD

Once baked, the French breads are ready for distribution. Both in the morning and in the afternoon, half of the breads manufactured are in the bakery and half are delivered to customers already agreed with Panificadora ADG.

The breads that will be sold in the bakery itself are then separated from the breads that will be delivered for resale in other establishments. Those that will be sold in the bakery come out of the oven and are placed directly in the display case for sale. Those that will be delivered are placed on the table to cool down. After being colded, they are packaged in plastic bags, with a maximum capacity of 25 loaves each, and are delivered through the bakery's car.

The owner and manager of the bakery is also responsible for delivering the products in both shifts, leaving in the morning at 5 am and in the afternoon at 1 pm. The morning delivery is only of the French breads, taking 30 minutes to complete. In the afternoon, in addition to French breads, package biscuits, breads, doughnuts, cakes, cream doughnuts and bread are also delivered, taking approximately 2 hours to complete.

FRENCH BREAD LOGISTICS

Panificadora ADG bases its production on its customers' demand for French breads. The breads that are resold are fixed, with changes only with prior notice to production, but the breads that are sold in the bakery itself have a variable output. Therefore, there may be a surplus or lack of bread.

If there is a shortage for two consecutive days, the bakery increases its production. If there is a surplus of bread, the bakery applies reverse logistics, where it packs all the breads that remain in the window at the end of the day, so that the next day they are sold as stale breads with a 30% reduction in the value of the kilo. Since the leftovers are small, all the loaves are sold the next day that way. If on a given day there is a large surplus of bread, the bakery makes toast with some and sells the rest as explained above, in addition to analyzing the possibility of reducing its production for the next day.

BOTTLENECKS PERCEIVED IN THE PRODUCTION PROCESS OF FRENCH BREAD

During the *on-site observation,* some bottlenecks related to the production of French bread were noticed. Regarding the *layout*, it was observed that the electronic scale, used to measure yeast, salt, sugar and bread reinforcer, is far from the other equipment. The baker

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needs to pick up the raw material located in the pantry below the table (represented by item 25 of Figure 1) and move to the scale (represented by item 12 of Figure 1) to carry out the weighing. Then, he keeps the rest of the raw material in the pantry and takes the weighed ingredients to the dough pan (represented by item 2 of Figure 1). A suggestion to optimize the time of this step and improve the *layout* of the process would be to place the scale on a small table next to the mechanical scale, which is on the side of the table that contains the pantry with the raw material used in the production of salt bread and in front of the dough mixer. Thus, the travel time would be minimal. This has not yet been done because, as much as there is space for the two scales on the table, the electronic scale only works by charging and there is an outlet where it is located. But with the help of a small extension, which could be next to it on the table, it would be possible to connect it, at the time of use, to an outlet that is on the wall next to the table, without the baker having to move to do so.

It was also observed that the breads frequently stick to the conveyor belt when they come out of the oven. To loosen them, the baker passes a smooth spatula between the bread and the mat, which damages the bottom of the loaves. In a conversation with the baker himself, it was realized that to avoid this problem he could grease the mats before placing the dough and, if some breads still caught, he should use a spatula with a saw to loosen them without damaging them. This measure had not yet been taken because the baker had not stopped to observe that the loaves suffer damage that, however small, could be easily avoided.

Timing the processes, it was noticed that an average of 20 minutes are spent to pack the resale breads in plastic bags. A suggestion to reduce this time would be the adoption of plastic boxes for delivery. This would facilitate the process and, in estimate, reduce the time by half, since it would only be necessary to count the loaves and put them in the boxes. In addition to being a more sustainable option, the boxes would also represent a reduction in the bakery's costs, since the bags are not reused and an average of 15 units per day are spent. With the boxes, there would only be an initial cost for their acquisition, considering that they last for a long time, requiring only frequent cleaning. To also facilitate hygiene, it is suggested to adopt closed plastic boxes, instead of hollow plastic boxes that have some reliefs that can be difficult to clean and would also avoid contact of the product with the external environment.

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ANALYSIS OF THE LEGISLATION SPECIFIC TO FRENCH BREAD

It was possible to observe that the ADG Bakery does not use menus outside the establishment, but that all the products made are always displayed in the windows, with a label and price, so that customers can choose the products they want. Advertisements are made on the city's radio and on social networks. The bakery does not use potassium bromate in any dough or product. The water used in the manufacture of bread dough is filtered, and the largest percentage placed is ice, which is supplied in 6kg bags that are stored in the freezer until the moment of use. A little filtered water is added to the ice to prepare the mixture.

Regarding the commercialization of French bread, it is sold by the kilo, so that customers can choose the breads they want to take and then weigh it in front of the consumer, on an electronic scale with a 2g division and indication of measured dough (weight) and the price to pay. French bread is not packaged and labeled before sale, being packaged only at the time of sale and weighed in front of the customer.

It was noticed that, considering its location, its facilities, its equipment and utensils, the storage of raw materials, cleanliness and hygiene, both of the personnel and of the production, with regard to the production of French bread, the bakery complies with the provisions of Ordinance SVS/MS No. 326, of July 30, 1997, which presents the technical regulation on "Hygienic-Sanitary Conditions and Good Manufacturing Practices for Establishments Producers/Industrializers of Food".

It was observed that the bakery also complies with RDC No. 90, of October 18, 2000, with regard to composition and requirements, weights and measures. As the commercialization of French bread takes place by weighing at the time of sale, there is no labeling process. The hygiene requirements provided for in this resolution were not investigated, as the study did not evaluate microscopic, microbiological and macroscopic characteristics.

The items of Resolution RDC No. 91, of May 11, 2001 were also not verified *in loco*. About Resolution No. 105, of May 19, 1999, the only plastic that comes into contact with French bread is the bag used to pack the breads to deliver to the customer, otherwise, in the whole process, no machinery is plastic.

Analyzing the resolution RDC nº. 216 of ANVISA and the Checklist of Good Manufacturing Practices in Food Producing Establishments of the DRC No. 275 of ANVISA, of October 21, 2002, it was observed that the bakery meets the requirements of food

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quality, with suppliers recognized in the market and appropriate accommodation of raw material, separating those that are open (in use) from those that are closed, which facilitates the handling and flow of employees. Regarding the evaluation of buildings and facilities, there is a positive result on flooring, access, bathroom, outdoor area and running water directly from the public network. The trash cans are managed daily and waste is removed by public collection three times a week. The lighting is effective. It has an exhaust fan in the room and equipment with safety locks. The cleaning of machines and equipment is done daily after the period of preparation and handling of the products and the preventive maintenance of the equipment is done for periods stipulated by the responsible outsourced company, with basic repairs made by the employees themselves, such as changing blades, adjustment and upholstery. The bakery does not have automatic closing doors, lighting and emergency exit, even though it has a door for the entry and exit of materials, and employees do not wear uniforms that separate the functions (sales and food handling). Therefore, adherence to these items may be a suggestion for adequacy for this specific resolution. In view of this, a price survey was carried out for these items to be implemented in the bakery (Chart 2).

Table 2 - Investment for compliance with legislation

Item	Price (R$)	Shipping (R$)	Un	Total (R$)	Site	Link
Baker's uniform kit with 1 t-shirt, 1 pair of pants and a cap	119.90 each	Free	3	359,70	mercadolivre.com.br	https://produto.mercadolivre.com.br/MLB-1504418438
Simple Custom Bakery Uniforms for Attendants & Kitchen	39.50 each	22,44	6	259,44	elo7.com.br	https://www.elo7.com.br/uniformes-para-padaria-e-confeitaria-uniformes-empresas/dp/1918BA7
Emergency Exit Sign with LED Lamp	76.45 each	3,99	1	80,44	www.americanas.com.br	https://www.americanas.com.br/produto/4273810498
Automatic Swing and Come Door in rigid ABS and heat seal	999.00 each	To be treated	1	999.00 without shipping	mercadolivre.com.br	https://produto.mercadolivre.com.br/MLB-1822258447
Total investment	R$ 1.698,58					

Source: Prepared by the authors (2022).

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CONCLUSION

The objective of the present study was to analyze the production process of French bread in a small bakery located in a municipality in the center-west of Minas Gerais and to verify possible bottlenecks throughout the process, in order to contribute to a better and more adequate management of the production of the organization studied. It was concluded that it was possible to detail the entire production process of French bread, its distribution and reverse logistics, in addition to analyzing the compliance with the specific legislation of the product by the bakery, finding bottlenecks and suggesting improvements, fulfilling the objective of the study. It can be concluded that the greatest difficulties encountered in the structuring of this study were to collect data on the production process while the bakers performed the steps that make up this process and to observe the entire layout of the kitchen for the creation of the physical arrangement of the bakery.

About the *layout* of the ADG Bakery, it is concluded that the location of the machinery is related to the stages of the production process, with a logical sequence of displacements between one equipment and another. This allows for time optimization, in addition to facilitating the bread production process. Only the arrangement of the electronic scale contradicts this sequence and the suggestion for its adaptation to the *layout* has already been indicated.

It is also concluded that, in a general analysis, Panificadora ADG complies with the specific legislation for the production of salt bread, but that it still needs to adhere to some items, such as: display of menus outside the establishment; self-closing doors; special uniforms for bakers; emergency exit lighting. As a suggestion for adequacy, an average budget survey was made for investment in these items and with the amount of R$ 1,698.58 (total value) the company could solve the structuring for production in accordance with the legislation.

It can be seen that the bakery is concerned with its production process, having well-maintained equipment, well-stored raw materials, valuing care with the production and fermentation time, which makes the loss of bread and dough due to these factors practically nil.

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