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PUBLIC UNIVERSITY OF NAVARRE

Agricultural, Food and Rural Environment Engineering

PROCESS DESIGN OF A FRUIT INDUSTRY

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September 2018

ABSTRACT

The objective of this project is the design of the conditioning process, refrigerated storage and with controlled atmosphere of a fruit industry meant to the conservation and its subsequent commercialization throughout the year. A differentiation of the product quality will be pursue thanks to pears with denomination of origin “Rincón de Soto” and peaches of integrated production, managing to maintain their physical and organoleptic characteristics of the product throughout the period.

To this end, an existing warehouse in the municipality of Alfaro, La Rioja, is being prepared, specifically in the Tambarria industrial estate, Tambarria 9 square, plots M.5.1 and M.5.2. In this industrial facility, the necessary machinery will be installed, and the appropriate refrigeration and plumbing installations will be calculated.

The market and the profitability and feasibility of the project will be analysed for an initially estimated production of 800 tons (600 t pears, 200 t peaches)

Key words: Designation of Origin, pear, integrated production, peach, refrigeration storage, controlled atmosphere.

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DOCUMENT 1
REPORT

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Content

1. Object

The objective of this Project is to design the process system of a fruit industry that Will be dedicated to the production of pears and peaches, located at southeast of Alfaro, La Rioja.

It is intended to provide the market with a product of differentiated quality, obtained through a Protected Designation of Origin and an integrated production.

The justification of the project is the study and analysis of the requirements of it, so that all the necessary actions can be executed correctly in order to achieve the maximum efficiency of activity in relation to the productivity and profitability of the project.

2. Scope

The scope of the project includes the design and start-up of a fruit plant proposed for the processing, storage and commercialization of pears and peaches. That is to say, the process that involves since the raw material is received until its later commercialization.

For this purpose, the technology and engineering of the production process of the plant will be studied, including the design of the plant distribution as well as the planning of the industrial activity and the design of the refrigeration and plumbing installations. Finally, a market and economic study will be carried out to analyse the viability of the project.

The pears of the Conference variety will be included in the Protected Designation of Origin pears "Rincón de Soto", while the peaches of the Catherina variety will be part of an integrated production identification guarantee.

The initial production of the industry will be 800 tons, of which 600 tons will be total production of D.O. and 200 t will correspond to the production of peaches.

In this project will not be carried out the installation of electrical network or the building of the ship. Neither any complementary work for the water supply nor the design of the piping network of hot water in the plumbing, as well as any other design or study that has not been previously commented.

The criteria for the acceptance of this project will be the economic viability and the feasibility of the same.

Several limitations are presented in the project:

- Economic limits
- Profitability limits
- Production limits
- Legal limits

Regarding the assumptions of the project, a strict control will be carried out on the product of origin (knowledge of the farms of origin and the good practices of manipulation in the field), since the high quality of the product is a priority objective in this draft.

The project will consist of the following documents in accordance with the UNE-EN 157001 standard: Report, Annexes, Plans, Measurements and Budget.

3. Background

The objective of this project is to overcome the skills needed for the subject "_501890_Trabajo Fin de Grado" to obtain the Agricultural, Food and Rural Environment Engineering degree from the Public University of Navarra.

The project estimates that there is a business opportunity in the treatment and processing of high quality pears and peaches for the supply throughout the whole year to the regional wholesale markets, initially expected, of La Rioja and Navarra.

To the achievement of this objective, it is proceed a refurbishment of an already existing warehouse in the municipal area of Alfaro, Tambarria industrial estate, in Tambarria square 9, plots M.5.1 and M.5.2. This locality is chosen due to its suitable location to obtain the selected raw material with a distinctive quality and its proximity and easy access to its target markets.

4. Standards and references

4.1. Legal provisions and regulations applicable

The main standards and references cited in this document *Report* are presented. The rest of the regulations and legal provisions that have been taken into consideration are included in *Annex 12. Standards and legislation.*

- Asociación Española de Normalización (2014). UNE 157001: General criteria on the formal elaboration of the documents that constitute a technical Project. Madrid: AENOR.

- REGLAMENTO (CE) N° 1619/2001 DE LA COMISIÓN of August 2001 laying down the rules for the marketing of apples and pears and modified in Reglamento (CEE) N° 920/98, of April 1999, establishing the quality standards for pears, or any other applicable legislation.
- Real Decreto 1201/2002, of November 20, which regulates the integrated production of agricultural products.

- REGLAMENTO (CE) No 1221/2008 DE LA COMISIÓN of December 5, 2008 amending, as regards the marketing regulations, the Reglamento (CE) no 1580/2007 laying down detailed rules for the application of Reglamentos (CE) no 2200/96, (CE) no 2201/96 y (CE) no 1182/2007 of the Council in the fruit and vegetable sector Real Decreto 1334/1999, de 31 de julio, por el que se aprueba la Norma general de etiquetado, presentación y publicidad de los productos alimenticios.
- Real Decreto 1311/2012, of September 14, which establishes the framework for action to achieve a sustainable use of plant protection products.

4.2. Calculation programs

- AutoCAD 2016
- Microsoft Word 2016
- Microsoft Excel 2016

4.3. Main bibliography

Vinas, I., Recasens, I., Usall, J., & Graell, J. Poscosecha de pera, manzana y melocotón.

Madrid Vicente, A., Gómez-Pastrana Rubio, J., & Santiago Regidor, F. (2010). Refrigeración, congelación y envasado de los alimentos. Madrid: AMV Ediciones.

Amigo Martín, P. (2005). Tecnología del frío y frigoconservación de alimentos. Madrid: Antonio Madrid Vicente Ediciones.

4.4. Other references

FAOSTAT. (2018). Retrieved from http://www.fao.org/faostat/es/#data

Ministerio de Agricultura,Pesca y Alimentación - Ministerio para la Transición Ecológica. (2018). Retrieved from https://www.mapama.gob.es/es/

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5. Definitions and abbreviations

AENOR: Asociación Española de Normalización (Spanish Association for Standardization)

P.D.O: Protected Designation of Origin. It is a type of indication of origin applied to a food product, generally of agricultural order, whose quality and characteristics are fundamentally and exclusively due to the geographical environment in which it is produced, transformed, processed and / or packaged.

FAO: Food and Agriculture Organization of the United Nations

ha: hectare

t: ton

km^2: square kilometre

TRT: Internal Rate f Return. Rate of interest or profitability offered by an investment.

UNE: Una Norma Española (A Spanish Standard)

NPV: Net Present Value

6. Design requirements

6.1. Internal constraints

The internal constraints are based on the existing industrial warehouse and the selection of the appropriate machinery for the process. Fundamentally:

- Suitable industrial building in size
- With easy access to the plot
- With easy circulation within it, that is, sufficiently spacious
- Correct ventilation, that is, with sufficient air circulation throughout the plant to work in optimal conditions
- Emergency and auxiliary doors
- Piping installation also suitable for machinery that requires water
- Refrigerating installation with storage chambers suitable for production capacity
- Fruit washing and drying machine
- Shower system for post-harvest treatment (drencher)
- Selection and transport conveyors
- Labelling machine and strapping machine

6.2. External constraints

6.2.1. Population and socioeconomic environment

Alfaro, as far as demography is concerned, is a municipality that has an area of 194.12 km^2 with 48.5 inhabitants per km^2. Population of great agricultural tradition, with fertile lands of irrigation, and that has created surroundings to this sector a great number of companies of transformation and feeding that in the last years have developed a great growth.

6.2.2. Employment and labour

The adequate recruitment of personnel should not involve any problem since it is an area with a long tradition in the agro-food industry and has a high number of experienced workers who can perform the work properly. In addition, Alfaro has a professional school in agro-foods industries, which can eventually facilitate the process.

6.2.3. Market

A market study of the pears and peaches fruit production has been carried out worldwide, as well as European level, Spanish level and local. This is how it has been possible to analyse the evolution of said market over the years from 2008 to 2016, whose development is in point *8. Market study* of this document.

6.2.4. Protected Designation of Origin

According to the specifications of Rincón de Soto pears, the pears protected by the Denomination of Origin "Rincón de Soto" pears are fruits of the species Pyrus Communis L., coming from the Blanquilla and Conference varieties, of the categories " Extra "and" I ", intended to be delivered to the consumer as a table pear in its fresh state.

The regulations that affect the extra category and I, must comply with the provisions of Reglamento (ce) n ° 1619/2001 of the commission of August 6, 2001, which establishes the commercialization standards for apples and pears and amending Regulation (EEC) No. 920/98 of April 11, 199, which establishes the quality standards for pears, or any other applicable legislation.

Alfaro is part of one of the four municipalities of La Rioja Baja that form part of the delimited geographical area of this denomination. The production area coincides with the conservation, conditioning and packaging.

6.2.5. Integrated production

Integrated production consists of an agrarian production system that respects the environment and ensures long-term sustainable agriculture. It combines biological and chemical control methods allowing the use of agrochemicals, but in a controlled and justified manner, always in accordance with the technical standards of each crop.

With integrated production, the entire production process is guaranteed, from before planting until the product reaches the consumer, knowing and controlling each step of the process to know the traceability of the product.

All this is regulated by Real Decreto 1201/2002, of November 20, which regulates the integrated production of agricultural products.

7. Location and siting

The location of the project is briefly summarized below, which is more detailed in *Annex 1. Location and siting.*

The fruit industry will be located at the southeast of the municipality of Alfaro, in the Spanish region of La Rioja. Specifically, it is located in Plaza Tambarria 9, plots M.5.1 and M.5.2, within the Tambarria industrial estate. The land has a total area of 8,334 m^2 of which 5,636 m^2 will be occupied by the warehouse.

The access to the plot is directly connected to the road of Logroño N-232, which is linked to the N-113 towards Valtierra. The N-232 connects directly with the capital of La Rioja, Logroño, as does the AP-68, which also easily connects with important regions of the country such as Zaragoza in Huesca. Navarra and the Basque Country also present easy communication.

As for the municipality of Alfaro, it is located to the east of the province of La Rioja Baja, being the largest municipality in the entire La Rioja and the fifth with the greatest number of inhabitants. It is very close to the Regional Community of Navarra and Aragón. The farmers of the area will be the main suppliers of the raw material of the plant, in this case of pears and peaches. Alfaro belongs to one of the municipalities where pears of Protected Designation of Origin "Rincón de Soto" are produced with which it is counted to treat the project mainly. That is why one of the main reasons why this location has been chosen for the project.

8. Market study

In this section, the market study will be summarized which is found in depth in the *Annex 3. Market study.*

The objective of this study is to collect a general idea of the situation of the fruit market at global scale, as European, Spanish and local level, to analyse the evolution that has been occurring in the market over the years.

The agri-food industry has undergone important changes thanks to innovation in forms of processing, handling and conservation of food, getting food less and less perishable and being available almost all year round.

8.1. At global scale

The main countries producing fresh fruits according to FAO are China and India, followed a long distance by Brazil and the USA. The continent that produces the most in the world is Asia, reaching half of the world's production and allocating a large part of its domestic consumption. On the other hand, America produces around 20% although it exports 70% of its gathering, while Europe has a production of only 16% and imports 50% of what it consumes.

The seed fruit trees along with stone fruit are two of the most known and consumed fruit trees in the world along with citrus fruits. Hereunder, certain data and evolutionary trends of both over the years during the 2008-2016 period are detailed.

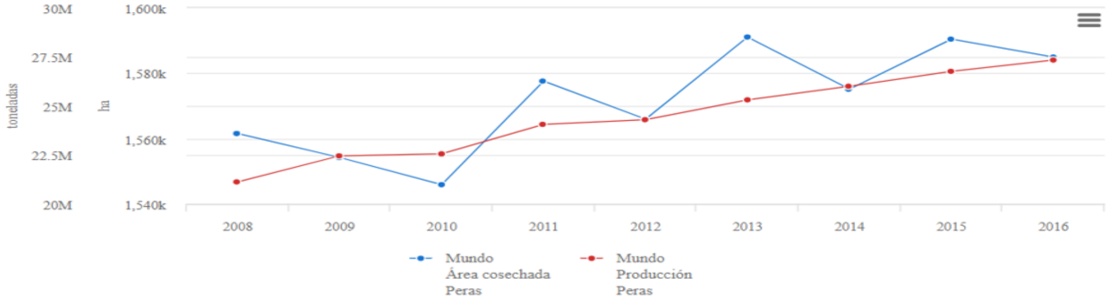
Table 1 shows the trend and relationship of production and surface area dedicated to the pear tree that suffers throughout the years in the world. In summary, despite the numerous increases and decreases in hectares, in total during the period 2008-2016 the area produced harvest has increased significantly (from 1560 hectares to 1580 has). Regarding its production during the period, it has been maintained in a stable and sustained growth, going from 21 million tons in 2008 to almost 27.8M ten years later.

The proportion of pears produced that represents each continent in the world is very disproportionate, representing Asia 76.5% of the total, followed by Europe with 12%, then America with 7.8% and finally Africa and Oceania, with a 3 % and 0.6% respectively. Thus, in terms of the top 10 pear producing countries in the world, the following countries are in the lead: China, Argentina, Chile, Italy, Spain and Turkey.

On the other hand, it shows the production trend that the peach has suffered over the years. In *table 2*, unlike the previous one, the production area has generally remained stable. The production is also stable maintaining a slight continuous growth over the years, since 2008 with 20 million tons until 2016 that reaches 22 million.

In terms of the proportion of the main peach producers in the world, Asia leads with 65.5% of the total, followed by Europe with 19.4%, America 10.7%, Africa 4% and Oceania 0.4%. Of them, the main countries are China, Italy, Spain in third place, followed by the US and Greece.

Table 1. Production / yield of pears in the world 2008-2016. (Source: FAOSTAT)



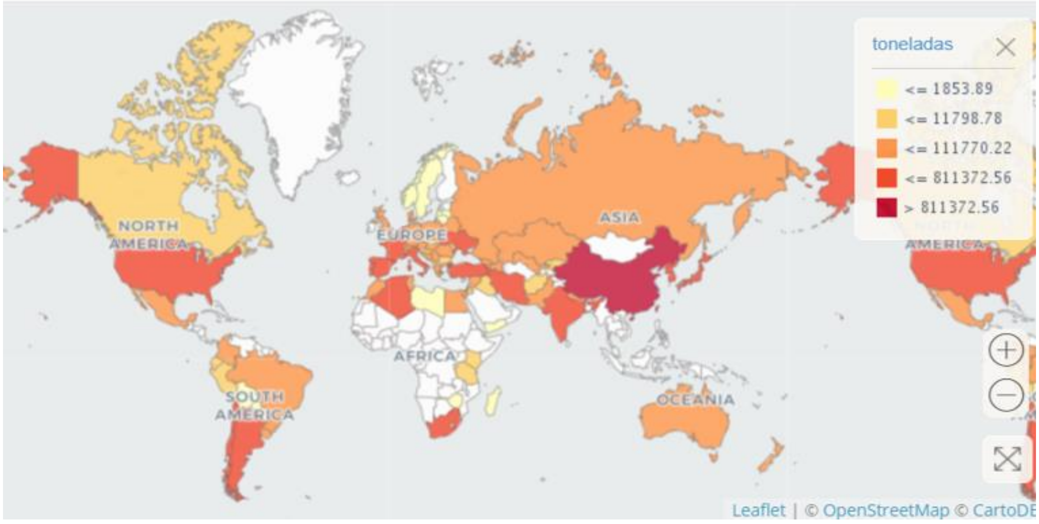
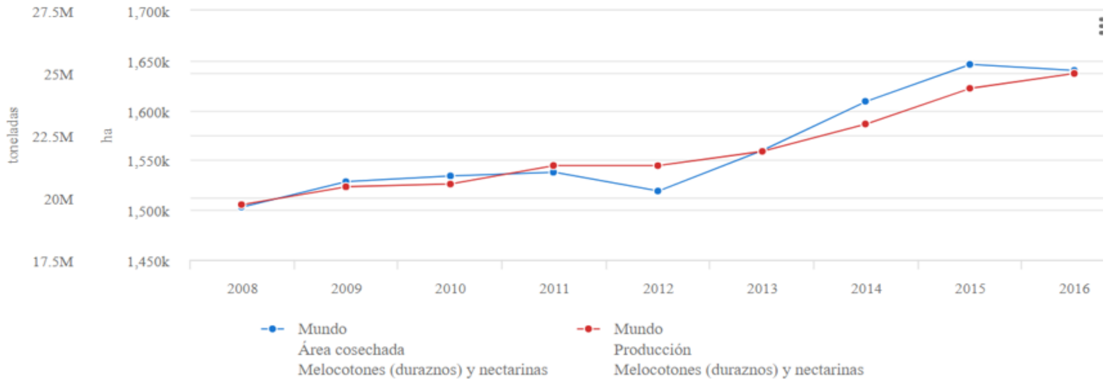


Figure 1. Production quantities of pears per country 2008-2016. (Source: FAOSTAT)

Table 2. Production / yield of peach in the world 2008-2016. (Source: FAOSTAT)



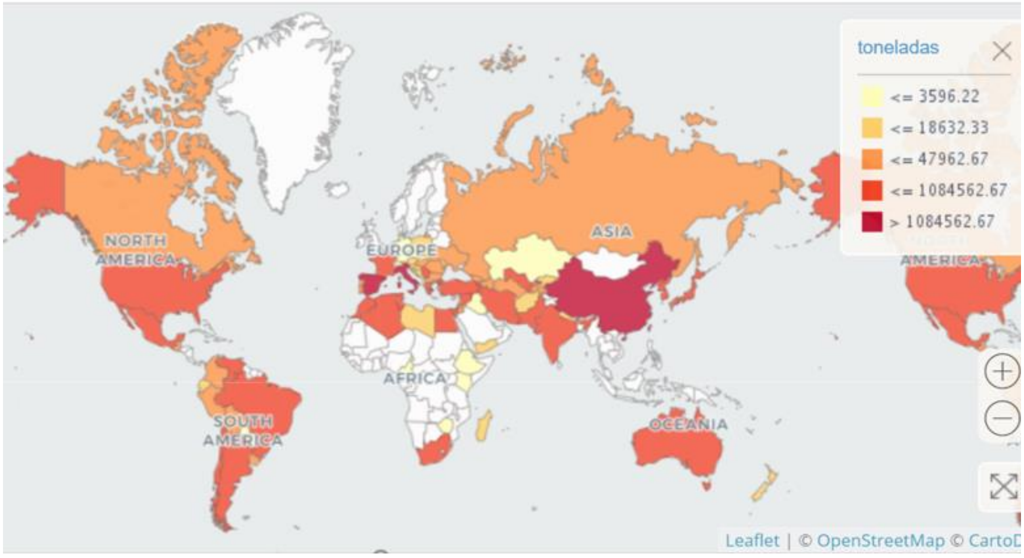


Figure 2. Production quantities of peaches per country 2008-2016. (Source: FAOSTAT)

8.2. Spanish market

The fruit production in Spanish agriculture has a very important weight both at export level and from the point of view of internal consumption. The pear tree has been historically together with the apple tree and the peach tree the three most cultivated fruit species in Spain, oscillating around 4500,000 tons in the last decade.

The level of production in Spain according to autonomous communities of pears and peaches are quite similar, with Cataluña being the community with the highest production in both cases. As regards medium / high production, Aragón is in both cases, only that in the case of peaches, Andalusia is also added. Finally, low peach production only occurs in Navarra compared to the case of pears that also occurs in Castilla y León, La Rioja and Murcia.

At European level, Spain and Italy are the main producers of fresh fruits. In the case of pears, during the period 2008-2016 suffers peaks of highs and lows, but is summarized in an increase in productivity despite the decrease in land. In the peach, production maintains practically the same downward trend as the reduction of the land until 2012, which produces a significant increase in productivity.

However, in Spain it happens unlike in Europe. The pear undergoes a continuous decrease in both surface and production and in the peach the opposite occurs. *Tables 3 and 4* show the evolution of the harvested area and the production of pears and peaches in Spain.

In the case of pears, the area has been decreasing steadily and permanently throughout the period, going from 28k ha in 2008 to 21k ha in 2016. Production suffers a sharp drop and falls more than the area of cultivated surface, being 540k tons the first year of the period and 22.5k in 2016.

In contrast, in the peach the reverse phenomenon occurs. Constantly increases the cultivated area (from 75k to over 85k has) and the production also increases, going from 1300 tons to 1500 tons.

Table 3. Production / yield of pear in Spain 2008-2016. (Source: FAOSTAT)

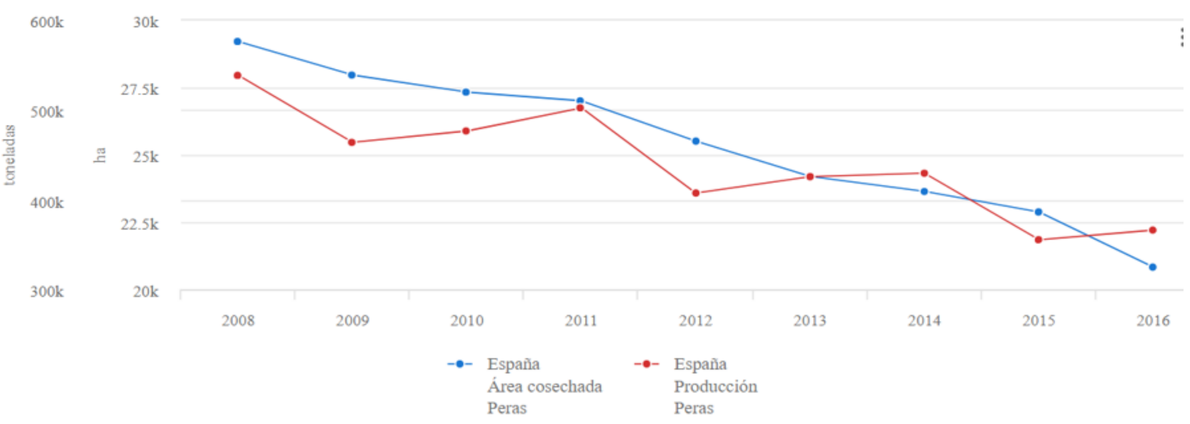
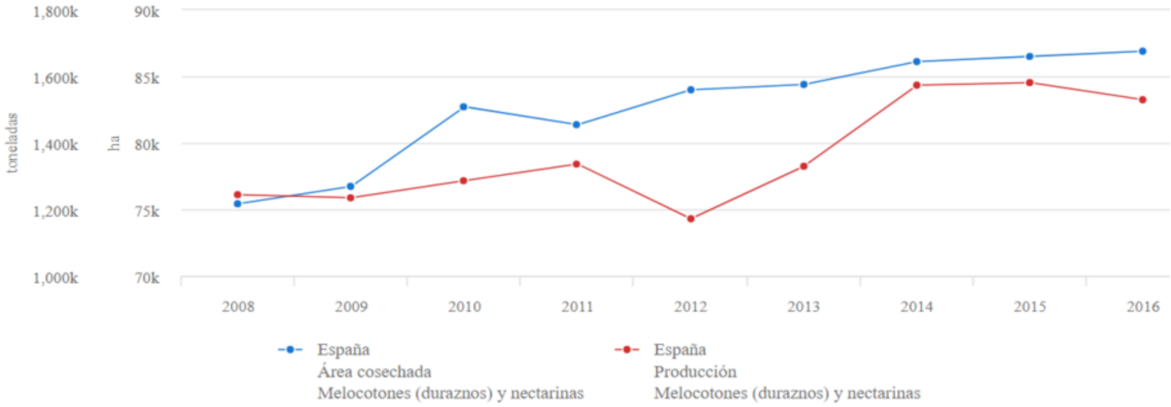


Table 4. Production / yield of peach in Spain 2008-2016. (Source: FAOSTAT)



8.3. Market in La Rioja

The market situation of pears and peaches in La Rioja, has been evolving over the years increasing and decreasing respectively, both in terms of area dedicated, as in production and price. It can be seen visually and clearly in the *tables from 9 to 14* of *Annex 3. Market study*

The surface dedicated to the pear tree has a more or less constant upward trend, being the maximum reached in 2014-1015 with 2500 hectares. However, production is suffering irregular peaks but reaching almost 60,000 tons in recent years (2015 and 2016) and in 2012 the lowest figure with around 48,000 tons of production. That is, the cultivated area is increasing and consequently, the production as well. Although there is greater production, there is an increase in price as the years pass. Normally, the more supply there is the lower the price, however, in this case.

In the case of peach, there is a decreasing trend in all cases. The area over the years decreases steadily, and production decreases in similar terms to the decrease in the harvested area. The prices, despite the decrease of production, are suffering peaks reaching their maximum in 2003, year from which the price goes down gradually. Therefore, the demand remained while production fell, where then the price rose until 2003, which all fell together.

Given the aforementioned global situation as a whole, and more especially taking into account that of La Rioja, to achieve an improvement in the increase in the sale price, it is convenient to focus on the integrated production peach to give it a special quality, with more distinction of the rest and therefore with greater value. The same is intended to be achieved with the pear, so to give added value and better quality, pears are chosen with the "Rincón de Soto" Denomination of Origin of the Conference variety, since it is still one of the main and most important productions in all the levels mentioned.

9. Raw material analysis

The analysis of raw materials is described briefly, the in-depth description is found in the *Annex 4. Raw material analysis.*

Thanks to their organoleptic and nutritional properties, the fruits are considered high value commercial crops. The ripening of the fruits encompasses a series of physiological processes controlled rigorously at the genetic level, which lead to a series of changes in the physical and organoleptic properties of the fruit such as color, taste, texture and smell.

Thus, the changes associated with maturation are mostly anabolic, so they require energy and a carbon source, which are mostly satisfied by respiratory metabolism. Depending on the evolution of the respiratory rate during ripening, the fruits can be classified as climacteric or non-climacteric. In this project, we will work with pear and peach fruits, both belonging to the group of climacteric fruits. In this case, the events related to maturation are coordinated globally by the ethylene phytohormone. This acts as a hormone in many aspects of the life cycle of the plant, so, from the point of view postharvest of fruits, its effects are very relevant commercially since they exert a great influence on the conditions of handling, packaging and storage Apply to the product.

Due to the low pH level of fruit tissue, both seed and stone fruit, moulds predominate as microorganisms that cause rot, most of them of the genera Penicillium, *Botrytus, Rhizopue, Mucor, Alternaria, Neofabraea and Monilinia spp*., the most important of which is *P.expansum* in pip fruit, both in appearance frequency and in volume of damage caused; and of the genus Monilinia spp. in the case of stone fruit. Both during the process of conservation in chambers and in their later commercialization, said moulds are the main responsible for the losses due to fruit rot. The use of synthetic chemicals for the control of rotting is the method most used today, mainly due to its low cost, its good level of effectiveness and its easy application.

9.1. Principal

9.1.1. Pear

The pear is the fruit of the pear tree, deciduous tree of the Rosaceae family up to 10 m high, with a rounded crown and a grayish green trunk. The fruit may appear green or yellow, broad at the bottom and thin at the top (where the peduncle); of fine skin and white flesh, with a sweet flavour and, in the centre, small black seeds. The main use is destined to fresh, reaching up to 90% of the total, the remaining 10% being destined to the industry for fruit salads, compotes, juices, etc.

The pear that is going to be treated in the fruit plant is protected under the Denomination of Origin pears of "Rincón de Soto". The differential characteristics of these pears are several. In the first place, the protected geographical area of its production makes the pears different from the rest. The technical and agronomic criteria that allow the P.D.O. of the pear are: the temperate Mediterranean climate, where 66.75% of the total irrigated area of the community is used for pear cultivation; its geographical situation, specifically the altitude and proximity to the surrounding valleys, the fertility of the alluvial soils next to the valleys, the cultivation techniques and the artisanal packaging method adapted to the current requirements of Food Safety.

Due to the altitude of the valley in which it is located and the adjacent rivers (Ebro, Alhama and Cidacos) that make it possible to generate a fog that ends up disappearing suddenly in a few hours, leaving a radiant sun and thus, the evaporation of the humidity deposited by the fog on the surface of the conference pear, due to the persistence of the sun, makes possible the appearance of Russetting naturally, without the need to use chemical products that artificially burn the surface of the skin. This parameter is highly valued in this area when differentiating its product from other geographical areas.

Thanks to the techniques used in the production processes as well as storage, conservation and expedition carried out in the area, together with the climatology and pedology of the area, it makes it larger, elongated, sweeter and its skin has more greenish colour, acquiring greater value in the market. Also, the peduncle once collected from the tree will be intact, whole, rounded and undamaged, thanks to the manual collection system used. At the same time, it is worth highlighting, apart from its great sweetness, the sufficient hardness it has, which facilitates its handling and conservation.

Regarding its organoleptic characteristics, the Conference pear presents a woody consistency that has an excellent flavour in terms of acidity and sweetness, high, intense and balanced. It has high juiciness and a high content of sugars, a component that greatly conditions the taste quality of the fruit.

Table 5. Parámetros óptimos de conservación de la pera.

	Tª (ºC)	HR (%)	CO2 (%)	O2 (%)	Período conservación
AN	-0,7/-1,0	94/96	-	-	3 meses
AC	-0,7/-1,0	94/96	1,4/1,7	2,5/3	5-6 meses
ULO	-0,5/-0,7	94/96	1	2	8 meses

9.1.2. Peach

The peach is the fruit of the peach tree, small tree and not very leafy. It is a typical drupe, with fleshy pulp with hard bone in the centre. It is usually yellow with reddish tones and is divided by a slit that gives it its characteristic shape. This is originally from China, where references to its cultivation date back to 3000 years. It comes from the Family: *Rosaceae, Genus: Prunus, Species: P. Pérsica.*

In this project, with the objective of finding differentiated products with quality marks, apart from the D.O.P in the Rincón de Soto pears, it has been decided to obtain peaches from an integrated production. This is based on, in accordance with RD 120172002, which regulates the integrated production of agricultural products, in a system for obtaining vegetables that make maximum use of natural resources and production mechanisms, ensuring a sustainable agriculture in the long term. To do this, it is introduce biological and chemical control methods and other techniques that combine the requirements of society, environmental protection and agricultural productivity, as well as the operations carried out for the handling, packaging, processing and labelling of plant products hosted to the system.

The management of this type of fruit is possible since it is dictated that it is only allowed in harvests destined to prolonged conservation, as it is the object of the project. All hygiene measures, handling, storage, reception and marketing of the product cited in the standard, are considered throughout the development of the process and completion of the work.

In this case, yellow peaches, specifically the early variety Catherina, will be manipulated in the central. The fruit has a calibre between medium and thick depending on the load, the thinning and the situation of the tree. Rounded, regular and symmetrical, with golden yellow or orange skin, with a light red plate on the sunny side. The pulp light yellow, consistent, juicy and perfumed, slightly acidulated, presenting a good taste quality.

Table 6. Parámetros óptimos de conservación del melocotón.

	Tª (ºC)	HR (%)	CO2 (%)	O2 (%)	Período conservación
AN	0/0,5	90/95	-	-	2-3 semanas
AC	0/0,5	90/95	4/5	2,5	4-5 semanas

9.2. Auxiliar

As for the main auxiliary material, it is count on crates, which cannot be made of plastic according to the PDO Specifications of "Rincón de Soto" pears, so they will be made of wood given their hygroscopic and insulating properties, which reduce the thermal jumps, decreasing fruit rots. This type of wooden crates will be applied also for peaches. The maximum capacity is 250 kilos of fruit per crate, avoiding excess pressure on the bottom fruit. They must be in perfect conditions of use and the lateral and inferior sheets must be sufficiently separated to allow aeration of the product.

The boxes are also taken into account to pack the product followed by its shipping. These will be made of plastic and with grid for ventilation, with dimensions of 495x370x155 mm. Before the expedition will be formed pallets called europalets retrieved heights with dimensions of 1200x800x145 mm. The pallet will be strapped through automatic strapping machines for which strip coils will be needed.

10. Study of the final product

The final product study can be seen complete in *Annex 2. Study of the final product*, which will be summarized below. In this case, the final product of the fruit processing plant is similar to the raw material, with the difference that it consists of the sale of pears and peaches that have been previously remained for long and shorter periods of time in storage chambers, either from normal refrigeration or controlled atmosphere. In addition, prior to storage, the product has received a post-harvest disinfection treatment to prevent future physic-chemical alterations in the chambers, along with a washing process before packaging.

In order to study the product, it is necessary to understand which are the properties that determine it, in this case, those that are both physical, chemical and sensorial, that is, those that define the concept of quality, which allows us to characterize the degree of excellence and superiority of the product itself. That is, through the food chain, the objective is that the product gathers the necessary characteristics to get a better adapt to its productive and commercial purposes.

In the case of this fruit industry, special importance is given to the refrigeration conservation capacity, including the intrinsic capacity of the fruit variety and resistance to microbiological diseases and physiological alterations. In addition, adequate management capacity, ease of handling and resistance to handling are demanded, as well as a prolonged shelf-life of the fruit after harvesting and cold storage, complemented by high visual quality. Food safety and the presentation of the product are also factors of great importance in the quality of marketing.

10.1. Quality atribute and its conditioning factors

Quality can be classified into different types, either visual, nutritive, sanitary, hygienic, etc., depending on the parameters and attributes determined. Among them, there is the external appearance, (colour, size, shape, external and / or internal defects due to mechanical damage, physiological alterations, pathogens, pests, etc.), the nutritional value (vitamins, minerals), the safety and hygiene of the product with an absence of chemical residues and microbial contamination.

In addition, there is the texture, which is part of one of the attributes with more weight in the final acceptability of fruit consumption. During maturation, one of the most common and visible changes is the softening of the fruit tissues, manifested in a decrease in the firmness of it. Apart from the relevance for the organoleptic quality of the fruit that this implies, this process has direct consequences on the potential for handling and conservation, since the weak tissues are more susceptible to microbial infections and mechanical damage, thus limiting the commercialization of the product.

Finally, the flavour, which covers all the components related to smell and taste. Along with texture, it is the attribute with the most influence on consumer acceptability.

There are several factors that intervene and directly affect the quality of the product throughout the productive process of the fruit; at the time of harvesting (climatic conditions and cultivation techniques required during the process) followed by post-harvest conservation techniques (with their consequent classification, packaging and transport operations) that the food suffers until reaching the final consumer, creating a direct effect about its fine quality.

To proceed with the study of the product, it is considered the fact that not only the factors that could condition throughout the industrial process determine the final product. That is to say, not only the possible effect on the storage conditions refrigeration and its subsequent commercial life, but also the effect of those factors conditioning the product during the pre-harvest, as well as those dependent on the variety and type of fruit and the effect of maturity in harvest.

Specifically, in relation to the conditions of cold storage and its subsequent commercial life, the effect that this suppose will depend directly on the species and variety considered, in this case of D.O Rincón de Soto pears and peaches, Conference and Catherina respectively. The conservation in controlled atmosphere produces a better maintenance of the parameters of quality with respect to the conservation in normal cold since they provide a greater firmness and a change of minor coloration, in front of a lower acidity and greater contents in soluble solids occurred in a conservation of normal cold. Regarding the commercial life after the conservation of the food, it is worth mentioning the abrupt fall of peach firmness that occurs easily.

10.2. Physical-chemical alterations

Some of the most frequent alterations in pears and peaches or those that have a greater economic impact at global level occur due to poor refrigeration conservation or due to fruit handling in the fruit central, which is important to have in account to be able to avoid it since the parameter of quality with absence of defects both internal and external is primordial.

10.2.1. Main alterations in seed fruit

- Blanching. The superficial blanching consists of a physiological alteration of the epidermis of the pears, manifested once a period of refrigerated storage has elapsed. The main problem that this involves is the considerable or total reduction of its commercial value, even though it does not affect the flavour or the texture of the fruit. This is manifest itself in the form of brown spots with diffuse edges of more or less intense brown colour, affecting the epidermis of the fruit without damaging the pulp. There is more risk the lower the conservation temperature is within the allowed range. Therefore, the product is subjected to storage in a controlled atmosphere for long periods of conservation, since it is more effective to avoid physiological alterations such as this in addition to delaying the ripening of the fruits and retaining the quality tolerances of firmness, colour and acidity.

- Internal decomposition. The internal alteration produced in the pear occurs mainly in the variety treated in the project, (Conference) after prolonged periods. It is characterized by a softening of the internal tissues which acquire a brown colour and appear soaked in water and soft. This is due to a fermentation process and fermentative metabolism related to low levels of O2 and high CO2 levels, but even so, CA prevents it to a greater extent since it also delays maturation and senescence against conservation in a normal atmosphere.
- Mechanical damage. There is a high proportion of defects in the pear due to bruises caused by mechanical or physical damage that can occur both before and after the harvest.

10.2.2. Main alterations in stone fruit

- - Cold damage. The range of critical temperatures is between 2.2 and 7.6 ºC and the damage, even though they originate during storage, the symptoms appear at room temperature, making it difficult to realize before the consumer. The most common effects are internal browning and reddening of the pulp, and, to a lesser extent, transparency of the pulp. In addition, cold damage can favour the development of microbiological diseases.

- Black colour. The black coloration is an alteration that affects the skin of the peaches, creating spots or streaks of black or dark brown colour. This is due to galling damage along with heavy metal contamination.

  As a control to acquire a final product without having these conditions, the quality of the water used for the treatments must be checked, particularly with regard to heavy metal contamination, keeping the equipment and containers used for harvesting clean, as well as how to handle fruit carefully and avoid long transports.

- Mechanical damage. The main mechanical damages in the peach fruit usually manifest as bruises or more extensive spots, usually caused by impact.

10.3. Commercialization of the product

According to the commercialization rules of Reglamento (CE) No. 1221/2008 of the commission of December 5, 2008, there are a minimum of quality requirements that both peaches and pears must meet after conditioning and packaging. Among these are the minimum quality requirements, that is, that they are clean, healthy, free from pests and damage, strange smells and tastes. In addition, they must be submitted within one of the three classification categories: Extra, I and II and meet their requirements. Finally, the peaches must meet a minimum characteristics of maturity: the refractometric index of the meat, measured in the median zone of the pulp of the fruit and in the equatorial plane, must be greater than or equal to 8ºBrix and the consistency less than 6.5 kg, measured with an 8 mm diameter shank.

10.3.1. Labelling and traceability

The traceability of the product is guaranteed when it is identified in each of the stages of production and commercialization.

The information that must appear compulsorily on food labelling, approved by Real Decreto 1334/1999 of July 31, is reflected in the "General norm of labelling, presentation and advertising of food products." They are the following data: Identification of the supplier, description of the product, expiration date, lot number, net weight and conservation conditions. Detailed information on labelling and traceability can be found in *Document 4. Specifications document.*

All units must be labelled with the logo of the denomination of origin of pears “Rincón de Soto" following the Specification sheet of the mentioned D.O and for peaches, the guarantee that they have origin of integrated production of the Communities must be identified Autonomous in this case, according to Real Decreto 1201/2002, of November 20, which regulates the integrated production of agricultural products.

Figure 4. Logotype of integrated production in L a Rioja.

Figure 4. Logotype of pears of D.O Rincón de Soto.

The format of the finished product will consist of plastic boxes with grid of 495x370x155 mm filled with pears or peaches with an alveoli base of 8x8 units. The boxes will be assembled in europallets and will be strapped before their shipment, with a height of eight boxes. That is, each box will weigh approximately eight kilos and each pallet will fit 6x8 boxes.

11. Analysis of alternatives: Process technology

In this section we will explain only the alternatives chosen as a solution in each stage of the process. All alternative options are developed in *Annex 7. Process technology.*

As can be seen in the flow charts, the only difference in peaches respect to pears, is that they do not undergo conservation in a controlled atmosphere, but in normal refrigeration, since they are only kept for less than one month and it is enough refrigeration.

11.1. Flow charts

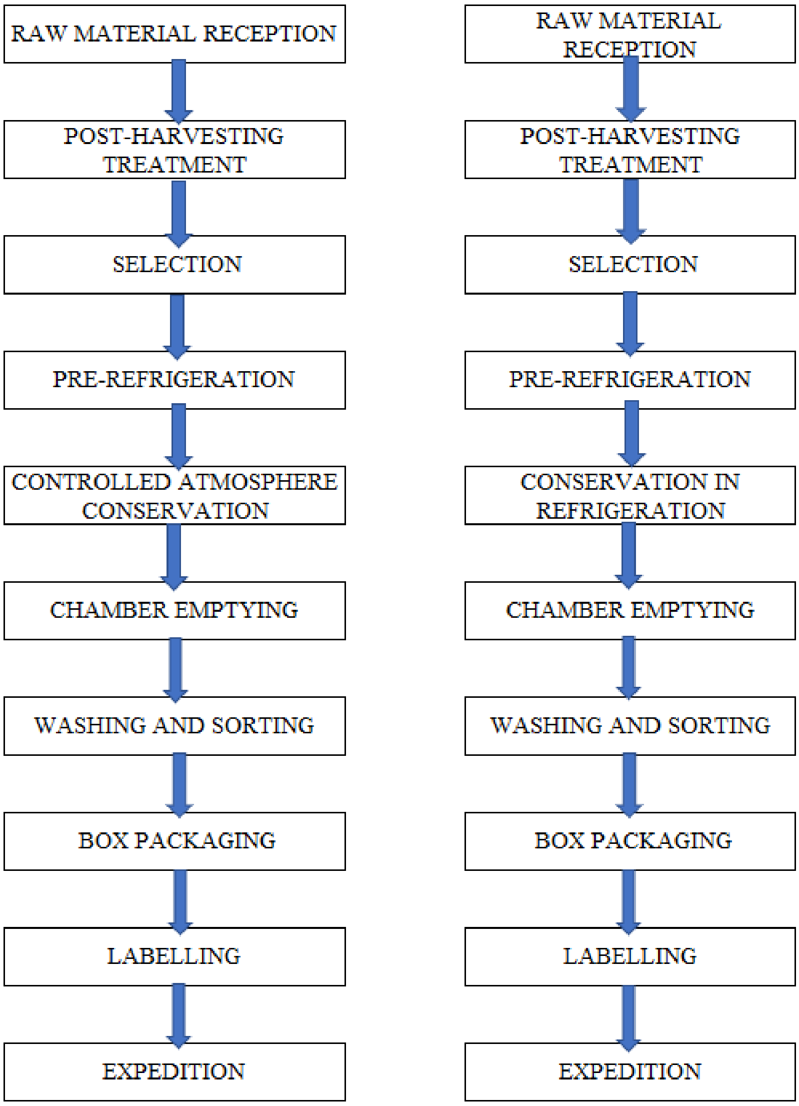


Figure 5. Flow charts of process technology in pears and peaches respectively.

11.2. Chosen alternatives

11.2.1. Raw material reception

The reception of the fruit will be made depending on the optimal moment of pear and peach harvesting. It is intended to supply practically all the year of raw material the power station and thus not to waste the cold storage chambers. The place where the product is unloaded must be spacious, fresh and well ventilated so that the newly arrived fruit progressively lowers its temperature.

In this stage we proceed to a first evaluation of the fruit taking samples of the different wooden crates randomly so that you can check if the raw material arrives in good condition, otherwise the game would be rejected.

11.2.2. Post-harvest pre-conservation treatment

The treatment is carried out once the fruit arrives at the plant and as an alternative it will be done through the shower system, called drencher, which is responsible for distributing the phytosanitary mixture by the containers full of fruit that run under the system of shower.

To obtain good results, it is necessary to take a series of precautions that can be summarized in:

- Treat the fruits quickly after harvest
- Check that the temperature of the fruit and water is higher than 10ºC and preferably between 15 and 20ºC.
- Limit the soaking time to 30 seconds and maximum to 1 minute and a half in drencher.
- Make sure that the mixture of the treatment solution is well mixed by starting the pump to drive water before the first fruits pass, in order to avoid the risk of phytotoxicity problems due to over-conservation of the product.

Only chemical products that are authorized in accordance with current legislation may be used, that is, following the Real Decreto 1311/2012, of September 14, which establishes the framework for action to achieve sustainable use of the plant protection products.

11.2.3. Selection

The non-conformities of the product are removed with respect to the specified in quality control parameters that do not comply with the necessary requirements. There will be a set of attributes that affect the time of selection and mainly those fruits that show wounds or alterations, either due to insects, rots, pathophysiology, etc., will be rejected.

There is no alternative but to strictly follow the standards and legislative requirements that are required to obtain the D.O.P "Rincón de Soto" pear product, which implies a method of manual selection. This is translated into a human visual selection, with several operators in the line in charge of removing those pears that do not conform to the tolerances that are sought. Because the pears are the main fruit of the factory since they will last up to 8 months in camera, it would not be economical to incorporate a machine for automatic optical selection only to apply it in peaches.

11.2.4. Pre-cooling

The pre-cooling consists of a rapid cooling of the fruits once harvested with the aim of improving the maintenance of the quality of them during its conservation process and so to be able to extend the duration of its post-harvest life. In this way, the heating of the fruit on arrival at the plant due to the action of the sun and the respiration of the fruit is considerably reduced. The delay of a day in the drop of temperature of the fruit to treat supposes up to 20 days less of conservation that is the reason why this stage is fundamental to carry out as soon as possible, especially in pear and peach that have a high respiratory rate.

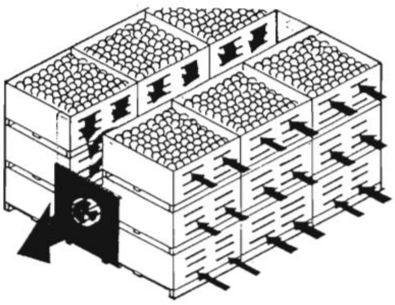


Figure 6. Air movement in forced air tunnel.

As a chosen alternative, the pre-cooling will be carried out in a forced air tunnel, since it is the most suitable for both fruits, for pears and peaches. The wooden crates will be placed in said tunnels by default, forming two blocks that are covered with a canvas, leaving a distance between the two in order to suck the air by the extractor located at the bottom of the two blocks. As such, a pressure gradient is created between the inside and outside that forces the air from the evaporators to pass through the middle of the fruit blocks, thus increasing the speed of product cooling. In general, in a period between five and seven hours the desired indoor temperature can be reached. The fruit is not kept inside the tunnel longer than necessary to avoid problems of freezing and dehydration.

11.2.5. Cold storage

The refrigerated conservation is especially necessary in the so-called climacteric fruits, such as pears and peaches, which are capable of continuing ripening once separated from the plant.

There are two types of conservation depending on the time you want them to last: conservation in a normal atmosphere and conservation in a controlled atmosphere. The latter consists of a refrigeration conservation technique in which the gas composition of the atmosphere is modified in a cold room, in which a regulation control of the physical variables of the environment, that is, temperature, humidity and circulation, is carried out from air.

In this case, a conservation in a normal atmosphere will be used for the peach case since it will be sold in a period of less than a month and, therefore, the conditions of the chamber in normal refrigeration are sufficient to keep the food in good condition. The optimum conservation parameters for the yellow peach variety Catherina consists of a temperature between 0 and 0.5 ºC, with a relative humidity between 90 and 95%.

However, for pome fruit, both controlled atmosphere and normal atmosphere chambers will be used. This is because the three normal cooling chambers of the plant will be used *(Annex 5. Planning of industrial activity*) since they allow a duration of pears of up to 3 months. For the following six months, it is necessary to subject them to conservation in a controlled atmosphere so that they can be maintained in good condition without suffering physical-chemical alterations.

The optimal parameters of conservation in normal atmosphere for the pear are: 0.7 / -1.0 ºC of temperature with a relative humidity between 90/96%. However, the optimum conditions of conservation of the pear in controlled atmosphere will be: 2.5 / 3% of O_2 and 1.4 / 1.7% of CO_2, the temperature should be between -0.7 / -1.0 ºC and humidity relative of 94-96%.

11.2.6. Washing

With the washing is intended to leave the product in an optimum state of quality and the fact of having spent long periods of time in the chamber can be sometimes harmful to the food and can present accumulated dirt or traces of fungicides.

The alternative chosen for this stage is wet washing since it is the one that most fits with the fruit that is treated in the plant being the one that produces less food deterioration, in addition to the ability it has to also eliminate pesticide residues.

At the end of the wash, the fruit will follow the conveyor line where a second product selection will be made to remove the product that is deteriorated and is not in accordance with the desired quality specifications that are very likely to occur after having long periods of storage. This selection will also be visual since the Specifications Sheet of the P.D.O pears "Rincón de Soto" dictates, and therefore, it will also be applied in peaches since it would not be profitable to have an automatic optical sorting machine, taking into account that the main product of the plant is the pear, which triples the tons of storage.

11.2.7. Packaging

The packaging must be totally manual following the specifications of the Specifications Sheet of pears "Rincón de Soto" and it will be done with great care. They will be deposited manually in plastic boxes with ventilation grilles, in a single layer and obligatorily making an accommodation with a base with alveoli so that they remain immobilized inside the packaging and that they do not cause damages during the periods of transport and distribution, as they are the alveoli.

12. Alternative analysis: Process engineering

12.1. Flow chart

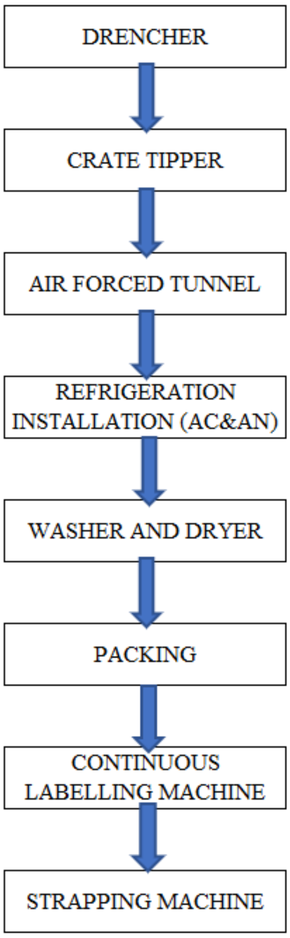


Figure 7. Flow chart of process engineering.

12.2. Chosen alternatives

Hereafter, only the summary of the selected machinery is presented. The alternatives are presented in depth in *Annex 8. Process engineering.*

DRENCHER				
Description	Drencher of chains for continuous treatment of fruit packed in palots or PVC bins. Profile and stainless steel sheet. Stainless chains.			
Dimensions	Length (mm)	9750		
	Height (mm)	4500	Height palos (mm)	1100
	Width (mm)	2000	Capacity (kg/h)	30000

CRATE TIPPER				
Description	Adjustable crate tipper with a hydraulic dump and dump system, with protective barriers and a progressive emptying. 45º of turn.			
Dimensions	Length (mm)	2000		
	Height (mm)	700		
	Width (mm)	2500	Capacity (palets/h)	40

AIR FORCED TUNNEL CHAMBER				
Description	The forced air tunnel corresponds to the pre-cooling of the raw material, which must be 7 hours in order to reduce the temperature of the fruit to the desired one. A canvas is placed between the corridor of the palots arranged in two rows to facilitate air flow.			
	Length (m)	17		
	Height (m)	4		
Dimensions	Width (m)	11	Capacity (t)	50

CONTROLLED ATMOSPHERE CHAMBER				
Description	Hermetically sealed chamber where the conservation technique consists of the modification of the gaseous composition of the atmosphere in the cold room, in low O2 conditions and enriched in CO2.			
	Length (m)	17		
	Height (m)	4		
Dimensions	Width (m)	11	Capacity (t)	100

WASHER AND DRYER				
Description	Complete line of washing by aspersion and drying for fruits. Entrance conveyor, washing, rinsing, blowing and drying module. Output conveyor.			
Dimensions	Length (mm)	10000		
	Height (mm)	1500		
	Width (mm)	800	Capacity (tn/h)	15

SELECTION AND TRANSPORTING CONVEYOR				
Description	Machine designed to transport products through the movement of a thermodrive band. They can be used to be able to select the product.			
Dimensions	Length (mm)	2500		
	Height (mm)	500		
	Width (mm)	900	Capacity (kg)	135

STRAPPING MACHINE				
Description	Máquina automática para el flejado de palets en vertical, sin limitación de tamaño de palet. Tensión ajustable mediante pinza. Control electrónico de toda la operación de tensión, soldadura, corte y lanzamiento del fleje.			
Dimensions	Length (mm)	700		
	Height (mm)	2400		
	Width (mm)	2100	Capacity (palets/h)	70

13. Refrigeration installation

A refrigeration chamber is basically a thermally insulated storage in whose interior heat is extracted, or what is the same, a thermal load is extracted through a refrigeration system of mechanical compression. These cameras are cubic in shape. They are hermetically sealed so that the refrigeration system is maintained in order to conserve the raw material in the best possible conditions, delaying the possible physiological alterations.

The fact that they are stored in one type of chamber or another, means that the conditions of the relative humidity, temperature, oxygen and carbon dioxide varies, and in turn depending on the type of fruit, these conditions also change slightly. That is, there are optimal storage conditions for both the type of fruit.

The capacity of the AC (controlled atmosphere) chambers will be 100 tons, while the pre-refrigeration chambers of 50 tons each.

The design and calculations of the cold rooms will be briefly described, a description which is detailed in *Annex 9. Refrigeration installation and in Drawing 6*.

13.1. Chamber designs

Hereafter, the different characteristics and thermal loads that have been taken into account for the calculation of the refrigeration installation are presented:

Table 7. Characteristics of the prouct inside the storage chamber.

	CA	PR
Entry temperature (°C)	8	22
Regime time (h)	24	8
Capacity of the storage chamber (t)	100	50
% daily entrance	50	50
Pallet (% weight)	5	5
Specific heat (KJ/Kg °C)	2.72	2.72

Table 8. Constructive features of the chamber.

Chamber side	Material	Thickness (cm)	Conductivity (W/m2 °C)	Heat losses (W/m2)
Walls and ceiling	Expanded polyruethane	10	0.221	5.7
Floor	Reinforced concrete + expanded polyruethane	12 + 6	0.397	5.1

13.2. Calculations and results

Table 9, 5. Final results of the chamber calculations.

PRE-REFRIGERATION

	Loads	Thermal power kW
Products	Product cooling	43
	Product respiration	4.89
	Pallets cooling	1.53
	Total	49.4
Installation	Walls, ceiling and floor	3.39
	Ventilators	3.76
	Air renovation	1.1
	Illumination	1.44
	Personnel	0.224
	Machines and engines	7
	Total	16.9

CONTROLLED ATMOSPHERE

	Loads	Thermal power kW
Products	Product cooling	19.8
	Pallets cooling	0.708
	Total	20.6
Installation	Walls, ceiling and floor	4.5
	Ventilators	2.09
	Air renovation	1.06
	Illumination	1.44
	Personnel	0.278
	Machines and engines	7
	Total	16.4

Final results	CA	PR
Total load of the chamber	36.9 kW	66,3 kW
Total load of the chamber majored	40.6 kW	73 kW
Refrigeration power of the chamber, during 18 and 24 h	54.2 kW	73 kW
Installed power per m3	75.1 W/m3	101 W/m3

Once the results of the previous table have been obtained, the equipment must be chosen that is adapted to the powers that the installation needs:

- Controlled atmosphere:
  - Compressor: KM15103 with 15 kW of cooling power.
  - Condenser: CC122-63 with 73.70 kW of power.
  - Evaporator: GRX-2950 with a cooling power of 59 kW.
- Normal refrigeration:
  - Compressor: SLDF 40-3, with 30 kW of power.
  - Condenser: CRH802HP3P with 110.1 kW of power.
  - Evaporator: GRM-4600 with a cooling power of 78 kW.

14. Piping installation

In *Annex 10. Piping installation* you can see what is explained below but in depth because at this point it will be explained in summary. In addition, the design can be seen in *Drawing 5*.

For the design and calculation of the piping installation, it is started from the general supply network of Tambarria state with which connects the total installation of the fruit industry.

The pipes designed will be made of stainless steel approved by the ASME B31.1 standard and there will be stretches in which the pipes are buried, glued to the wall and others at a certain height depending on the area where they have to pass.

The objective is to design the plumbing installation in such a way that the water can reach all points with sufficient flow and pressure to supply the needs of each area.

The following figure shows the simplified scheme of the installation designed as a result of the *drawing 6*, with its corresponding sections and terminal points in order to better understand the tables that come next.

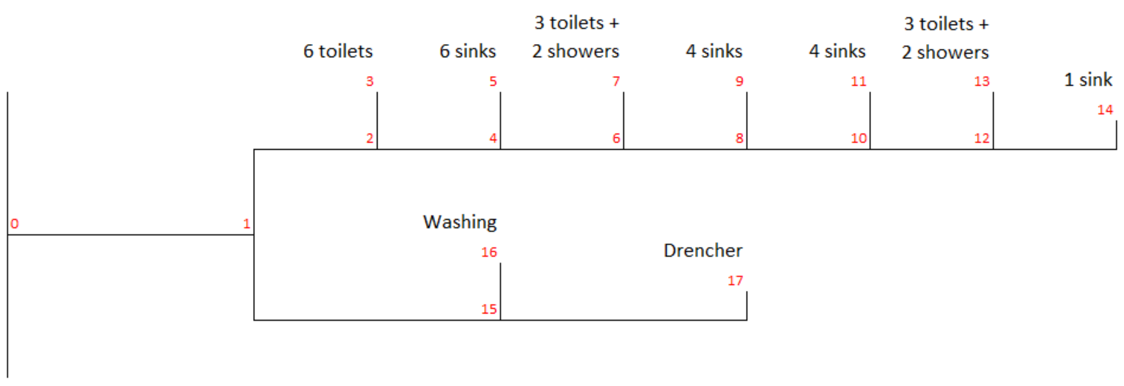


Figure 8. Simplified scheme of the piping installation.

14.2. Hydraulic calculations

Table 10. Total flow needed in terminal points.

Terminal points	Element	Nº	Demand [l/s]	K	Partial flow Q [l/s]	Total flow Q [l/s]	Total flow Q [m3/s]
3	Toilet	6	0.1	0.9	0.54	0.54	0.00054
5	Sink	3	0.1	1	0.3	0.3	0.0003
7	Shower	2	0.2	1	0.4	0.67	0.00067
	Toilet	3	0.1	0.9	0.27		
9	Sink	4	0.1	1	0.4	0.4	0.0004
11	Sink	4	0.1	1	0.4	0.4	0.0004
13	Shower	2	0.2	0.9	0.36	0.66	0.00066
	Toilet	3	0.1	1	0.3		
14	Sink	1	0.1	1	0.1	0.1	0.0001

Table 11. Calculation of the nominal diameters and the real velocity needed in each tranche.

Tranche	Theoretical velocity [m/s]	Flow Q [m3/s]	D theoretical [mm]	D nominal [mm]	D nominal [inch]	Real velocity [m/s]	L [m]	L/D
12 - 14	2	0.0001	7.979	9.22	1/4	1.498	35.5	3850.33
12 - 13	2	0.00066	20.498	20.96	3/4	1.913	5.5	262.40
10 - 12	2	0.00076	21.996	26.64	1	1.364	4.7	176.43
10 - 11	2	0.0004	15.958	20.96	3/4	1.159	1.95	93.03
8 - 10	2	0.00116	27.175	35.28	1 1/4	1.187	8.44	239.23
8 - 9	2	0.0004	15.958	20.96	3/4	1.159	1.95	93.03
6 - 8	2	0.00156	31.514	35.28	1 1/4	1.596	8.74	247.73
6 - 7	2	0.00067	20.653	20.96	3/4	1.942	5.5	262.40
4 - 6	2	0.00223	37.678	40.92	1 1/2	1.696	11.83	289.10
4 - 5	2	0.0003	13.820	15.76	3/8	1.538	1.95	123.73
2 - 4	2	0.00253	40.133	40.92	1 1/2	1.924	14.42	352.39
2 - 3	2	0.00054	18.541	20.96	3/4	1.565	0.5	23.85
1 - 2	2	0.00307	44.209	52.46	2	1.420	7.08	134.96
15 - 17	2	0.0017	32.898	35.28	1 1/4	1.739	55.15	1563.21
15 - 16	2	0.001	25.231	26.64	1	1.794	0.42	15.77
1 - 15	2	0.0027	41.459	52.46	2	1.249	59.81	1140.11
0 - 1	2	0.00577	60.608	62.68	2 1/2	1.870	22.95	366.15

Table 12. Lineal head losses.

Tranche	Reynolds	Type of flow	Friction factor	Lineal head losses [m]
12 - 14	12018.39	Turbulent	0.0302	13.317
12 - 13	34892.32	Turbulent	0.0232	1.134
10 - 12	31612.33	Turbulent	0.0237	0.397
10 - 11	21146.86	Turbulent	0.0262	0.167
8 - 10	36433.98	Turbulent	0.0229	0.394
8 - 9	21146.86	Turbulent	0.0262	0.167
6 - 8	48997.42	Turbulent	0.0213	0.685
6 - 7	35420.99	Turbulent	0.0231	1.164
4 - 6	60387.41	Turbulent	0.0202	0.856
4 - 5	21093.19	Turbulent	0.0263	0.392
2 - 4	68511.28	Turbulent	0.0196	1.301
2 - 3	28548.26	Turbulent	0.0243	0.073
1 - 2	64846.61	Turbulent	0.0198	0.275
15 - 17	53394.62	Turbulent	0.0208	5.020
15 - 16	41595.18	Turbulent	0.0222	0.057
1 - 15	57031.22	Turbulent	0.0205	1.858
0 - 1	102005.60	Turbulent	0.0177	1.156

Table 13. Located head losses.

Tranche	Elbow 90º	T in line	Located head losses in elbows	Located head losses in T
K	0.33	0.4		
12 - 14	2		0.076	
12 - 13	1		0.062	
10 - 12		1		0.038
10 - 11	1		0.023	
8 - 10	1	1	0.024	0.029
8 - 9				
6 - 8	1	1	0.043	0.052
6 - 7	1		0.063	
4 - 6	1		0.048	
4 - 5	1		0.040	
2 - 4	2	1	0.125	0.076
2 - 3	3		0.124	
1 - 2		1		0.041
15 - 17	2		0.102	
15 - 16	1		0.054	
1 - 15	3	1	0.079	0.032
0 - 1		1		0.071

Finally, the total load losses in each section of pipeline will be the result of the sum of both linear and localized losses by sections:

Table 14. Total head losses.

Tranche	Total head losses [m]
12 - 14	13.393
12 - 13	1.196
10 - 12	0.435
10 - 11	0.190
8 - 10	0.446
8 - 9	0.167
6 - 8	0.779
6 - 7	1.228
4 - 6	0.904
4 - 5	0.432
2 - 4	1.501
2 - 3	0.196
1 - 2	0.317
15 - 17	5.122
15 - 16	0.112
1 - 15	1.969
0 - 1	1.228

15. Planning of industrial activity

The annual production of the fruit plant will initially be 800 tons, divided into 600 tons of Rincón de Soto Denomination of Origin pears and 200 tons of peaches. That is to say, the production of pears represents 75%, while the peach production represents 25%, thus being a minority product in the production of the company.

The choice of these two products has been carried out with the aim of having the plant in operation for as long as possible, taking into account their harvest periods and the time they can spend in cold rooms.

15.1. Calendar production

It is important the relation and importance that has the moment of harvest and the physical state of the fruit. This must occur at its optimum time to avoid excess maturation or lack of it, to avoid possible physical-chemical alterations. The more or less susceptible to these alterations depends on several factors: date of harvest, conditions during and after harvest and the duration in cold storage.

The choice of these two products has been carried out with the aim of having the plant in operation for as long as possible taking into account their harvest periods and the time they can spend in the cold rooms. Thus, the system has been organized so that there is also enough time to carry out a proper maintenance of the machinery throughout the year.

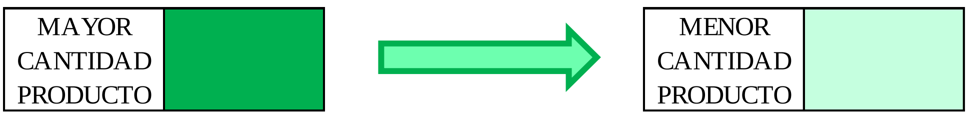
Table 15. Calendar of the industrial activity throughout the year.

ENERO/FEB	FEB/MARZO	MARZO/ABRIL	ABRIL/MAYO	MAYO/JUNIO	JUNIO/JULIO
JULIO/AGOSTO	AGOSTO/SEPT	SEPT/OCT	OCT/NOV	NOV/DIC	DIC/ENERO

PERAS	
MELOCOTÓN	
MANTENIMIENTO	

Table 15 shows the calendar of industrial activity in the year, which is organized as follows. In the first place, the peach lasts only one month of production. Specifically, in the case of yellow peaches of the Catherina variety, optimal harvesting occurs in the second half of July, between the 16th and 18th of this month. This fruit is a minority in the company because its refrigerated conservation does not last more than a month maintaining its quality properties. That is to say, once the 200 tons of peach are delivered on the industry, they are stored in the cold rooms in a period of time of one month, and, after that time, the cameras are emptied.

However, in Conference pears, from its optimum collection moment between August 18 and 20, the 600 tons will be introduced as the days go by in the cold rooms, starting with the controlled atmosphere and finally in normal refrigeration, which will be expedited month by month, so the amount of product available as the months pass is less.



A very important point of this project is the storage capacity of the cold rooms. Within the two products that exist, the Rincón de Soto Denomination of Origin pears represent a percentage clearly greater than that of the peaches, therefore, the critical point in terms of the capacity of the chambers is the number of pears per year. Thus, starting with a production of 600 tons per year of pears, in principle with a capacity of 600 tons in total for the entire factory would be sufficient.

The process of production of the pears is divided into two stages: from reception to storage in chambers, and after the necessary time in each, the emptying of the those for commercialization, washed and fitted in boxes to form pallets.

Hereafter, a scheme of the refrigeration chambers is represented in order to explain the organization system that has been based on it:

- CPR: Chamber of Pre-refrigeration
- CCA: Chamber of controlled atmosphere
- CR: Chamber of refrigeration in normal atmosphere

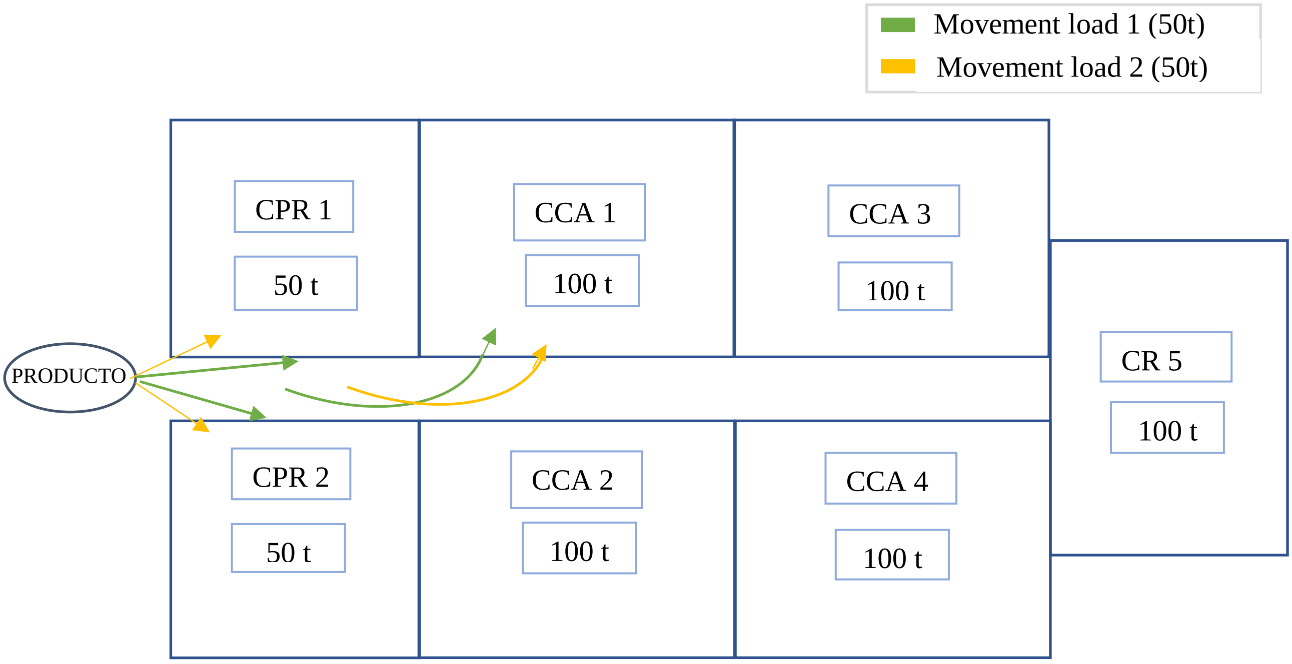


Figure 9. Structure of refrigerated storage chambers.

Thus, the product would initially enter in the pre-cooling chambers 1 and 2 (CPR), and it would complete a period of 7 hours both chambers until the beginning of its transfer to the CA chambers and finally, to the Refrigeration chamber (5). Once the PR 1 and 2 cameras have been completed their pre-cooling function until the filling of the next five chambers, these two will be used as normal cooling chambers.

Every truck that arrive at the fruit industry bring 25 t, each day two trucks will arrive, that is, 50 tons a day. The proposed scheme shows a filling of mentioned load divided into the two pre-cooling chambers, that is, 25t in each one. The aim of proceeding in this way is to be able to reduce the thermal load in terms of power cooling capacity if the total filling of the chambers would occur.

Despite using 50% capacity for pre-cooling, it has maintained a total capacity of the 50 tons in the chamber for its subsequent use as normal cooling chambers.

Table 16. Schedule of the planning and organization of the process of 600 tons of pear.

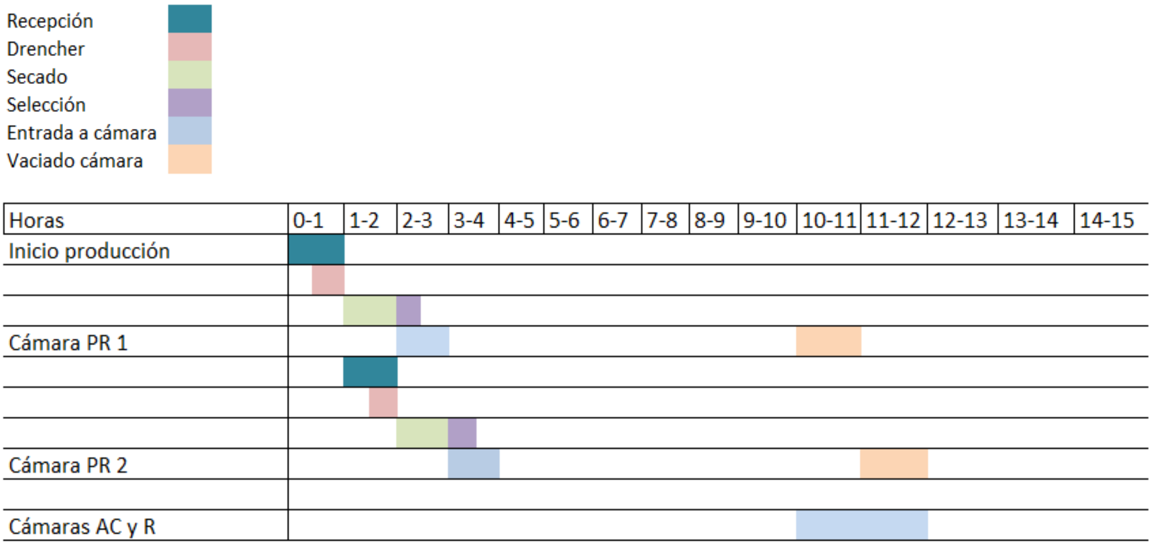
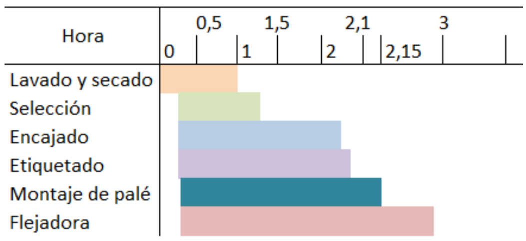


Table 16 summarizes in a simple way the continuous process that must be carried out in the same way for all the storage chambers that we have. Thus, you can see the hours elapsed on the abscissa axis and the stages performed in the cameras over time

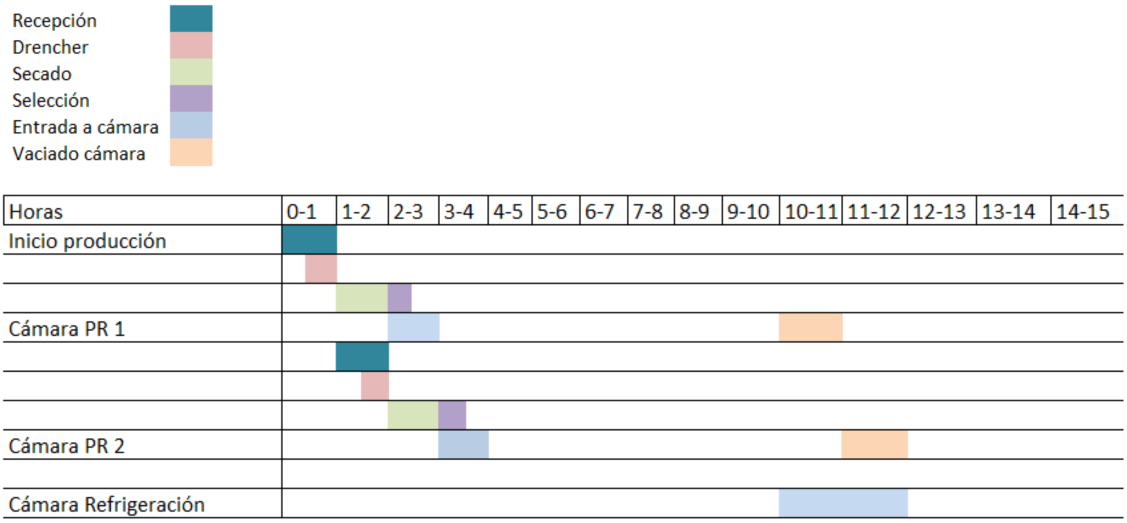
Table 17. Schedule of the planning of the second part of the process according to an assumption of 10 tons of product.



The process of the second part of the process takes approximately 3 hours. Being a continuous process, all the activities start practically at the same time, except for the small margin of time from the moment the first quantity of fruit enters the washing machine until it leaves. The rest is proceded in a permanent continuum.

In the case of peach, the scheme is equivalent to the previous one, as shown in the following diagram:

Table 18. Timeline of the organization system of the first part of the process for the 240 t of peaches.



The second part of the process corresponds exactly to the case of the pears explained in the previous point and simplified in the schedule of table 18.

16. Planning and control of Project execution

One of the most important parts of the project is the planning of its execution over time. In order to carry out an adequate control of the activities, the Gantt diagram has been used as a representation, created through the Microsoft Project 2010 program. In addition, this tool allows to link or not an activity with another, so that it can be specified in the case that an activity can be carried out simultaneously.

To see the full description of the planning and control of the execution, review on *Annex 11. Planning and control of the execution of the project.*

The previous activities that have been considered before starting the industrial activity are:

1. Conditioning of the plant industry
2. Piping installation
3. Refrigeration installation
4. Assembly of equipment
5. Start-up of the production line

Once identified, a certain time is estimated for each activity and the Gantt Chart is drawn up that summarizes it:

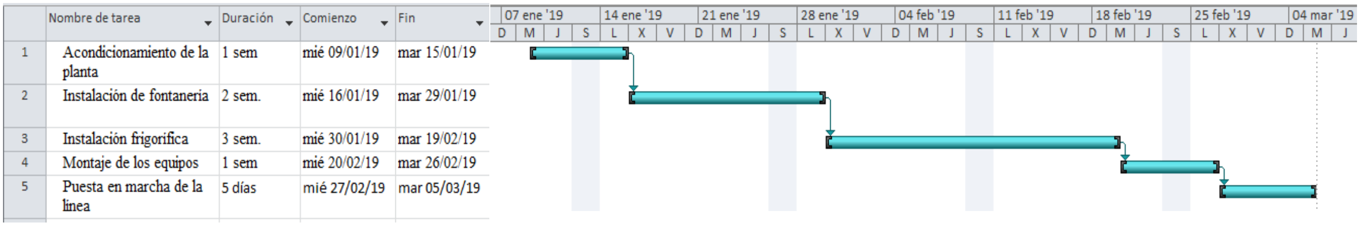


Figure 10. Gantt Diagram

17. Economic study

Through this section, it is presented an economic-financial evaluation will be carried out in order to calculate the cost of the project and be able to conclude if it is economically viable or not.

In order to carry it out, the payment of the investment, the cash flow, the time horizon are studied and the indices of economic profitability, the Net Present Value (NPV) and the Internal Rate of Return (IRR) are used.

The study of the cash flow is used with the differences between the revenues and the costs generated to know what the benefit of the company will be, estimating approximately the inflows and outflows of money that will occur during the course of the activity.

It is estimated a project life of approximately 20 years, with an initial execution budget amounting to 322,323.27 €.

Here after, it is represented the revenues and costs, both ordinary and extraordinary:

17.1. Incomes

Table 19. . Ordinary incomes.

Product	Kg/year	€/kg	Annual incomes
Pear "Rincón de Soto"	594,000	1.63	968,220.00
Peach (integrated production)	198,000	0.92	182,160.00
		total (€)	1,150,380.00
		97% total (€)	1,115,868.60

Table 20. Extraordinay incomes.

Product	Kg/year	€/kg	Annual incomes
Pear "Rincón de Soto"	6,000	0.70	4,200.00
Peach (integrated production)	2,000	0.40	800.00
		total (€)	5,000.00

As an extraordinary income, there is the initial raw material that cannot be used for the plant but can be used by other companies that use juice. This volume, which is considered 1% of the total, will be sold at 40% of its value.

17.2. Expenses

The initial investment of the project amounts to € 322,323.27, as described in *Document 5. Measurements and Budget.* In order to carry out said investment, a bank loan of this amount is requested, granted at 4% interest and with a two-year amortization period for the principal that coincides with the period considered not to reach 100%. % production as mentioned above.

Table 21. Raw material expense.

Product	Kg/year	€/kg	Annual incomes
Pear "Rincón de Soto"	600,000	0.60	360,000.00
Peach (integrated production)	200,000	0.39	78,000.00
		total (€)	438,000.00

Table 22. Auxiliar material expense.

Auxiliary material	Price/Unit (€)	Annual units	Total price (€)
Boxes of fruit	1.49	47,000	70,000.00
Wooden crates	40.00	2,400	96,000.00
Plastic strip coils	88.00	0.5	44.00
		total (€)	166,044.00

Table 23. Salary expenses.

Workstation	Number/post	Salary/person (€)	Monthly salary (€)	Annual salary (€)
Manager	1	4,000	4,000	48,000
Comercial	1	1,900	1,900	22,800
Administration	2	1,400	3,000	36,000
Laboratory technicians	2	1,150	2,300	27,600
Production manager	1	1,600	1,600	19,200
Maintenance	2	1,400	2,800	33,600
Workers	12	1,000	12,000	144,000
			total (€)	325,200.00

Other expenses:

- Rent: 20,000 € /year
- Logistics and transport costs: € 15,000 / year

- Material costs of the laboratory for analysis, cleaning products, new materials, etc: € 500 /year

- Insurance: € 1000 / year

Table 24. Cash flow.

Years	Ordinary income (€)	Extraordinary incomes (€)	Ordinary expenses (€)	Extraordinary expenses (€)	Investment payment (€)	Cash flow (€)	V.A.N	T.I.R.
0					322,323.27	-322,323.27	258,236.0528	15.65%
1	781,108.02	5,000	965,744		12,892.92	-192,528.90		
2	948,488.31	5,000	965,744		12,892.92	-25,148.61		
3	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
4	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
5	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
6	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
7	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
8	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
9	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
10	1,115,868.60	5,000	965,744	25,000.00	39,160.44	90,964.16		
11	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
12	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
13	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
14	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
15	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
16	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
17	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
18	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
19	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
20	1,115,868.60	5,000	965,744		39,160.44	115,964.16		

Finally, the profitability indexes calculated based on the data presented previously are presented:

- N.P.V = 258,236.0528 €.
- I.R.R =15.65 %.

Given these results, it can be said that the project is viable.

18. General summary of budget

In this section a summary table of the different expenses that have been given for each incorporation to the industry will be presented. For more information about the budget, it is recommended to review *Document 5. Measurements and Budget.*

SUMMARY (€)		
Production line		159100
Installations	Refrigeration	132477.24
	Piping	1706.0285
Direct execution budget		293283.269
Contractual execution budget	Total	24000
	General expenses (13%)	3120
	Industrial benefit (6%)	1440
	Total + I.V.A	29040

Direct execution budget	293283.27
Contractual execution budget	29040
TOTAL GENERAL BUDGET	**322323.27**

19. Priority order of documents

1. Drawings
2. Specifications document
3. Measurements and budget
4. Report
5. Annexes

Location: Alfaro, La Rioja

Date: September 2018

Begoña Bobo Guardamino

PUBLIC UNIVERSITY OF NAVARRE

Agricultural, Food and Rural Environment Engineering

PROCESS DESIGN OF A FRUIT INDUSTRY

DOCUMENT 2
ANNEXES

Author:

Begoña Bobo Guardamino

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Teresa Fernández García

September 2018

Content

PUBLIC UNIVERSITY OF NAVARRE

Agricultural, Food and Rural Environment Engineering

PROCESS DESIGN OF A FRUIT INDUSTRY

ANNEX 1. LOCATION AND SITING

Content

1. Location and siting

The fruit plant whose process system is the object of this project, will be located in the Spanish region of La Rioja, specifically at the southeast of the municipality of Alfaro. Although the civil work is not included in the scope of the project, the ship has been designed according to the needs of the fruit plant. The polygon has the necessary infrastructure for its correct operation that is, electrical network, water supply, sewerage, etc.

This plant is located on a land that belongs to the Tambarria industrial estate, specifically in Tambarria Square 9, plots M.5.1 and M.5.2. The land has a total area of 8,334 m^2 of which 5,636 m^2 will be occupied by the ship. The access to the plot is directly connected to the Logroño N-232 road, which is linked to the N-113 towards Valtierra. The N-232 is also the one that connects directly with the capital of La Rioja, Logroño, in addition to the AP-68. It is also easily connected to important regions of the country such as Zaragoza in Huesca, by the AP-68. Navarra and the Basque Country also present easy communication. It is approximately 70 km from Logroño, 90 km from Pamplona, 100 km from Zaragoza and 90 km from Soria.

Alfaro is located at the east of the province of La Rioja Baja, at the end of it, being the largest municipality in all of La Rioja and the fifth town with the largest number of inhabitants. It is very close to the Community of Navarra and Aragón, at a height of 302 meters above sea level. Its 193.3 km^2 extends from the banks of the Ebro to Mount Yerga, which with its 1101 meters, is the highest in the area. They irrigate it Ebro and its affluent Alhama, which makes it be located in a land with an abundance of water from both the mentioned rivers and the Canal de Lodosa and numerous artificial reservoirs.

The farmers of the zone are the main suppliers of the raw material of the fruit central, in this case of pears and peaches. In addition, it has the advantage that Alfaro belongs to one of the municipalities of La Rioja Baja where pears of Protected Designation of Origin "Rincón de Soto" are produced, with which they will be treated mainly in the project. This is one of the reasons why this location has been chosen for the project, since the objective of the fruit centre in question is to provide a product of differentiated quality, which is obtained, both with the aforesaid appellation of origin for the pears, as by an integrated production for peaches.

2. Crops and environment of the area

The secret of Rioja's famous gastronomy is found in the excellent raw materials produced by its fertile lands located in the Ebro valley, a territory where ideal natural conditions converge, bathed by seven rivers and with a mild climate that, together with the long agro-food tradition that has been incorporating modern cultivation techniques, it offers as a result a wide range of foods marked by quality and taste.

La Rioja, therefore, is grounded in the agro-food sector. It stands out for its crops of vegetables and fruits, which occupy the second and third place respectively in the final agricultural production of the region, behind the vineyard. Specifically, the total area devoted to fruit reaches a total of 15,000 ha. Among them stands out the pear of Rincón de Soto of P.D.O.

The origin of the virtues of these products of great importance in the area is largely to the area of land where they are in flat areas, with good ventilation, deep, humid, permeable, healthy and clayey, where fogs are frequent first hours of the day and where there are significant differences in temperature between day and night.

3. References

Gobierno de La Rioja - IDERIOJA Visualizador Municipal de. (2018). Retrieved from https://www.iderioja.larioja.org/municipios/index_mapamuni.php?lang=es

Sede Electrónica del Catastro. (2018). Retrieved from https://www1.sedecatastro.gob.es/OVCFrames.aspx?TIPO=consulta

PUBLIC UNIVERSITY OF NAVARRE

Agricultural, Food and Rural Environment Engineering

PROCESS DESIGN OF A FRUIT INDUSTRY

ANNEX 2. STUDY OF THE FINAL PRODUCT

Content

1. Introduction

The concept of quality can be considered as one that encompasses all the characteristics, attributes or properties that define a product as it is, allowing characterizing the degree of excellence and superiority of it. The properties that determine the food are based on the combination of both physical and chemical and sensory.

In the case of fruit plants, special importance is given to the refrigeration conservation capacity, including the intrinsic capacity of the fruit variety and resistance to microbiological diseases and physiological alterations; In addition, adequate management capacity, ease of handling and resistance to handling are demanded, as well as a prolonged shelf-life of the fruit after harvesting and cold storage, complemented by high visual quality. Food safety and product presentation are also factors of great importance in the quality of marketing, in addition, traceability compliance is required, with large quantities of product and homogeneous characteristics. In short, through the food chain, the objective is that the product has the necessary characteristics to better adapt to its productive and commercial purposes.

2. Quality attributes

The quality can be classified in different types, whether visual, nutrition, health, hygiene, trade, etc., depending on the parameters and certain attributes. Below, there are some of the main quality attributes:

- External appearance. It includes those aspects that can be detected visually, such as colour, size and shape. It also refers to external and / or internal defects that may occur due to mechanical damage, alterations or physiological disorders, pathogens, pests, etc.

  Thus, colour is one of these main physical factors of the fruit since they determine its visual quality. Regarding the colour change during ripening, it varies in intensities according to the fruit, being more apparent in the tissues of the superficial layers of the fruit. The own colour depends on the synthesis and type of vegetable pigments present in the tissues, thus constituting the chemical basis of this attribute of quality. The pigments are grouped into three different groups: chlorophylls, anthocyanins and carotenoids, giving green tones, blue to red-purple and yellow to red, respectively. Therefore, it can be said that in the pear the chlorophylls predominate and in the peach the carotenoids. The content of pigments is regulated by both genetic and environmental factors and results from the balance between their biosynthesis and degradation.

- Taste This covers all the components related to smell and taste. The taste is the result of a complex mixture of different sensory stimuli that mainly include aroma and taste, as well as astringency and other tactile sensations captured by the mouth when consuming the fruit. The taste is in the balance between sweetness and acidity, which means therefore that it is in consequence of the concentration and type of sugars and organic acids in the tissues. Regarding the aroma, it is the result of the perception of the volatile compounds emitted by the fruit while chewing. The taste, together with the texture, is the attribute with the most influence on the acceptability of consumption.

  The content of soluble solids and acidity, are indicators of the content of sugars and organic acids respectively, which are part of the routine evaluation of the standard quality both in harvest and after the frigo conservation, without taking into account the attribute of the aroma at the time to determine the suitability of a specific post-harvest technology given its complexity, despite having relevance to the quality of consumption.

In turn, the sugar / acid ratio, the main components that define the taste of the fruit, is used as an evaluation of the commercial quality, being the free sugars more frequent in fruits glucose, fructose and sucrose, as a result of photosynthesis. The most frequent free sugars in fruits are fructose, glucose and sucrose, obtained from photosynthesis. As for organic acids, which provide fresh and acid nuances to the fruit, both pear and peach the predominant is malic acid, also containing considerable amounts of citric acid and, to a lesser extent, chemical acid; thus providing an important influence on the organoleptic properties.

Finally, the aroma is a fundamental component of the flavour of the fruit, a consequence of the volatile compounds produced, also offering an important quality to the consumption. Said aromatic compounds consist of a complex mixture of different compounds, variable according to the species and variety, which include alcohols, aldehydes and ketones among others. Both in pear and peach, the major compounds are ester-type, which can represent up to 98% of the aromatic profile. The quotient between concentration and detection threshold of a compound determines its aromatic intensity, expressed as odor units. However, the aroma of the fruit is a very complex attribute because of the diversity of the compounds emitted and the broad spectrum of its chemical nature.

- Texture. Includes all the attributes that can be perceived in the process of decomposition of a fruit in the mouth and also affect the perception of taste, such as firmness, juiciness, flouriness, granularity, fibrosity ... The texture is part of one of the attributes with more weight in the final acceptability of consumption in sweet fruit. During maturation, one of the most common and visible changes is the softening of the tissues of the fruit is manifested in a decrease in the firmness of it. Apart from the relevance for the organoleptic quality of the fruit that this implies, this process has direct consequences on the potential for handling and conservation, since the weak tissues are more susceptible to microbial infections and mechanical damage, thus limiting the commercialization of the product. In the case of the pear, the softening of the tissues is very drastic and fast, while normally in the peach it is moderate.

The decrease of the firmness and the consequent textural changes, carry out important modifications in both the structure and the composition of the cell walls, especially the degradation of the polysaccharides that constitute it.

- Nutritional value. Vitamins (A, C and B), minerals (calcium, phosphorus and potassium), phenolics and fiber are part of the important nutritional components in the fruit.

- Safety and hygiene. In order to ensure hygiene and safety in the food, the absence of chemical residues from phytosanitary treatments as well as aspects of microbial contamination and the presence of heavy metals are important to treat and avoid.

2.1. Conditioning factors of quality attributes

There are several factors that intervene and directly affect the quality of the product throughout the productive process of the fruit; at the time of harvesting (climatic conditions and cultivation techniques required during the process) followed by postharvest conservation techniques (with their consequent classification, packaging and transport operations) that the food undergoes until reaching the final consumer, creating a direct effect about its final quality.

In this product study, it is necessary to take into account not only the factors that may have conditioned the fruit plant, that is, the effect that refrigeration storage conditions may have on their subsequent commercial life. but also, the effect of those conditions of the product during the pre-harvest, as well as the dependents of the variety and typology of the fruit and the effect of maturity in harvest.

This is how climatic conditions, mineral nutrition, irrigation, tree load and fruit position in it have a direct influence on quality and are highly interrelated. Regarding the climatic conditions, the temperature and insolation affect especially the different attributes of quality, providing firmer fruits and more contained in sugars at the same time as a red coloration favoured in the case of a high light intensity, also providing an increase of capacity of conservation of the fruits when presenting greater content in dry matter whereas the elevated temperatures favour the production of aromas and synthesis of sugars and acids. Mineral nutrition is related to the quality both at the time of harvest and its subsequent storage capacity because it directly affects the composition of the fruit. Also, the balance between the production and the size of the fruits is necessary, since allowing too many fruits in the tree implies a reduction in the size and soluble solids, while if the load of the tree were reduced the size of the fruit would increase although it would also reduce total production. Those fruits located in more lighted positions will show better external appearance. On the other hand, the variety of the fruit is essential because it determines to a great extent the final quality and the acceptance by the consumer of the product; while, in turn, the moment of collection has a great influence. This is because if the harvest is too early, the fruits result with little development both in colour and size, with high acidity and firmness and a low concentration of soluble solids. On the contrary, if the harvests are too late they cause a loss of firmness and severe acidity and / or they can sensitize the fruit to various physiological disorders or to fungal diseases manifested mainly after long periods of storage.

Regarding the conditions of cold storage and its subsequent commercial life, the effect that this entails will depend directly on the species and variety considered, in this case of pears D.O Rincón de Soto and peaches, Conference and Catherina respectively. The conservation in controlled atmosphere produces a better maintenance of the parameters of quality with respect to the conservation in normal cold since they provide a greater firmness and a change of minor coloration, in front of a lower acidity and greater contents in soluble solids occurred in a conservation of normal cold Regarding the commercial life after the conservation of the food, it is worth mentioning the abrupt fall of peach firmness that occurs easily.

3. Aromatic and sensory quality

Both the aromatic quality and the sensory quality play a fundamental role when determining the final quality of the product as seen in the previous section. Therefore, they will be explained in more detail below in what consists both concepts.

In fruit, the aroma is a complex mixture of a large number of volatile compounds whose composition is specific to each species and variety (Sanz et al., 1997). There are about 300 volatile compounds that provide odor to pears and peaches, where the olfactometry technique is responsible for defining the aromatic quality. This consists of first extracting the volatile compounds from the fruit, then separating them in time by gas chromatography and finally detecting their individual odor by trained judges. Thanks to this, it has been possible to identify the esters as the main responsible for fruit odors, along with the alcohols that contribute to the sweetness and the aldehydes and terpenes which provide herbal or citrus odors, as well as the acids, which give acid or vinegar odor . The aroma with a pleasant smell provided by the volatile compounds in the fruit is present in the skin and in the pulp of the fresh fruit, which evolve throughout the physiological ripening of the fruit, in harvesting and during storage and subsequent commercial life. That is why there are a number of conditioning factors to this aromatic quality that are: The variety and the typology of the fruit (qualitative as well as quantitative differences between varieties of the same species), the state of maturity in the harvest (compounds like esters that increase their concentration with ripeness in pears and peaches), and finally, the conditions of cold storage and subsequent commercial life, which affects differently the emission of the different volatile compounds, which has a relationship between gaseous conditions of the chamber and the duration of storage, depending also the effect of both factors of the variety considered.

On the other hand, the sensory quality of a fruit, also called organoleptic quality, refers to that sensed by the senses at the time of consumption (taste, smell, sight, touch and hearing) and expressed in the form of various sensory attributes, which are grouped into three categories: appearance, taste and texture. The objective of the sensory evaluation of the fruit is to identify and evaluate the organoleptic characteristics of it, and on the other hand to express the satisfaction perceived by the consumers once it has been tasted. This is, therefore, a tool of great interest to evaluate the quality of the product, the basic aspect to optimize the production, the handling and storage and the commercialization of the fruit. In order to provide the consumer with a minimum organoleptic quality of the fruit, several factors that have a great influence on it must be taken into account, such as: the pre-harvest factors (clear influence on the external appearance and flavour of the fruit), the variety and the type (firmness, crispness and juiciness of the pulp as the most determining factors in the purchase of the variety of any fruit), the ripeness in harvest (greater sweetness the greater the state of maturity) and finally, once again the conditions of cold storage and his later commercial life.

4. Possible physical-chemical alterations

This section presents some of the most frequent alterations in pears and peaches or those that have a greater economic impact at a global level, due to poor refrigeration conservation or due to fruit handling at the fruit plant, which is important to take into account to be able to avoid it since the quality parameter with absence of internal and external defects is paramount. It must be taken into account that the objective is that these alterations do not occur or at least that they do not reach the consumer, although there are some that may happen a posteriori. However, it must be considered that although there is a product selection after emptying the chamber and before packaging, it is possible that this occurs, although in smaller proportions

4.1. Main alterations in seed fruits (pear)

4.1.1. Superficial blanching

The superficial blanching consists of a physiological alteration of the epidermis of the pears, manifested once a period of refrigerated storage has elapsed. The main problem that this involves is the considerable or total reduction of its commercial value, even though it does not affect the flavour or the texture of the fruit.

Said superficial blanching is manifested in the form of brown spots with diffuse edges, of a more or less intense brown colour, affecting the epidermis of the fruit without damaging the pulp. The varieties that are treated in the D.O Rincón de Soto, Blanquilla and Conference project, are especially sensitive to the reticular blanching, where the browning occurs around the lenticels, acquiring a reticulated appearance.

There is more risk of scalding the lower the conservation temperature is within the allowed range. Although low temperatures encourage scalding, they also delay its appearance. Thus, the gaseous composition of the atmosphere of the cold room affects determinedly, being notably greater in cold with normal atmosphere (AN) than in controlled atmosphere (AC). The good recirculation of the air inside the chamber is also important to stop the alteration.

As a control to avoid this phenomenon, the product is subjected to storage in a controlled atmosphere for long storage periods. Thanks to the reduction of O_2 levels, it is an effective remedy for the control of physiological alterations such as the aforementioned superficial blanching; In addition, it delays the maturation of the fruits and retains the tolerances of firmness, colour and acidity quality. The conditions are based on maintaining low levels of O_2 to the limit allowed to avoid fermentations, and, in turn, high levels of CO_2 just below the toxicity limit.

4.1.2. Internal decomposition

The internal alteration produced in the pear occurs mainly in the variety treated in the project, (Conference) after prolonged periods. This internal decomposition is characterized by a softening of the internal tissues which acquire a brown colour and appear soaked in water and soft. This alteration originates in the heart and then to the whole pulp and is caused by a fermentative metabolism coming from the respiration.

This occurs due to a fermentation process and fermentative metabolism related to low levels of O_2 and high CO_2, but even so, CA prevents it to a greater extent since it also delays maturation and senescence against conservation in a normal atmosphere.

4.1.3. Brown heart

This alteration is characterized because brown tonalities appear in certain areas of the pear pulp, especially around the heart, where later the affected tissues dry and die leaving air-filled voids called caverns. The main disadvantage that this alteration implies is that it cannot be perceived with the naked eye since the firmness of the fruit is maintained, therefore, it is difficult to select and eliminate altered fruits in the classification lines. This is the result of the forceful reduction of respiration and the diffusion of pulp internal gases due to the conservation conditions.

The temperature is a determining factor that explains this fact, specifically during the period of fruit growth; however, the most important is the date of collection, where the degree of maturity determines the possible physiological alterations that the fruit may have. That is why, as a control and solution, it will be necessary to ensure that the harvesting and reception at the fruit central occurs at the appropriate time. The pre-cooling that takes place in the factory is one of the techniques that allows to reduce the incidence of brown heart.

4.1.4. Mechanical damages

There is a high proportion of defects in the pear due to bruises caused by mechanical or physical damage that can occur both before and after harvest. Harvesting is one of the operations that causes the highest level of damage, while in the post-harvest phase, damage can occur in each of the operations of process technology: transport to the plant, post-harvest treatments, refrigerated conservation, classification, packaging and transport to the points of sale. That is why the physical properties of the food are evolving throughout the production and packaging phase.

4.2. Main alterations in stone fruits (peach)

4.2.1. Cold damage

The fruits of this species are especially susceptible to cold. These damages occur when the fruits are subjected to low temperatures, although higher than those of freezing, manifesting themselves in case the exposure has been sufficiently prolonged. The critical temperature range is between 2.2 and 7.6 ºC, and the damage, despite the fact that they originate during storage, the symptoms appear at room temperature, so it is difficult to realize before consuming it. The most common effects are internal browning, mealiness and reddening of the pulp, and, to a lesser extent, transparency of the pulp. In addition, cold damage can favor the development of microbiological diseases.

4.2.2. Black coloration

The black coloration is an alteration that affects the skin of the peaches, creating spots or streaks of black or dark brown colour. This is due to galling damage along with heavy metal contamination. In the colouring process it happens that in the damaged areas due to chafing the skin cells are broken and the cellular contents react with the heavy metals (iron, copper and aluminium) acquiring dark tones.

As a control to acquire a final product without having these conditions, the quality of the water used for the treatments must be checked, particularly with regard to heavy metal contamination, keeping the equipment and containers used for harvesting clean, as well as how to handle the fruit carefully and avoid long transports.

4.2.3. Mechanical damages

The main mechanical damages in the peach fruit usually manifest as bruises or more extensive spots, usually caused by impact. Damages can occur throughout the entire maturation of the fruit that is, in harvest, transport to the plant, classification, packaging or transport to the point of sale.

Appropriate pre-harvest treatments and high-weight fruits reduce the sensitivity of impact and compression damage.

5. Product distribution

According to the commercialization rules of Regulation (EC) No. 1221/2008 of the commission of December 5, 2008, there are a minimum of quality requirements that both peaches and pears must meet after conditioning and packaging. These are:

A) Minimum quality requirements.

The products must be:

- Whole,
- healthy, excluding products affected by rottenness or alterations that make them unfit for consumption,
- clean, practically free of visible foreign matter,

virtually free of pests and damage caused by pests,

- exempt from an abnormal degree of external humidity and
- free of strange smells and flavours.

In addition, they must have a status in order to support transport and handling in order to reach their destination in satisfactory conditions.

B) Classification

There are three types of categories: Extra, I and II.

The "extra" quality will be presented by the pears and peaches that have a superior quality, presenting the form, development and colouring characteristic of the variety, taking into account the production area, in this case, from La Rioja.

On the other hand, to belong to Category I the peaches must be of good quality and present the characteristics of the variety in the production area (Catherina in peach and Conference in pear). However, slight defects in shape, development or colouring can be admitted. The pulp on the other hand must not have suffered any deterioration. It excludes those that are open at the junction of the peduncle.

Finally, Category II includes those that cannot be classified in the higher categories but that meet the minimum requirements defined above. The pulp should not present important defects, and the open fruits at the junction point of the peduncle are only allowed up to the tolerance limit of quality.

C) Minimum maturity requirements (in peaches)

The fruits must reach a sufficient degree of development and maturity; thus, they are allowed to continue with the maturation process so that they are able to reach the sufficient degree of maturity. To comply with this provision, the refractometric index of the meat, measured in the median zone of the pulp of the fruit and in the equatorial plane, must be greater than or equal to 8ºBrix and the consistency less than 6.5 kg, measured with a stem of 8 mm in diameter.

The final product will comply with the provisions regarding the presentation, homogeneity, packaging and presentation according to RD1221 / 2008. That is to say, with a content of each homogenous package and composed only of peaches grouped by the same origin, variety, degree of maturity and size and, in the case of those of Extra category, with a uniform colouring. In addition, the packaging will be such that the protection of the packaging is conveniently guaranteed, using materials inside clean, new and of a quality such that they cannot cause external or internal alterations in the products, as well as printing inks on non-toxic labels. The containers must also be devoid of foreign matter.

6. Labelling and traceability

The traceability of the product is guaranteed when it is identified in each of the stages of production and commercialization. This is why labels are of great importance, since they are the ones that mark the product from its sale to the consumer.

Following the specifications of the specifications of D.O Rincón de Soto pears, once the certified product leaves the fruit plant for later commercialization, the corresponding delivery note is made and the labels and shipping certificates are checked. The labels that accompany the D.O. pears they must be listed labels, in such a way that the cost of the label carried out in each establishment can be controlled, corresponding to the quantity of certified product issued, thus avoiding that they can be labelled with the logo of the denomination, pears not covered by the Protected Designation of Origin.

The information that must appear compulsorily on food labelling, approved by Royal Decree 1334/1999 of July 31, is reflected in the "General norm of labelling, presentation and advertising of food products." They are the following data: Identification of the supplier, description of the product, expiration date, lot number, net weight and conservation conditions.

7. Finished product

The format of the finished product will consist of plastic boxes with grid of 495x370x155 mm filled with pears or peaches with an alveoli base of 40x60 units.

The boxes will be assembled in euro pallets and will be pre-strapped to their expedition.

8. References

Vinas, I., Recasens, I., Usall, J., & Graell, J. Poscosecha de pera, manzana y melocotón.

EUR-Lex - 32008R1221 - EN - EUR-Lex. (2018). Eur-lex.europa.eu. Retrieved 11 April 2018, from https://eur-lex.europa.eu/legal-content/ES/TXT/?uri=CELEX%3A32008R1221

PUBLIC UNIVERSITY OF NAVARRE

Agricultural, Food and Rural Environment Engineering

PROCESS DESIGN OF A FRUIT INDUSTRY

ANNEX 3. MARKET STUDY

Content

1. Introduction

Thanks to this annex, the general idea of the market situation of fruit at a global, European, Spanish and local level in La Rioja is gathered, that is, the evolution that has been taking place in the fruit market can be evaluated over the years according to the different geographical areas and what that entails.

The agro-food industry has undergone important changes because, thanks to the innovation in different types of processing, handling and conservation of food, it is increasingly possible that they are less perishable and can also be disposed of practically all year round.

2. Market study

2.1. Worldwide

The main countries producing fresh fruits according to FAO are China and India, followed at a great distance by Brazil and the USA. The continent that produces the most in the world is Asia, reaching half of the world's production and allocating a large part of its domestic consumption. On the other hand, America produces around 20%, although it exports 70% of its collections, while Europe has a production of only 16% and imports 50% of what it consumes.

Pip fruit trees, along with those of bone are two of the best known and consumed fruit trees in the world along with citrus fruits. In recent decades, tropical and exotic fruits are competing or complementing these mentioned, such as kiwi, mango, or avocado. In the case of pears, the availability of new varieties is very limited, and few have managed to position themselves in the market, with traditional varieties prevailing.

In terms of fruit exports, the main exporting countries are the United States, Spain, Italy, Holland, China, Ecuador and Costa Rica, while the largest buyers are the United States, Germany, France, the United Kingdom, Belgium and the Netherlands. International fruit trade in recent years has been consolidated due to a progressive opening of markets through the agreements of the common organizations of markets and the successive enlargements of the EU. For the facilitation of these exchanges and the timeless consumption of fresh fruits, logistical and technical improvements have been fundamental through the improvement of transport and information systems, communications and conservation techniques. (Vinas, I., I., Usall, Graell, J, 2013).

Regarding international trade in fruits, there are limitations such as import tariffs, quotas, quarantine pests and pesticide residues. Regarding the latter, they are used by supermarket chains as a way to differentiate themselves from other competitors, demanding limits that are well below those established by the country where these supermarkets are located, and in some cases allowing no more than 4 5 active products present. According to the WHO (World Health Organization), this is a practice that has no technical basis from the point of view of human health and only harms the producing sector, which must not only control pests, but also that also must accommodate the demands of these supermarket chains. In addition, there are numerous requirements regarding certifications: GlobalGAP, HACCP, Fair Trade, BRC, etc.

The main importing countries of pears are Russia, Brazil, followed by Holland, Germany and the United Kingdom; whereas, the main exporting countries of pears are: China, Argentina, the Netherlands, Belgium and the USA. Spain is placed the ninth.

On the other hand, the peach is typical of temperate zones, its cultivation occurs between 30 and 45 degrees North and South latitude, its climatic limitations being above all extreme temperatures in cold areas and spring frosts. Its world production oscillates around 10 million tons

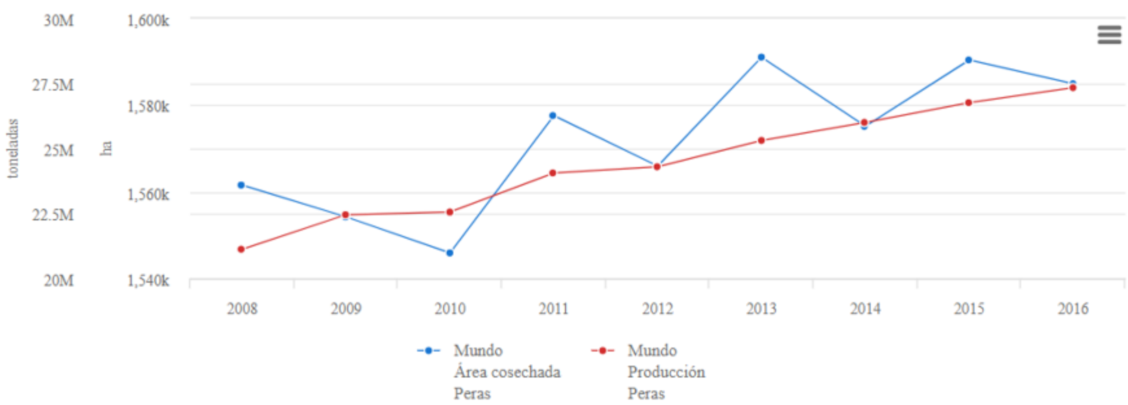
As can be seen in figure 1, the average of tons of pears produced per country in the world during the years 2008-2016, stands out mainly in China with a production higher than 811372.56 tons, followed by countries with less production than this one like the USA, Mediterranean Europe (Spain, France and Italy), Argentina and Chile with regard to South America, Algeria especially in Africa and finally India and Alaska. Regarding the lesser producers of pears with an amount lower than 1853.89 tonnes, the Nordic countries stand out, together with a large part of Africa.

Regarding the varieties of pears, the main worldwide are Conference, Williams, Beurre D'Anjou, Packhams Triumph, being the importance of each relative to each country. Thus, Rocha is the almost exclusive variety of Portugal, Lecture is produced mainly by Belgium and Holland, Williams in Argentina, Italy, France and USA, Forelle by South Africa, etc.

In Table 1, we can observe the trend and relationship between the production and the surface area dedicated to the pear tree that suffers throughout the years 2008-2016 in the world. In this period, the harvested area has suffered strong increases and decreases. A constant trend is not followed; from 2008 to 2010 there is a decrease that is strongly recovered in 2011 with a significant increase, however, the following year it decreases again and then reaches its highest peak of area harvested in 2013 with approximately 1.90k ha. In summary, despite the numerous increases and decreases in hectares, in total during this period the area produced harvest has increased significantly (from 1,560k ha to 1,580k). In terms of production during the period, it has maintained a stable and sustained growth, going from 21 million tons in 2008 to almost 27.8 million ten years later.

Finally, as can be seen in figures 2 and 3, the proportion represented by each continent in the world is very disproportionate, with Asia accounting for 76.5% of pear production, followed by Europe with 12%, followed by America (7.8%) and finally Africa (3%) and Oceania (0.6%). Thus, in terms of the top 10 pear producing countries in the world, it is in the lead as mentioned above, China, followed by: Argentina, Chile, Italy, Spain and Turkey.

Table 25. Production / yield of pears in the world 2008-2016. (Source: FAOSTAT)



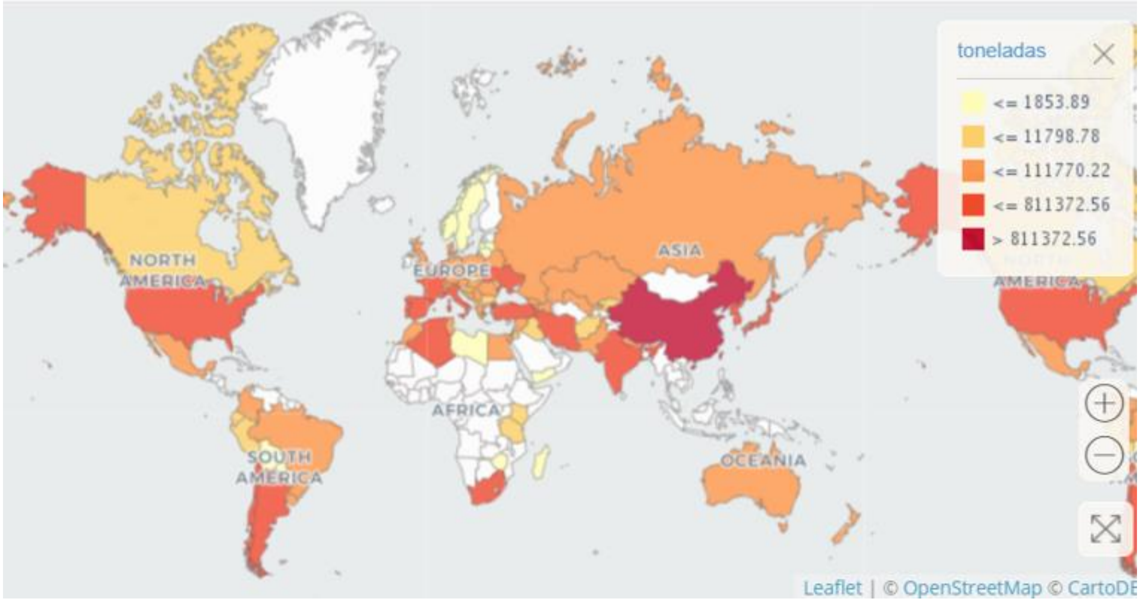


Figure 11. Production quantities of pears per country 2008-2016. (Source: FAOSTAT)

On the other hand, the following illustrations show the production trend that the peach has suffered throughout the years 2008-2016. First, regarding the average of the quantities produced during said period, it is summarized similarly to the previous case with the pears. Thus, in Figure 4, the largest producer of peaches in the world is Asia, Spain and Italy with more than 1084562.67 tons. The following countries with the highest production are, in the Americas, the US, Mexico, Brazil, Chile and Argentina, as well as Oceania, Southwest Asia and North Africa.

In table 2, on the contrary to the previous table, the production area in the case of peach has remained fairly stable in this period in an increasing way, especially from 2012 to 2015. The production is stable maintaining a slight continuous growth over the years, since 2008 with 20 million tons until 2016 that reaches 22 million tons.

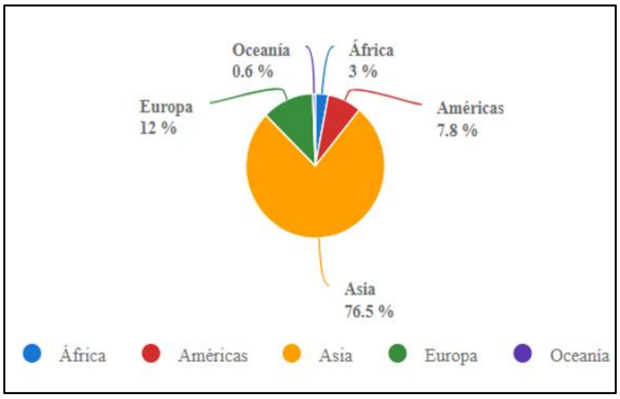


Figure 13. Proportion of pear production by region 2008-2016. (Source: FAOSTAT)

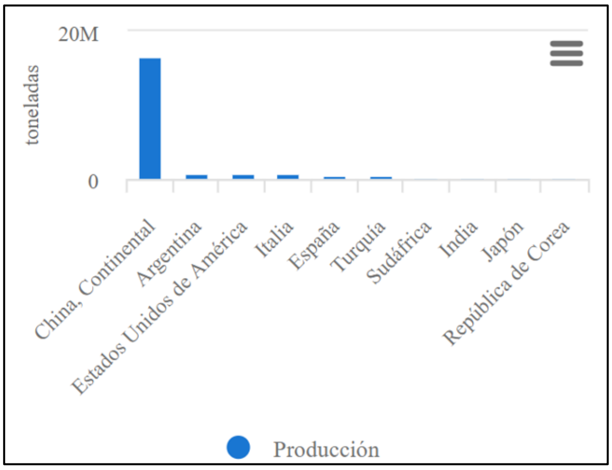


Figure 13. The 10 leading pear producing countries in the world 2008-2016. (Source: FAOSTAT)

Similarly, in figures 5 and 6 we can see how the proportion of major producers in the world is headed by Asia with 65.5% of the total, followed by Europe with 19.4%, America 10.7%, Africa 4% and Oceania 0.4%. Of them, the main countries are China, Italy, Spain in third place, followed by the US and Greece.

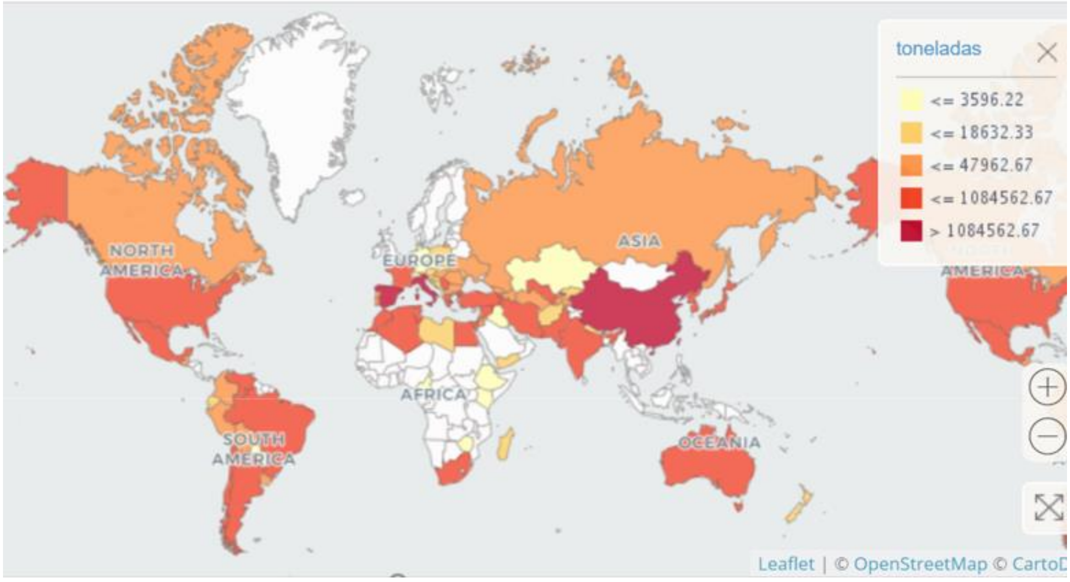
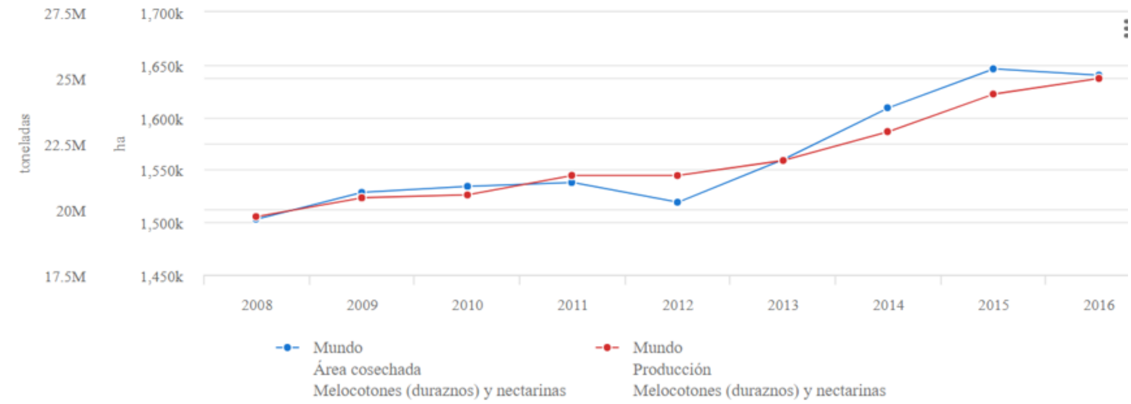


Figure 16. Production quantities of peach per country 2008-2016. (Source: FAOSTAT)

Table 26. Production / yield of peach in the world 2008-2016. (Source: FAOSTAT)



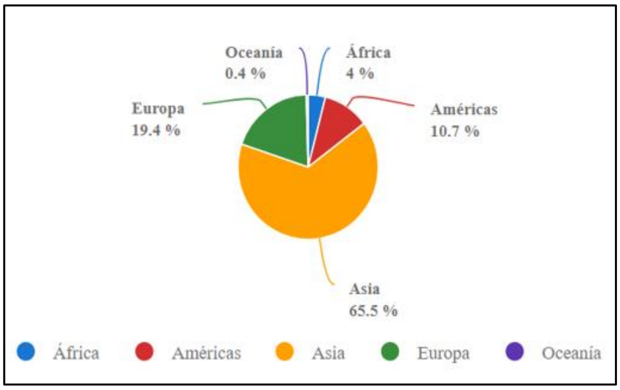


Figure 16. Proportion of peach production by region 2008-2016. (Source: FAOSTAT).

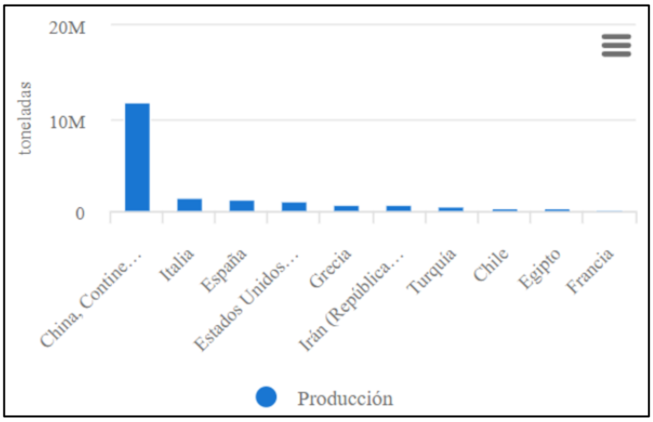


Figure 16. The 10 leading peach producing countries in the world 2008-2016. (Source: FAOSTAT)

2.2. Market in Europe

At European level, the largest production of fresh fruits is found in Italy and Spain. The weather in Europe has caused imbalances in the fruit trees, this has been translated with the pear, among other things, in a poor setting, which has led to a lower production.

Another important change is the decision of the European Union to prohibit practically the use of antioxidants for the control of superficial scald, which represents a serious problem in pears, that is why the development of the Dynamic Controlled Atmosphere for the conservation of The pears and apples presents an important development around the world to help the control of the superficial scald.

The European production of pears is stabilized around 2.5 million tons and in some countries like Belgium and Holland the area planted with pears is increasing. The main pear producing countries are Italy, Belgium, Spain, Holland, France and Portugal, each with its varieties that distinguish them as mentioned above. Over the years, practically in all countries, there has been a decreasing trend in the volume of production over the years except in the case of Belgium, the Netherlands and Portugal. Regarding its varieties, Conference is the main European variety.

Tables 3 and 4 that appear next can be seen in the same way, the evolution over the years 2008-2016 of the production and the harvested area of both pears and peaches in Europe.

In the first place, the harvested area of pears has undergone a considerable decrease since in 2008 the 191k hectares are reached and it begins to decrease until 2016, which only reaches 165k ha of harvested area. However, production during the same period has remained at 2700 tons in 2008, practically the same as in 2016, despite the fact that during the years between and there have been peaks of highs and lows. In 2016 it is even slightly higher than 2008. Therefore, productivity has increased despite the decrease in the terrain that occurred.

Secondly, in the case of the peach, the harvested area suffers also a significant decrease in the land, since it goes from 275k hectares dedicated to peach in 2008 to stay below 260k ha at the end of the period in 2016. From in 2009, the decrease in surface area is constant with the exception of one year, from 2014 to 2015. In terms of production, during this period the same downward trend has been practically maintained as land reduction, that is, it is practically proportional to the reduction of arable land in the period 2008-2012. As of 2012, production increases to end the period in 2016 slightly above its beginning. With this it is understood that from 2012 there is a significant increase in productivity either by technical improvements, fertilizers, etc.

Table 27. Production / yield of pear in Europe 2008-2016. (Source: FAOSTAT)

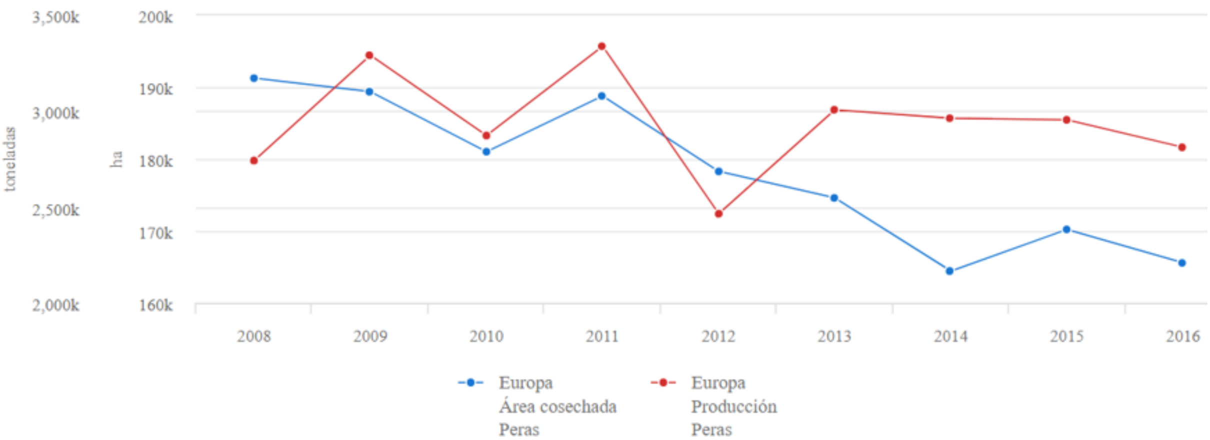
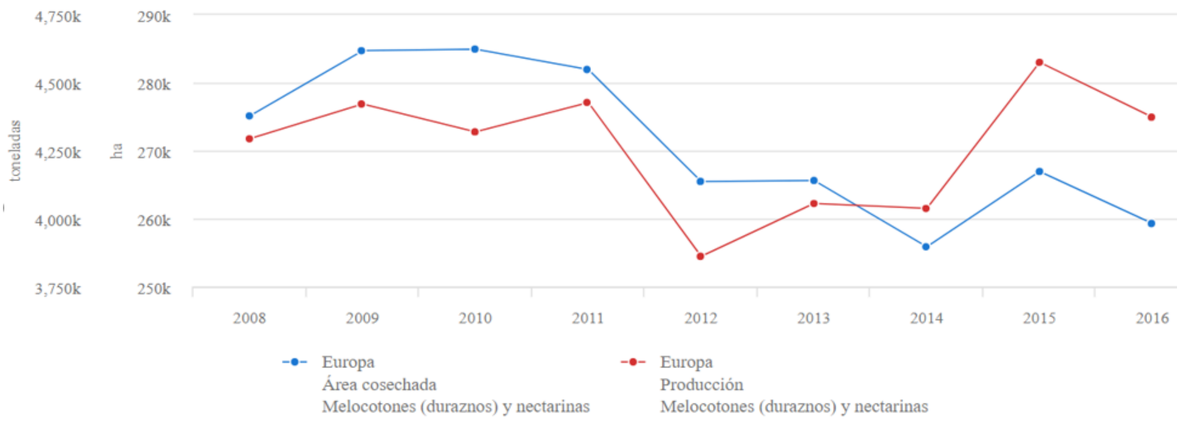


Table 28. Production / yield of peach in Europe 2008-2016. (Source: FAOSTAT)



2.3. Market in Spain

The fruit production in Spanish agriculture has a very important weight both at export level and from the point of view of domestic consumption. The fruits that are most important for the market in fresh are the orange, apple, pear, peach, apricot and cherry. In turn, those intended for industry, the species that stand out are the peach hard meat, apricot, apple and pear. It should be noted that the great diversity of productions that Spain presents because it can be grown in different climates with extensive collection periods, being Murcia and Andalusia the most important for early productions and Catalonia and Aragon for intermediate and late productions. (Vinas, I., I., Usall, Graell, J, 2013).

The pear tree has been historically along with the apple tree and the peach tree the three most cultivated fruit species in Spain, with an annual production that in the last decade has oscillated around 450,000 tons. However, in recent years in Spain there is a constant decline of this species for a number of reasons discussed below. In the first place, the species requires a high level of technology, where varietal innovation has barely taken place and where consumption is declining in most of the countries of the European Union.

In Spain, pear cultivation is mainly located in the Ebro Valley, where about 60% of the national total is produced. The crop is mostly located in the plain areas of this valley, particularly in Catalonia (262,700t) and Aragón (65,450t), followed by La Rioja (56,600t) and Navarra, where this species has traditionally been cultivated. Castilla y León, Murcia and Extremadura are regions where the crop was important, but also where the decrease over the last two decades has been greater, especially in Extremadura, deviating production to bone species such as nectarine or peach, being so, pear cultivation is very unimportant at present. The evolution of pear production in Spain since 1995 shows a decreasing trend, having gone from annual average productions of 650,000t in the 90s to 350,000t in 2012, with the 2012-2014 average of 422,000 t. In large part, this decline is due to the sharp decline in varieties Blanquilla, which was the most important for almost two decades, and Limonera, which has also experienced a significant decline, and was and remains one of the most exported varieties.

Regarding imports, unlike exports, it was growing over the period 2005-2016, reaching an annual average in this period of 43,021 t, the highest in 2007 with 58,027 t. The main exporting countries are Belgium (38%) and the Netherlands (15%), followed by the countries of South America, Chile and Argentina. Specifically, in 2016 compared to the previous year, imports increased slightly, by 1%; the purchase, by Spain to countries such as Belgium, the Netherlands and South Africa and the significant decline of Portugal make the balance stand a little above. Regarding the Spanish export of pear, it is mainly exported to Italy (25%) and Germany (14%).

The evolution of exports since 2000 follows a mild but negative trend and is closely related to the Spanish and European productions of the year, subject to significant variations between years. Spanish exports of pear, up to November 2016, show a decrease of 11% compared to 2015, probably due to a lower product availability since there was less harvest than in the previous year, and also due to competition in the Spanish markets of destination of product from Belgium and the Netherlands, which has resulted in significant drops in countries such as Morocco, Italy, Israel, Algeria or Greece. (Datacomes, February 2017, Rural Life, September 2013, Interempresas, 2017)

On the other hand, regarding the situation of peach in Spain, it is the most cultivated species in the country among the different species of sweet fruit. In 2016, about 84,000 hectares were harvested. This is due to its better adaptation to warm climates since production costs are lower than those of other producer / competitor countries such as Italy or France. Its main characteristic, compared with other species, is the great varietal dynamism, especially in the nectarine of yellow flesh and to a lesser degree in white meat. In 2017, the volume of peaches exported from Spain is large, heading Germany with 115,249 tons exported, followed by France with 84,389t, Italy (57,224t), the United Kingdom (33,724t) and Poland mainly. Regarding peach imports into Spain, France stands out, with 1556 tonnes imported in 2017, followed by Portugal with 1185 tonnes and Italy with 892 tonnes.

In tables 5 and 6, in the same way as in the previous ones, the evolution of the harvested area and the production of pears and peaches in Spain in the years 2008-2016 can be observed.

The area dedicated to the harvest of pear trees since 2008 has been decreasing permanently and stable throughout the period, going from 28k ha (2008) to 21k ha (2016). Production suffers a sharp drop in the year 2008-2009, producing a small recovery during 2009-2011 to fall again significantly the following year, until it reaches the minimum production period in 2015. The following year it rebounds slightly increased production despite the fall of harvested area. It is striking that production falls more than the area of cultivated area.

In the case of peach, the inverse phenomenon occurs. Constantly raise the area of cultivated area, going from 75k to be above 85k has. The production also increases during the period, although to a lesser extent than the cultivated surface area, passing from 1300 tons to 1500 tons.

Table 29. Production / yield of pear in Spain 2008-2016. (Source: FAOSTAT)

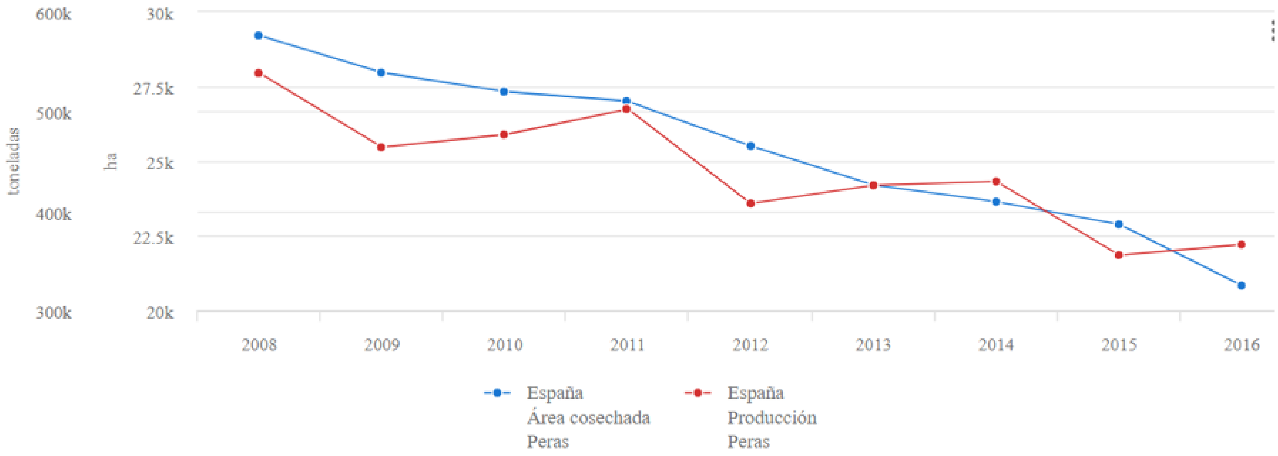
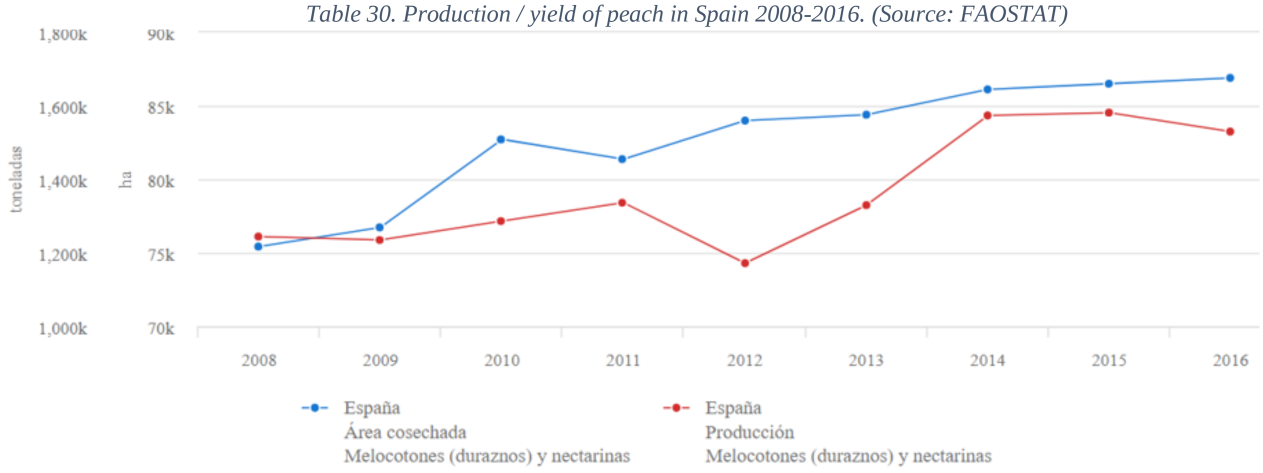


Table 30. Production / yield of peach in Spain 2008-2016. (Source: FAOSTAT)



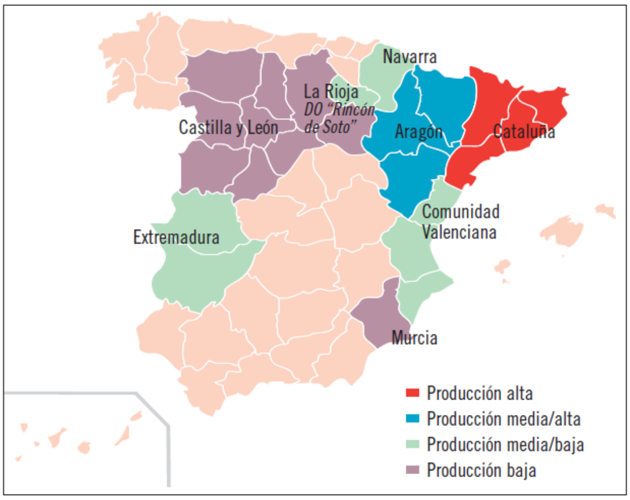


Figure 18. Main production areas for pears in Spain.

Figure 18. Main production areas for peaches in Spain.

As can be seen in figures 7 and 8, the level of production in Spain according to the autonomous regions of pears and peaches are quite similar. In both cases, Catalonia is the community with the highest production. As medium / high production the two are presented in Aragon, only that in the case of peaches also adds Andalusia. Regarding the low production of peaches only occurs in Navarra, compared to the case of pears that both Castilla y León, and La Rioja and Murcia have a low production.

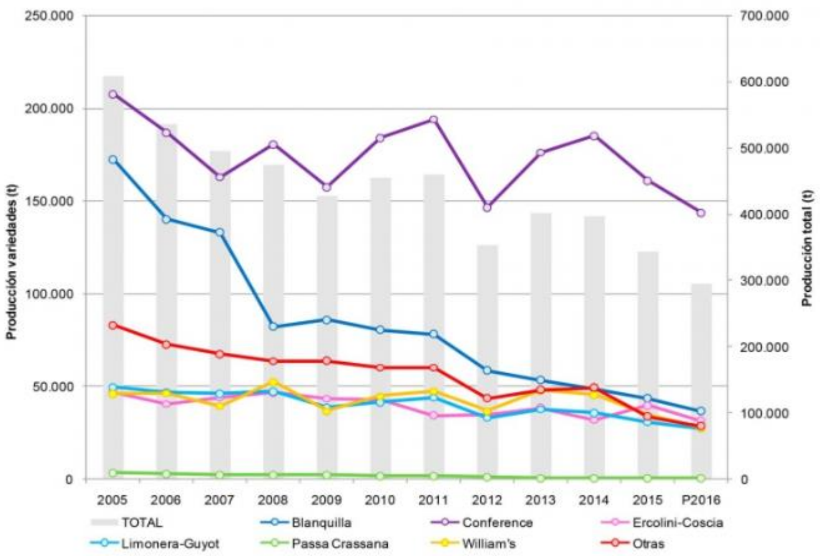


Figure 19. Evolution of the pear production according to the different varieties during 2005-2016. (Source: from CCAE data, Dic.2016)

2.4. Market in La Rioja

Regarding the market situation of pears and peaches in La Rioja, it can be clearly seen, through the following tables, how the evolution of these has been both at a productive level, as a surface and in their price throughout the year. the years.

As far as the pear tree is concerned, in Table 11 we can see how the total surface of this fruit has an upward trend over the years, but, nevertheless, it does not mean that the production in it has also been so since There are numerous factors that determine it, mainly the climate. The maximum area of pear trees reached was slightly above 2500 hectares in the years 2014 and 2015. The following table shows how the tons increase or decrease according to the year irregularly, reaching almost 60000 tons in recent years and being in 2012 of the lowest figures of the last period with around 48,000 tons of production. That is to say, the cultivated surface is increasing and consequently, the production also, it seems that something more than in the harvest area with which you can see improvements in the field. As for table 13, despite the fact that there is more production, there is an increase in price while increasing over the years. Normally, the more supply there is the lower the price, however, in this case no. Despite an increase in demand, in 2014 there was a strong downturn.

Table 31. Evolution of the total pear area in La Rioja

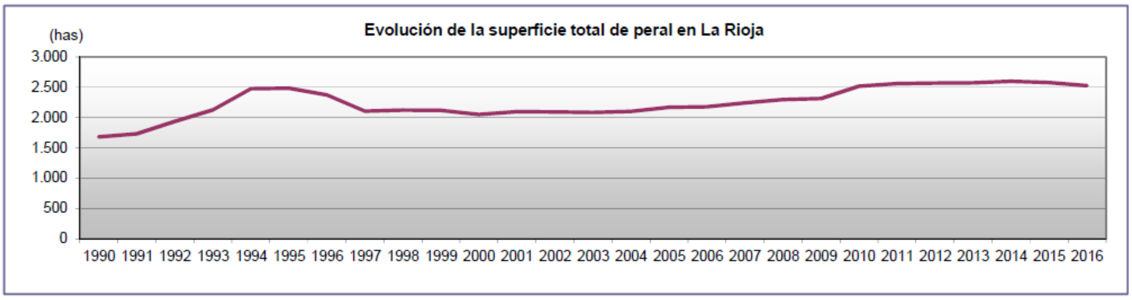


Table 33. Evolution of the total pear production in La Rioja.

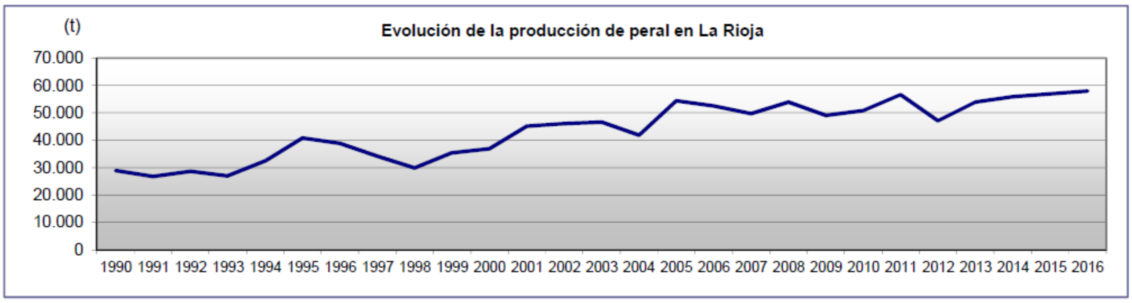
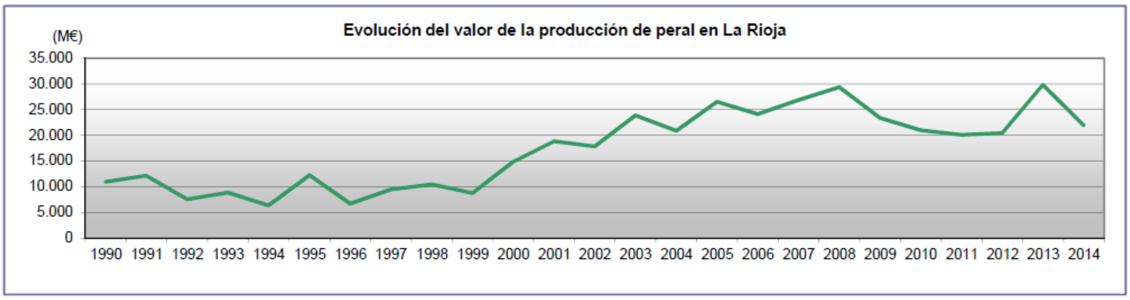


Table 32. Evolution of the value of pear production in La Rioja.



However, in all cases, the evolution of the peach tree over the years, both in its surface, as in its production and in its value over the years, follows a downward trend as can be seen in the following tables (15, 16 and 17). Regarding the surface, there is a constant decreasing decrease over the years important, and it seems that the production decreases in similar terms to the decrease in the harvested area of peaches. Prices, despite the decrease in production, are suffering peaks reaching their maximum in 2003, year from which the price gradually decreases. Therefore, the demand remained while production fell, where then the price went up until 2003, when all of this goes down together.

Table 34. Evolution of the total peach area in La Rioja.

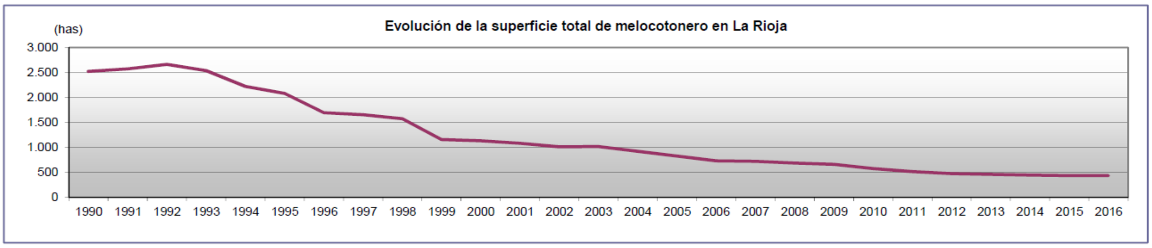


Table 36. Evolution of the value of peach production in La Rioja.

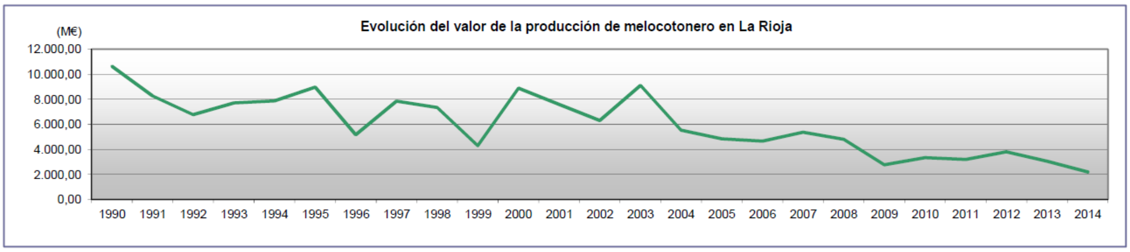
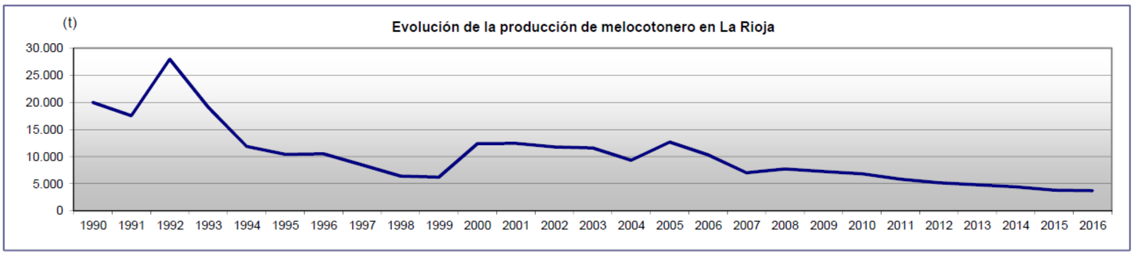


Table 35. Evolution of the total peach production in La Rioja



3. Conclusions

In general terms, it could be said that both pears and peaches are increasing both in production and harvested areas, but nevertheless, at European level, both fruits decrease as the years pass, contrasted with what happens in Spain. The peach increases but the pear does not. In contrast, in the case of La Rioja, it happens the other way around, the pear is what is increasing in production, surface and price, while in the peach it is the opposite.

In pear you can also find a lot of variability of qualities and sizes. In general, the market is stable, although the large calibres (and with good russeting, as is the case of the Conference variety) are more valued than the small ones and are getting better prices.

Given the aforementioned global situation as a whole, and more especially taking into account that of La Rioja, to achieve an improvement in sales price increase, it is convenient to focus on the integrated production peach to give it a special quality, with more distinction of the rest and therefore with greater value. The same is intended to be achieved with the pear, so to give added value and better quality, pears are chosen with the "Rincón de Soto" Denomination of Origin of the Conference variety, since it is still one of the main and most important productions in all the levels mentioned.

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PUBLIC UNIVERSITY OF NAVARRE

Agricultural, Food and Rural Environment Engineering

PROCESS DESIGN OF A FRUIT INDUSTRY

ANNEX 4. RAW MATERIAL ANALYSIS

Content

1. Introduction

In the case of the treated plant, the production process is based on the manipulation of the fruit incorporated into it through the reception, selection, conservation and packaging of the same, in such a way that the raw material incorporated is the result of the product to market. The purpose of this annex is to present the main fruit varieties with which it is going to be processed and their respective collection periods, so that a continuous product dynamic is achieved throughout the year in the plant.

The fruit itself is a specialized organ of the angiosperms, developed from the ovary, and with the function of providing an adequate environment for the maturation of seeds and a mechanism for their dispersion. Thanks to their organoleptic and nutritional properties, the fruits are considered high value commercial crops. The maturation of the fruits encompasses a series of physiological processes rigorously controlled at the genetic level, which lead to a series of changes in the physical and organoleptic properties of the fruit such as color, taste, texture and smell. Thus, the phenotype of a fruit results from its genetic characteristics and the influence of different environmental conditions determine it, acquiring attributes that determine the overall quality of the fruit. This expression of the genes that are potentially activated by the maturation process manifests the activation of numerous specific metabolic pathways and also the enzymes that regulate them are synthesized.

Thus, the changes associated with maturation are mostly anabolic, so they require energy and a carbon source, which are mostly met by respiratory metabolism. Depending on the evolution of the respiratory rate during ripening, the fruits can be classified as climacteric or non-climacteric. In this project, we will work with pear and peach fruits, both belonging to the group of climacteric fruits. In this case, the events related to maturation are coordinated globally by the ethylene phytohormone.

Also, this raw material study will discuss the main post-harvest diseases that may occur and the importance that this implies, as well as the need for effective methods of controlling these alterations without posing a risk to human health or For the environment. Due to the low pH level of fruit tissue, both pip and bone, molds predominate as microorganisms responsible for rotting, most of them of the genera Penicillium, Botrytus, Rhizopue, Mucor, Alternaria, Neofabraea and Monilinia. , the most important of which is P.expansum in pip fruit, both in appearance frequency and in volume of damage caused; and of the genus Monilinia spp. in the case of stone fruit. Both during the process of conservation in chambers and in their later commercialization, said molds are the main responsible for the losses due to fruit rot. The use of synthetic chemicals for the control of rotting is the most widely used method today, mainly due to its low cost, its good level of effectiveness and its easy application. However, we are looking for more sustainable and less aggressive systems with the environment and human health due to the problems related to the excessive use of fungicides in certain cases.

1.1. Ethylene action

Ethylene is the simplest alkene, with a gaseous state and a standard temperature. It acts as a hormone in many aspects of the life cycle of plants, such as seed germination, fruit ripening or response to different types of biotic and abiotic stress; so, from the point of view of the postharvest of fruits, its effects are very relevant commercially since they exert great influence on the conditions of handling, packaging and storage that are applied to the product. This important varied hormonal activity is like this because the ethylene of hydrocarbon character allows it to easily cross the cell membranes which helps its rapid extracellular diffusion.

2. Main raw material

2.1. Pear

The pear is the fruit of the pear tree, deciduous tree of the Rosaceae family up to 10m high, with a rounded crown and a greyish green trunk. The fruit may appear green, yellow or red, broad at the bottom and thin at the top (where the peduncle); of fine skin and white flesh, with a sweet flavour and, in the centre, small black seeds. The main use is destined to fresh, reaching up to 90% of the total, the remaining 10% being destined to the industry for salads, compotes, juices, etc.

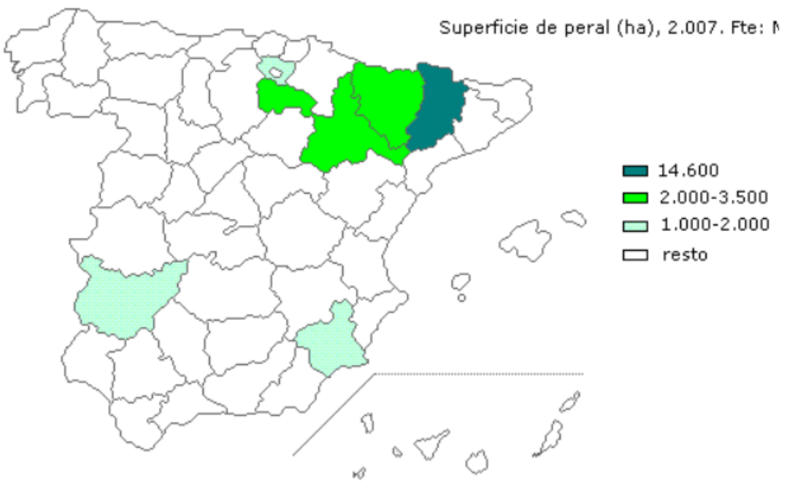

Figure 20. Pear cultivation area (ha) in the main regions of Spain (Source: MAPAMA)

Regarding the production of the pear crop, it can be seen in Figure 1 that the predominant city with more than 14600 hectares dedicated to this crop is Lérida, followed by La Rioja and Aragón with approximately 2000-3000 ha.

The pear to be treated in the fruit plant is protected under the Denomination of Origin pear of ”Rincón de Soto" and, therefore, this is the one that will be explained below in more detail in accordance with the specifications of P.D.O “Rincón de Soto".

2.1.1. Morphology

These characteristic pears of the species Pyrus Communis L., come from Blanquilla and Conference varieties, of the "Extra" and "I" categories, destined to be delivered to the consumer in fresh condition.

The variety that will be treated in the plant is the Conference, which was introduced in 1885 in England:

- Tree: medium vigor and upright bearing that becomes open with age. Apical dominance little accused of the axis that tends to be easily annulled. Branch a little anarchic. Entry into relatively fast production and good and fairly regular production.

- Flowering: Late period and half entity. Good pollinators are: Decana del Comicio, Limonera, Williams.

- Fruit: Of average and thick calibre according to culture and years, elongated piriform of regular enough contours, sometimes somewhat symmetrical. The skin is thick, yellowish green with more or less russeting according to climates. The pulp in yellowish white, melting, juicy, sweetened and of excellent taste quality.

- Collection and conservation: collection between August 18 and 20; It is badly preserved in a fruit bowl, but normal cold arrives until February with good quality and in controlled atmosphere until April. It presents good aptitude to transport and manipulation.

The differential characteristics of said pears are several. First, the protected geographical area of its production (where Alfaro, location of the fruit plant in question of this work, is one of the four municipalities of the Rioja Baja that delimits this geographical area with 19936 hectares dedicated to "Rincón de Soto" ") Make the pears different from the rest. The technical and agronomic criteria that allow the D.O.P of the pear are: the temperate Mediterranean climate, where 66.75% of the total irrigated area of the community is used for pear cultivation; its geographical situation, specifically the altitude and proximity to the surrounding valleys, the fertility of the alluvial soils near the valleys, the cultivation techniques and the artisanal packaging method adapted to the current requirements of Food Safety.

Due to the altitude of the valley in which it is located and the adjoining rivers (Ebro, Alhama and Cidacos) that make it possible to generate a fog that ends up disappearing suddenly in a few hours, leaving a radiant sun and thus, the evaporation of The humidity deposited by the fog on the surface of the conference pear, due to the persistence of the sun, makes possible the appearance of Russetting naturally, without the need to use chemical products that artificially burn the surface of the skin. This parameter is highly valued in this area when differentiating its product from that of other geographical areas.

On the other hand, thanks to the techniques used in the production processes as well as storage, conservation and expedition carried out in the area, together with the climatology and soil science of the area, makes it larger, elongated, sweeter and its skin has a more greenish color, acquiring greater value in the market. Also, the peduncle once collected from the tree will be intact, whole, rounded and undamaged, thanks to the manual collection system used. At the same time, it is worth highlighting, apart from its great sweetness, the sufficient hardness it has, which facilitates its handling and conservation.

Regarding the organoleptic characteristics, the Conference presents a woody consistency that has an excellent flavour in terms of acidity and sweetness, high, intense and balanced. Both have high juiciness and a high content of sugars, a component that greatly affects the taste quality of the fruit.

2.1.2. Optimal conservation parameters

	Tª (ºC)	HR (%)	CO2 (%)	O2 (%)	Conservation period
AN	-0,7/-1,0	94/96	-	-	3 meses
AC	-0,7/-1,0	94/96	1,4/1,7	2,5/3	5-6 meses
ULO	-0,5/-0,7	94/96	1	2	8 meses

- Variety very sensitive to CO_2 damage. To minimize the incidence of the associated disorders (decomposition and formation of internal cavities) it is recommended to keep the CO_2 levels low, cool the product well, not extend the conservation period and not preserve mature batches.
- Frequent dehirdratation and risk of freezing in the peduncular area.
- Variety sensitive to the colour change of the epidermis when oxygen levels are high. To minimize it, it is essential to cool the product quickly and reach levels of ULO (Ultra Low Oxygen) as soon as possible.

Due to the fact that the conservation period is long in this variety, rottenness problems can occur mainly in the wounds caused by the harvest and by the peduncles. Trrat fungi. Previous to the camera and good practices necessary harvest.

- For conservation of more than three months, the use of a chemical or physical system with anti-scalding effect is considered necessary.

(Vinas I., 2013)

2.2. Peach

The peach is the fruit of the peach tree, small tree and not very leafy. It is a typical drupe, with fleshy pulp with hard bone in the centre. It is usually yellow with reddish tones and is divided by a slit that gives it its characteristic shape. This is originally from China, where references to its cultivation date back to 3000 years. It comes from the Family: Rosaceae, Genus: Prunus, Species: P. Pérsica.

Peach production occurs mainly in regions of dry and hot climates given the lower incidence of diseases and spring frosts that present, being the highest risk in the Ebro Valley region, but also being the area where the greatest number of cold hours, thus making possible the cultivation of more demanding varieties in winter rest. More to the south of Spain. The availability of cold hours are lower and the most cultivated varieties are the early or early extra, with low requirements. The temperature is the most important climatic factor, since it influences the damages to the organs of the plant from -30ºC, reason why the frosts of spring turn out to be the most limiting factor since they can destroy the flowers or the fruit set.

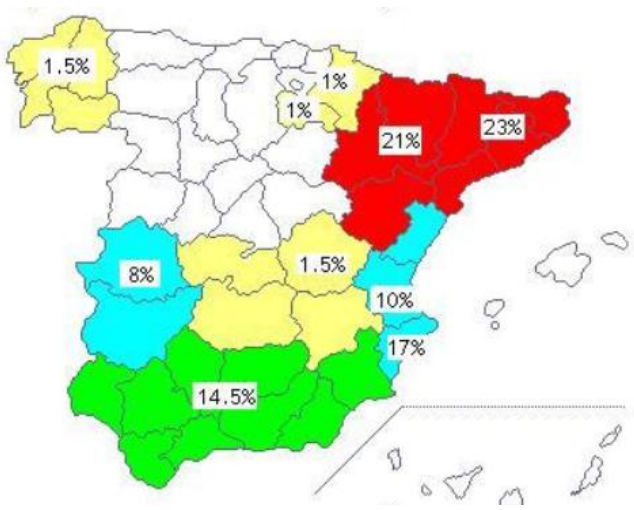

Figure 21. Percentage contribution of the CCAA to the total area cultivated in Spain of peach. (MAPAMA)

As can be seen in Figure 1, Andalusia has the largest area of peach trees cultivated with 14.5%, followed by Catalonia and Aragon (23% and 21% respectively).

In this project, with the objective of finding differentiated products with quality marks, apart from the D.O.P in the Rincón de Soto pears, it has been decided to obtain peaches from an integrated production. This is based on, in accordance with RD 120172002, which regulates the integrated production of agricultural products, in a system for obtaining vegetables that make maximum use of natural resources and production mechanisms, ensuring a sustainable agriculture in the long term. To do this, we introduce biological and chemical control methods and other techniques that combine the requirements of society, environmental protection and agricultural productivity, as well as the operations carried out for the handling, packaging, processing and labelling of plant products hosted to the system.

The management of this type of fruit is possible since it is dictated that it is only allowed in harvests destined to prolonged conservation, as it is the object of the project. All hygiene measures, handling, storage, reception and marketing of the product cited in the standard, are considered throughout the development of the process and completion of the work.

2.2.1. Morphology

Within this species, up to four types of different fruit are included: peach, pavia, Paraguayan and nectarine. In addition, within the peach and the nectarine, it can be subdivided according to whether they are yellow or white meat. The most important difference is due to the colouring of the fruits, the taste quality (firmness, sugar content, acidity), and the date of maturation and in some cases the shape of the fruit.

In the case of this work, they will be manipulated in the central yellow peaches, specifically the early variety Catherina. Next, it will be described more specifically each one.

2.2.1.1. CATHERINA

- Tree: it is vigorous and of erect bearing, with reniform leaf glands. The production is high and regular.

- Flowering: the time of flowering occurs in March around day 10 and the flower appears pinkish.

- Fruit: the calibre is between medium and coarse depending on the load, the thinning and the situation of the tree. Rounded, regular and symmetrical, with golden yellow or orange skin, with a light red plate on the sunny side. The pulp light yellow, consistent, juicy and perfumed, slightly acidulated, presenting a good taste quality.

- Collection and conservation: it is collected from the second half of July, between the 16th and 18th of the month. They have good transport and handling aptitude and are appreciated for industrial transformation and fresh consumption. Limited conservation.

- Agronomic considerations: Fructifies preferably on mixed shoots of the previous year that must be thick and located in the lower part and outside the tree to improve the quality of the fruit and reduce its acrotonic tendency. It requires a normal pruning of renewal of producing branches of the indicated type. It is interesting for the ripening season although its excellent agronomic and commercial qualities have turned this variety into surplus due to the large amount of tonnage produced. Good behaviour against spring frosts. As for the calibre, it is something just for the demands of the fresh Spanish market. In the pruning, the mixed branches that are not very vigorous and located in the interior should be eliminated as far as possible, producing fruits of smaller size, colour and flavour. High thinning requirements.

2.2.2. Optimal conservation parameters

	Tª (ºC)	HR (%)	CO2 (%)	O2 (%)	Conservation period
AN	0/0,5	90/95	-	-	2-3 semanas
AC	0/0,5	90/95	4/5	2,5	4-5 semanas

- Varieties sensitive to browning of the epidermis (in the form of darkening of the areas that have been touched during handling) as its preservation is extended. This sensitivity can increase especially if it is collected in periods of high relative humidity.
- They are "non-melting" varieties, that is, the pulp does not usually soften during storage and subsequent commercial life.
- It is convenient to control the temperature very well to maintain the quality of the product.
- High susceptibility to decay in late varieties.

(Vinas I., 2013)

2.3. Diseases

Next, we will talk about the main diseases and pests that can occur in pears and peaches, both in harvest and consequently during post-harvest, as well as their necessary management and control measures to avoid the greatest economic damage due to possible losses.

2.3.1. Blue rot caused by *Penicillium expansum*

This disease is caused by Penicillium expansum and is called blue mold in English, being the most common and important in pears, where more than 70% of total losses by fungi. It is a soft rot, watery and usually brown, with fast developing temperatures of 20 to 25 ºC. Although the colour may vary from one fruit to another, this disease can be distinguished by the watery consistency of the rot and the clear margin that exists between the damaged soft zone and the healthy zone. The surface is covered with a whitish mycelium at the beginning, but which ends up taking typical blue-green coloration and ends up covering the whole affected area. In the case of pears, it is very common that this fungus produces peduncular rot, where the infected peduncle is dry and the blue sporulation can be present in it.

This disease is practically exclusive of post-harvest, originated through infections in non-healed wounds, produced in the field, during harvesting or later manipulation in the plant. The conidia penetrate the wounds and develop quickly between 20-25ºC, which can be present both in the packaging, as in the environment of the plant or in the aqueous suspensions of the showers where the post-harvest treatments are carried out. The development occurs slower if it is kept cold but after a few months rot can be observed even though it has been preserved in chambers with very low oxygen levels.

One of the most important ways to control this disease is to avoid the production of wounds during harvest and subsequent handling. The farmer must be careful and discard the fruit that has not healed wounds. In addition, it would be necessary to carry out periodic cleaning and disinfection of both the field packaging and the cold storage facilities. It is also recommended to separate the dirty areas from the clean ones in order to avoid cross contamination in the fruit plant. As still, especially in the case of pears, it is not enough, the activity is complemented with a pre- and above all post-harvest application of some synthetic fungicide, as with the showers used in this project.

Figure 22. Blue rot caused by P. expansum in Conference pear.

2.3.2. Grey rot caused by *Botrytis cinerea*

This disease also called grey mold, is much more important in pears than in peaches, extended by all the major fruit producing areas in the world, creating significant economic losses.

The rot is pale brown with diffuse margins, becoming darker in the centre as time passes and this rot may affect the entire fruit. The texture is firm and when the fruit ripens it becomes softer. On the affected area, a whitish mycelium can develop, which depending on the humidity and temperature can get to sporulate and take on a grey colour. Unlike the previous case, it is not possible to separate the affected tissue from the healthy one and the fruits in contact can be infected.

As for the disease cycle, the fungus that creates it has a high saprophytic capacity that survives in the soil of fruit fields or on any organic residue in the fruit plant itself. Its development tends to be mainly in postharvest although it can also appear in the field. The conidia disperse in the field through the wind or because of the rain splashed on the fruits, or in the case of the plant, by air or by the treatment water. Referring to the infection, it is originated mainly through wounds produced in the field and later handling, but it is also possible to infect healthy fruits that are in direct contact with the infected zone. Peduncular rot can also occur, that is, invading the peduncles of the fruits.

To try to avoid this disease, it is recommended to eliminate weeds under the tree tops and promote air circulation and rapid drying of the fruit, as well as avoid post-harvest handling with wounds in the product. The personnel that makes the harvest must be very careful with the handling of the fruit in order to avoid that it suffers blows and not pick up the fruit that has fallen to the ground. As an important point, it would be necessary to carry out periodic cleaning and disinfection both in the field and in cold storage facilities. In turn, try to avoid cross contamination in the plant, separating the dirty areas from the clean ones. The disease can be controlled quite efficiently, especially by post-harvest applications through the application of some synthetic fungicide.

Figure 23. Grey rot caused by Botrytis cinera in peach.

2.3.3. Rot caused by mucosal moulds

The rots of this disease are caused specifically by mould Rizhopues spp. and Mucor spp. Both the symptomatology, as well as the disease cycle and the control methods are similar for both fungi, so they are explained together. This rottenness is as widespread as it is important, although its appearance is not as regular as the blue rot, however, if it does appear, the economic losses suffered may be greater than 50% of the stored fruit. This rot affects both pears and peaches, that is, in general, both pip and bone fruits.

It is a brown rot, very soft and rapid development, producing an internal decomposition of the very liquid fruit. On the infected mass a white filamentous micellar mass appears, with globular sporangia that soon turn black. The fungus needs a wound for its initial penetration, but once it occurs, it develops quickly, easily producing a break in the skin. From the affected area drips a juice with characteristic sour smell that contains enzymes, which serve for the spread of the fungus to other healthy fruits, destroying the epidermis of these and forming nests without the need of wounds.

Regarding the cycle of this disease, the fungus remains in vegetable remains in the soil of the fruit fields and is common the presence of conidia in the air, so that infections occur in fruits with wounds in both the tree and the fruits that fall from the ground. Most of the fungicides used are effective against these fungi, assuming the treatment water of the plant one of the main sources of secondary inoculum.

To carry out its management and control correctly, it is essential to combine prophylaxis techniques with preventive treatments because there are few authorized curative treatments. That is why we must put special emphasis on this disease and treat it in the best possible way. For its correct control, it is necessary to implement strict hygiene measures and sampling of both the fruit that comes from the field and the fruit plant. As a minimum, both at the beginning and the end of the fruit season, the cleaning and disinfection of both the packaging and the surfaces of the cold rooms and facilities will be carried out.

Figure 24- Rot caused by Mucor hiemalis in pear.

2.3.4. Brown rot caused by *Monilinia spp.*

This is the main disease in peaches, although in some humid areas it can also attack on pip fruit. The fruit can be infected throughout the crop cycle and brownish brown spots appear as the first symptoms, which quickly show rottenness and are covered with conidia. The tissue of the rot is very soft and the disease can appear in the field, but in post-harvest is when more losses cause, causing several problems in the commercialization since after 3-4 days at room temperature may already appear rotten, so the Fruit can come out of the plant towards the market in optimal conditions and once the transport or the marketing process is finished, they can be totally unsalable.

In the cycle of the disease, the pathogen spends the winter in the form of mycelium or conidia on the mummified fruits, above all those that are in the tree. With the arrival of spring, new conidia are produced which, together with the existing ones, are dispersed by the air, water or insects, infecting the flowers, which will act as a secondary inoculum source for the fruits. The factors that are decisive for the development of the disease are rainy periods or very high relative humidity, in flowering or shortly before harvest. During the period of cold storage, the infection continues to develop, but much more slowly.

Currently the control of this disease is carried out by fungicides applied in the field mainly. Post-harvest treatments or an alternative system may be appropriate depending on the cases. A correct field management of the disease must be implemented by reducing the inoculum and avoiding producing wounds for the subsequent manipulation of the fruit. Regular cleaning and disinfection is recommended both in field packaging and in facilities, as well as cooling the fruit as soon as possible and avoiding interruptions in the cold chain during its handling in the fruit plant and subsequent transport to the point of sale.

Figure 25. Different intensity of rot caused by Molinia spp. in peaches.

3. Pests

3.1. Pear pests

3.1.1. San Jose Louse (Quadraspidiotus perniciosus)

This plague develops at the end of winter after its hibernation. With the arrival of heat, the plague is visually observed. This causes damage to the fruits, reducing their commercialization. They present some violaceous spots on the leaves or on the nerves of the leaves and circular reddish stings in fruits. This is due to the toxic substance that is injected creating this red halo around the bite.

Figure 26. Damage caused by San Jose Louse.

3.1.2. Psila of pear tree (Cacopsylla pyri)

The psila of pear is one of the most important pests in pear trees that cause remarkable economic damages.

The psila of pear tree becomes active in spring, and begins by feeding on young leaves and flowers, while in summer, it feeds on new shoots. Direct dietary damage such as growth inhibition and leaf malformation are not as important as the damage that is caused by the excreted molasses. It stains the fruit and the branches, and turns them black. In addition, it also transmits viruses and weakens the floral buds of next season. That is, the harvest of the next season may also be in danger.

As a preventive measure, the monitoring of populations in the field and the laying or hatching of the first generation carried out on 40 floral organs. The rest of the vegetative period is sampled with 50 growing shoots and the percentage of eggs and nymphs is determined.

Figure 27. Psila of pear tree.

3.1.3. Fruit fly (Ceratitis capitata)

The activity of the fruit fly, an insect native to Africa, begins in spring with the arrival of heat. The damage caused to the fruit is due to the bite of the female, producing holes that turn a chestnut yellow colour.

As a preventive measure, it is advisable to use food traps and control the disseminated fruit trees, with traps or treatments. It is treated with a frequency of 7 to 10 days with insecticide.

Figure 28. Fruit fly (Ceratitis capitata)

3.2.4. Carpocapsa (Cydia pomonella)

The carcocapsa usually measures between 1.5 and 2 cm, the male being smaller than the female. The damages produced by this one in the pear tree consist of the perforation of the fruit, causing the destrío and the non-commercialization.

As a preventive measure, it is effective to eliminate the places where hibernation of the pest takes place, such as the bark of the trunks or the remains of vegetables under the canopy, as well as in the vicinity of the trees, during the months of October and March.

Figure 29. Carpocapsa (Cydia pomonella)

3.2. Peach pests

Apart from the fruit fly and the louse of San José, already explained in the previous point, the pests that can occur in the peach tree are the following:

3.2.1. Mites (Panonychus ulmi, Tetranychus urticae)

The damage caused by the bites of this spider, is that the brightness of the buds and leaves is lost, discolouring and appearing tan spots. In case the attack is intense, the leaves and buds dry and fall from the plant. The production of the plants can be strongly affected due to the weakening and defoliation that it produces in the plants, as a result of the decrease of photosynthetic assimilation.

As a preventive measure, you should avoid excess nitrogen fertilization and excess vegetation, in addition to encourage the presence of natural enemies.

Figure 30. Mite (Panonychus ulmi)

3.2.2. Green aphid (Myzus persicae Sulzer)

This plague produces the winding of the leaves, attacking whole shoots, which causes the interruption of its development, thus affecting the fattening of the fruit. The damage caused to the fruit is more important in nectarines, where it causes deformed and discoloured areas where the stylus sticks. The green aphid is a vector of several viruses, among them, the Sharka virus, very important in fruit crops of bone.

As a preventive measure, it is recommended to eliminate secondary hosts where the aphid spends the summer. Also, physical control methods such as how to prevent ants from having access to the tree.

Figure 31. Green aphid.

3.2.3. Oriental moth (Grapholita molesta)

The caterpillar feeds first of the tender shoots (until May-June) and then of the fruits. Damaged buds are dried, which is serious in trees in formation or newly grafted. As of June, the damages appear in the fruits, penetrating to the bone. The damaged fruits spoil and do not serve for commercialization.

Figure 32. Oriental moth.

4. Auxiliary raw material

4.1. Crates

The crates used cannot be plastic according to the specifications of PDO pears "Rincón de Soto", so they will be made of wood due to their hygroscopic and insulating properties that reduce the thermal and hygrometric jumps, also reducing possible knocks and fruit rots. Therefore, this type of wooden crates will also be applied in the case of peaches.

These will always be in perfect conditions of use and their lateral and inferior sheets should be sufficiently separated to allow aeration of the product. All crates before use, should be disinfected with a formulation of low or no toxicity for humans, terrestrial and aquatic fauna, combating, among others, the appearance of Botrytis, Gloeosporium, Penicillium and Rhizopus.

The maximum capacity of each wooden crate will be about 250 kilos of fruit, avoiding such as an excess of pressure on the bottom pears.

The wooden crates are provided to the farmer by the fruit plant.

Figure 33. Wooden crate (1200x1200x740)

4.2. Boxes

The boxes will be used for the shipment of the product. These will be made of plastic and with a grid for ventilation. The dimensions will be 495x370x155 mm. In them, the product will be placed with a base of aveoli that cover 8x8 units.

Figure 34. Plastic box and 8x8 alveoli of pears and peaches.

4.3. Strapping coil

The strap will be flexible and manageable for the strapping of the pallets. It will be available in coil and the automatic machine will be responsible for carrying out the strapping action. It does not spoil the product and allows ventilation of the fruit on the pallet.

Figure 35. Flexible strapping coil

4.4. Pallets

The boxes of fruit ready to be shipped are stacked and supported on what is called euro pallets.

On the pallets, depending on the size of the boxes, they will be placed correctly covering the entire surface of the pallet, giving it more stability overall. Normally the pallets go up to eight or nine heights.

The dimensions of the Euro pallets are going to be those shown in the following illustration:

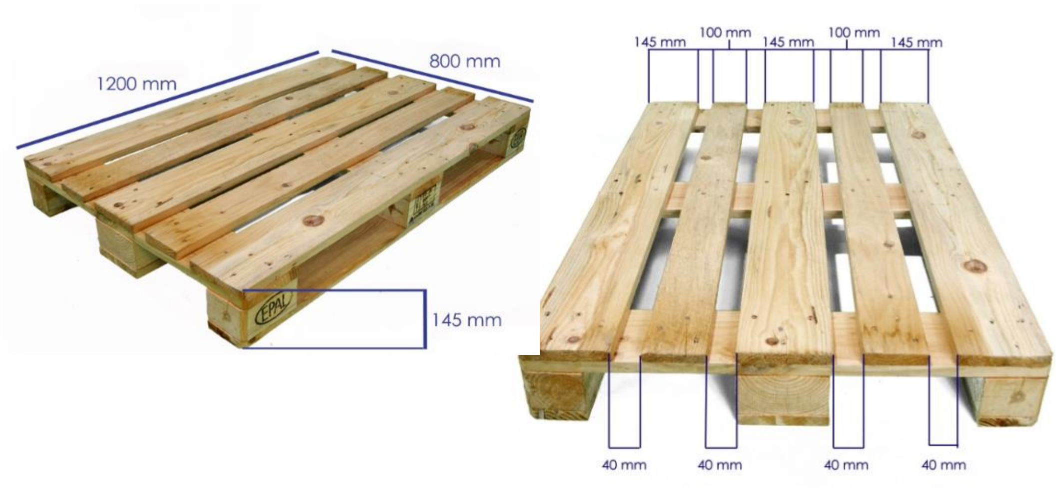

Figure 36. Europallet dimensions

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Agricultural, Food and Rural Environment Engineering

PROCESS DESIGN OF A FRUIT INDUSTRY

ANNEX 5. PLANNING OF INDUSTRIAL ACTIVITY

Content

1. Introduction

In this section we will describe the planning of the industrial planning of the fruit plant. The annual production of the fruit plant will initially be 800 tons, divided into 600 tons of Denomination of Origin pears "Rincón de Soto" and 200 tons of peaches.

In this way, the production of pears represents 75%, while peach production represents 25%, thus being a minority product in the company's production.

The choice of these two products has been carried out with the aim of having the plant in operation for as long as possible considering their harvest periods and the time they can spend in the cold rooms. Thus, the system has been organized so that there is enough time to carry out a proper maintenance of the machinery throughout the year.

2. Calendar of the industrial activity

It is important the relation and importance that has the moment of harvest and the state of the fruit. This must occur at its optimum time to avoid excess maturation or lack of it, because during refrigeration excessively prolonged or with a product that no longer comes in optimal conditions from the beginning, can result in numerous physical-chemical alterations discussed in Annex 3 of product study. That they are more or less susceptible to these alterations depends on several factors such as the date of harvest, their conditions during harvest and post-harvest, and their duration in cold storage. Therefore, too great differences with respect to the optimal collection date result in a loss of quality in the product and physiological conservation disorders. In pears, the most important parameter that determines the beginning of the harvest is the firmness of the pulp, this being 5.5 / 6.5 kg. On the other hand, in the peaches, their optimum moment is determined in addition to the firmness of the pulp (4.0 / 5.0), due to their skin colour.

Next, the calendar of annual industrial activity is presented.

Table 1. Calendar of industrial activity throughout the year.

ENERO/FEB	FEB/MARZO	MARZO/ABRIL	ABRIL/MAYO	MAYO/JUNIO	JUNIO/JULIO
JULIO/AGOSTO	AGOSTO/SEPT	SEPT/OCT	OCT/NOV	NOV/DIC	DIC/ENERO

PERAS	
MELOCOTÓN	
MANTENIMIENTO	

The calendar is organized as follows; In the first place, the peach that is a minority product of the company, as mentioned above, has a duration of only one month of production. Specifically, in the case of yellow peaches of the Catherina variety, optimal harvesting occurs in the second half of July, between the 16th and 18th of this month. This fruit is a minority in the company because its refrigerated conservation does not last more than a month, maintaining its quality properties. That is to say, once the 200 tons of peach are delivered, they are stored in the cold rooms in a period of time of one month, and, after that time, the cameras are evicted.

However, the Conference pears will have a different organization. Once its reception is made from its optimal collection moment, between August 18 and 20, the 600 tons in the first days of the campaign, will be introduced in the cold stores and will be expedited month by month, it is say the amount of product available will go down every month as you can see in the calendar image.

On the contrary, pears will have a different organization, there will be a decrease in the amount of product available in the cameras as the months go by. It corresponds to:

As you can see in the calendar, in principle there will be two months to carry out maintenance of the plant but taking into account that the amount of product available in the cold storage will go down, this maintenance of certain equipment could be advanced.

An important point of this project is the storage capacity of the cold rooms. To decide what capacity is appropriate for the situation of this company, we must take into account which products are going to be treated. Within the two products that exist, the Rincón de Soto Denomination of Origin pears represent a percentage clearly greater than that of the peaches, therefore, the critical point in terms of the capacity of the chambers is the number of pears per year. Thus, starting with a production of 600 tons per year of pears, in principle with a capacity of 600 tons in total for the entire factory would be sufficient.

However, the company taking into account the periods of time that the plant is not going to be fully operational as discussed above, it is estimated a higher capacity in order to meet these needs in the near future.

3. Planning of industrial activity

3.1. Production of pears of D.O "Rincón de Soto"

The production process of the stones is divided into two stages: from reception to storage in chambers, and after the necessary time in each, the emptying of the same for marketing, washed and fitted forming pallets.

The first stage consists of: fruit reception, chemical treatment, manual selection, pre-refrigeration and refrigeration in controlled atmosphere or simple refrigeration. In order to explain the organization system, it is necessary to provide the following information:

- Taking into account that there are 600 tons of pears to store, and that the harvest lasts between 7 and 15 days, it is calculated how much would be convenient to receive each day according to the planning of filling of cameras that is made later in relation to the time it takes to carry it out. There will be 5 cameras of 100t capacity each (4 of Controlled Atmosphere and 1 of normal cooling); besides two cameras of 50t of capacity that will be used initially for the pre-refrigeration of the fruit and like normal refrigeration later.

- First of all, there is an hour of reception stage. This consists of unloading each truck of fruit wooden crates, and making a first scan of the state of the raw material prior to the entry of the same in the plant. This moment is very important since, depending on the first visual analysis of the received item, it will be decided if the raw material is in suitable conditions so as not to be rejected and to submit it to the production process of the plant. 50 tons per day of fruit will be received early in the morning, in 25 ton trucks, so the period of pear harvesting and storage will last twelve days, while for peaches it will last only four days.

- It is assumed that in each wooden crate there are 250 kg of fruit. The passage through the Drencher team is the only stage in which the automatic method is used (before entering the camera). The team works continuously, covering a time of 30 seconds with each wooden crate. Therefore, the equipment is capable of processing approximately 25 tons / hour.

- Following the drencher and after one hour of drying, the wooden crate is dumped with a crate tipper to the manual visual selection conveyor and from there it is placed again in wooden crate, ready to put in camera. From there, a period of one hour is considered until the completion of the first hour of production, that is to say, of 25 tons, or what is the same, the filling of half of the pre-production chamber is completed refrigeration. As it is a continuous process, as it is drying the crates after the drencher, it takes another hour to put the first 25t (previously selected) into the camera, meanwhile, another 25 tons will have already passed through the drain and will be drying during that hour. Therefore, the time it takes to fill 50 t, between the two pre-cooling chambers would be 4 hours, taking into account the first hour of receipt and scan, the time of drying, and the camera filling, adding one more hour of phase shift since the second batch of 25 t / h once dried, (while filling the other 25 t first), they have to be moved to the chamber as well. However, the proposed solution consists in that, since 50t are processed daily, which means that the harvest lasts no more than 12 days, and, in order to reduce the powers of the severe refrigeration installation that are required, the product It will be distributed to the pre-refrigeration chambers in 25 tons in each, that is, in half. As mentioned above, these chambers will be used as normal refrigeration for the last 100 tons entering the plant, that is, these chambers will be stored at full capacity.

- It is taken into account that the pre-cooling chambers have half the capacity of the AC (Controlled Atmosphere) and refrigeration chambers, that is, 50 tons capacity, and that all the fruit has to pass through these two chambers first of pre-cooling. In addition, the complete filling of the chamber in pre-cooling, has to last approximately 7 hours in the chamber (because it is recommended between 5-7 hours), enough time in which the product can reach the desired temperatures (5/8). ºC). It is advisable not to keep it inside the forced air tunnel chamber longer than necessary to avoid freezing and dehydration problems. The 7 hours are chosen in the pre-refrigeration chamber taking into account that the harvest time of the raw material occurs in this case during the summer (July and August), therefore, the temperatures that the fruit can reach in the reception is high and consequently, a considerable time is required in the pre-cooling chambers until the temperature is reduced to the desired one, since the first 14ºC are lowered relatively quickly but the following are more expensive in time. Once this period of time has elapsed, the fruit will move to the controlled atmosphere chambers.

Then, an outline of the refrigeration chambers is shown in order to explain the organization system that has been based on it:

- CPR: Chamber of pre-refrigeration
- CAC: Chamber of Controlled Atmosphere
- CR: Chamber of normal atmosphere refrigeration

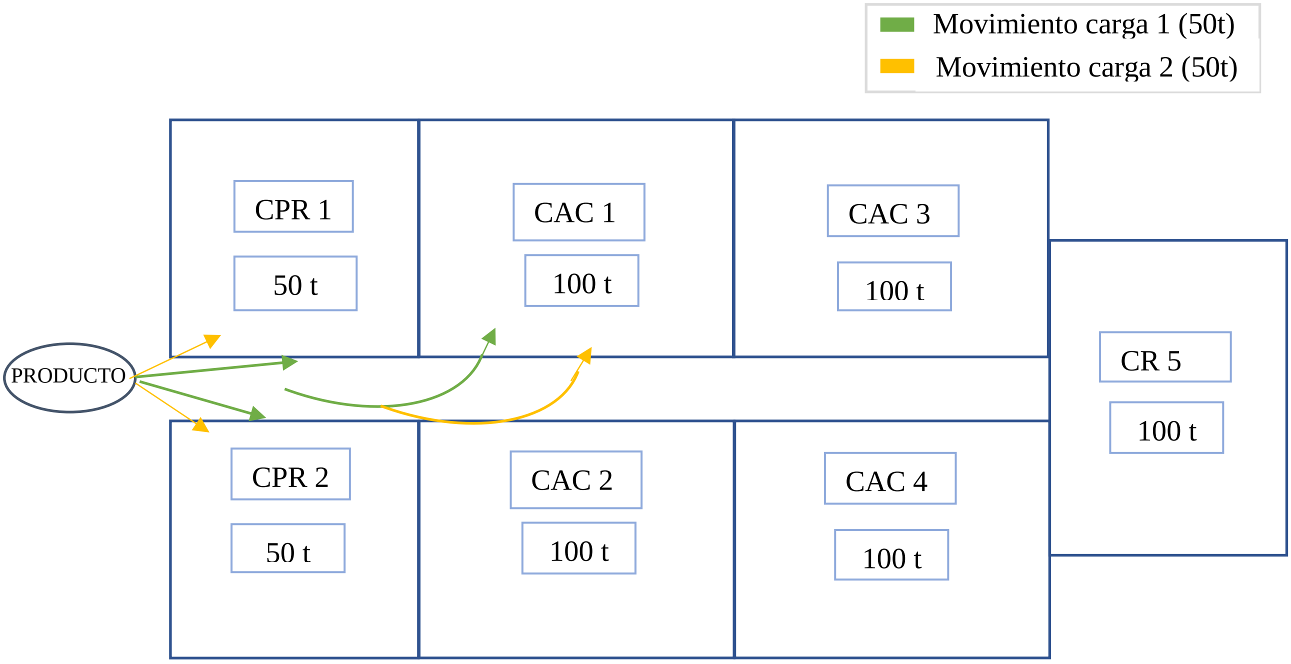


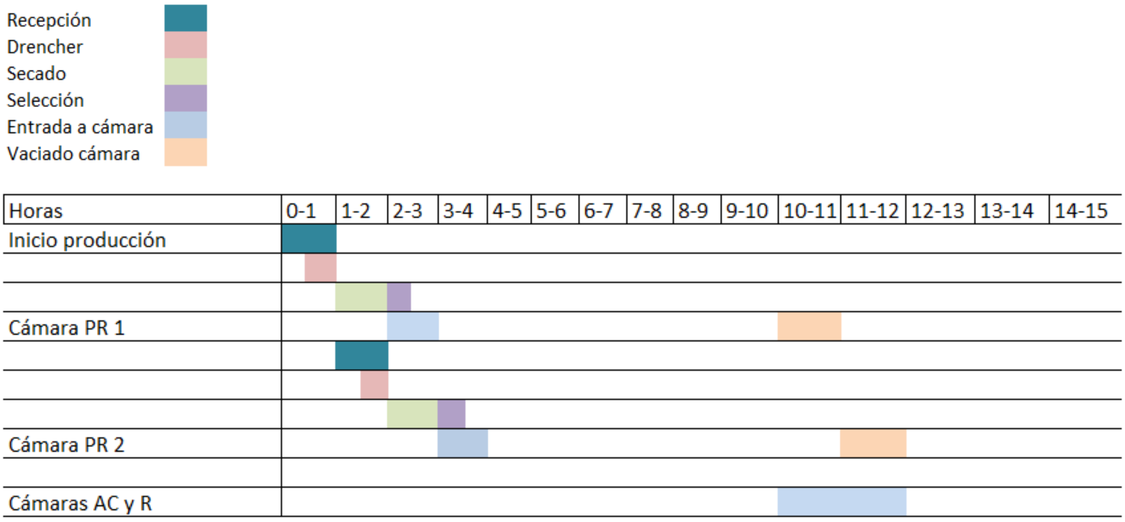
Figure 1. Esquema cámaras de almacenamiento refrigerado.

Therefore, the diagram follows the flow of the arrows successively, which indicate the filling process that must be followed continuously with each chamber. Thus, the product would initially enter the pre-cooling chambers 1 and 2 (CPR), and complete a period of 7 hours each until the product begins to move to the AC chambers and finally to the cooling chamber (5). As can be seen in *Figure 1*, the product enters divided into the two PR chambers since each colour (green and yellow) represent 50 tons of raw material input. Therefore, it is divided as already explained, half to each (25t), and from there, the total load of CPR 1 and 2 is transferred to the chamber of AC 1, filling it in half. Therefore, to complete and seal the entire AC chamber, the following 50t (in yellow) will be transferred to that same CAC 1 to complete the filling. The same happens with the filling of the following AC cameras. Once the filling of the four AC chambers and the fifth cooling chamber is complete, the initial pre-cooling chambers (1 and 2) will also be used as normal cooling, changing the properties of the chamber itself with the fan and the canvas specific used for the forced air tunnel in the pre-cooling, so that it can be used to store another 100 tons in normal refrigeration (50t in each). First, the pre-cooling of one of them will be used so that, at 7 o'clock, it can be stored in chamber 2 (now as normal refrigeration), and finally, directly in chamber 1, the 50 tons of capacity will be filled, which It will also be the first to be emptied for commercialization, since, under normal atmosphere conditions, the duration of the fruit is shorter.

As explained above, taking into account the time spent for each stage and the continuous process in which it works, it takes 4 hours to process the 50 tons per day that enter the plant. Being 25 tons that are pre-cooled in each chamber, that is, 25000 kg, and each wooden crate of 250 kg, a total of 100 crates, arranged in two rows of 50 crates each, of 25 columns each one, that is, stacked two by two, with a corridor in between and with the canvas covering it, as has been explained in *Annex 7*. Process technology. Therefore, as the continuous process from reception, it is passed through the drencher, the wooden crates are dried and classified until they are put into the camera 4 hours later, the second camera PR 2, will take a time lag of one hour with respect to PR 1.

Then, the program of the industrial activity can be seen in *Table 2* through the schedule:

Table 2. Schedule of the planning and organization of the process of 600 tons of pear.



This table summarizes in a simple way the continuous process that must be carried out in the same way for all the storage chambers that you have. Thus, we have the hours elapsed on the abscissa axis and the stages performed in the cameras over time.

Therefore, following the schedule according to the activities carried out and the time that elapses during the development of them, you can see how the process goes on continuously and how the filling of the two pre-cooling chambers 1 and 2 with 25 tons each one has a total duration of 4 hours, that is to say, the duration that will consist of each shift of workers. From there, you can see how after 7 hours of pre-cooling in a forced air tunnel, it takes two hours to empty the product from the PR cameras and take it to the first AC chamber (1). It is taken into account that, while this hour elapses, one less will be left to the fruit of the CPR 2 to be able to be transferred to the CAC 1. In this way, in two days the entire AC chamber is filled and can be sealed. It is not inconvenient since the controlled atmosphere chambers require some time to acquire the proper oxygen and carbon dioxide conditions, and therefore, it would simply be gaining in the cooling capacity of the installation that must be installed. The more product load is subjected to the camera, the more work will be needed to cool it.

In this way, it will be subjected to the same procedure in the following AC chambers (2, 3 and 4) and finally those of normal refrigeration. Thus, it is seen that for a chamber of 100 t of capacity to be sealed, a total of 12 hours has to pass, of which four pass until the filling of the two pre-cooling chambers and only two for the movement of the load of the CPR to those of AC and refrigeration. That is, as with the first AC camera, the same procedure will be continued, but this time, from CPR 1 and 2, CAC 2 will be filled, and so on.

Finally, with these calculations it is concluded that with a shift in the morning of 4 hours is enough to process 50 tons in the two pre-cooling chambers, which corresponds to half of each chamber of both AC and normal cooling, and for both, having 5 cameras of these, plus the two of PR that will be used as normal refrigeration with another 100 tons of capacity, with 12 shifts is enough to store the 600 tons of pears. In the case of the transfer of product from pre-cooling chambers to controlled atmosphere chambers, it takes two hours, one hour to empty and fill each chamber.

After storage in chambers, the product will be removed from them as they go to market, starting with the last chambers that have been filled that are the normal refrigeration that last the first three months. This is why, as seen in the previous calendar, as the months go by each time there will be less product left. Therefore, after each emptying of cameras to market, the fruit is washed and dried with the same machinery, and then passes through the manual selection tape, where products that have undergone some physiological alteration may be removed. the period of time in camera. Once they go through the selection process, they are placed in the boxes, which go through a conveyor where they are automatically labeled. Finally, once the pallet of boxes is ready, they are strapped with the automatic strapping machine and will be ready to load on trucks.

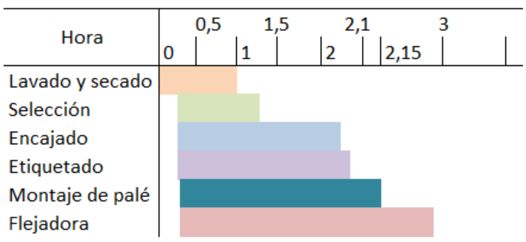
It must also be taken into account that, prior to commercialization, the AC chambers need at least a week of conditioning to normal conditions in the atmosphere to be able to enter the chamber and use the product.

The schedule represented in *Table 3* consists of the second part of the process, that is, once it is going to be commercialized. This is given based on the maximum production capacity of the washing machine, which is a maximum of 10 tons / hour. Therefore, below, a load assumption is analyzed for a medium truck of 10 tons.

The idea is that the peak sale period is immediately after the collection and storage time, that is, in approximately the following three months (September, October and November), having sold 42% (on camera per month). This is why it is considered that the camera 5 does not need to be AC, but with a cooling in normal atmosphere is enough. The remaining four months, sales of 10% in each.

As you can see, the process lasts approximately 3 hours. Being a continuous process, all the activities start practically at the same time, except for the small margin of time from the moment the first quantity of fruit enters the washing machine until it leaves. The rest of the activities are proceeded in a permanent continuum.

Table 3. Schedule of the planning of the second part of the process according to an assumption of 10 tons of product



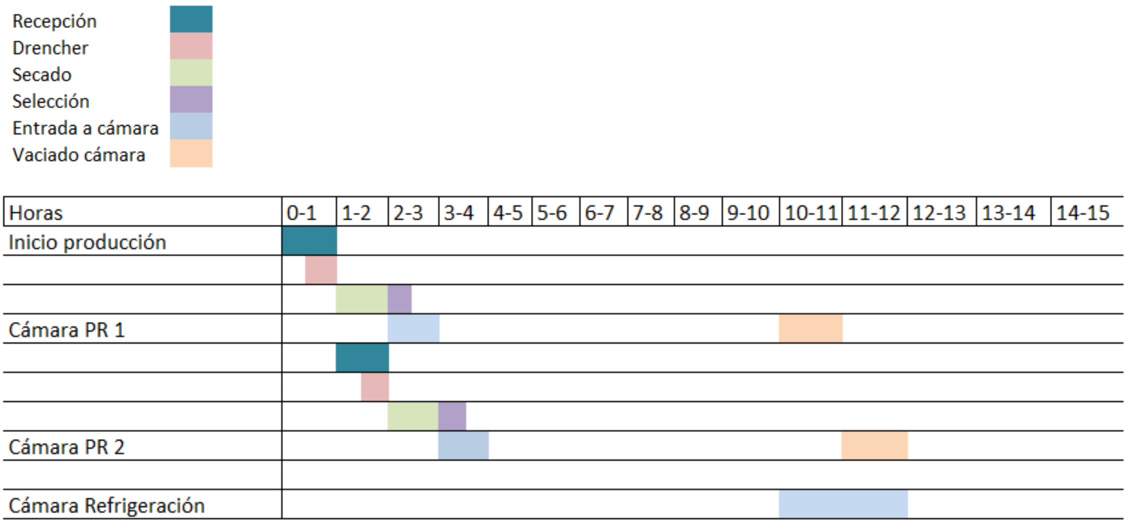
3.2. Industrial activity planning of peaches

In relation to the planning of the process for the peach, since it is the secondary product of the company, the production capacity has been defined as a result of the planning of storage chambers with 600 tons of pears, for which 5 cameras plus the two pre-cooling. Therefore, the total amount of peaches will be 200 tons. In this way, the organization is better suited to the capacity of the camera, without wasting space.

Thus, the occupation that will involve the total of peaches in the plant will be only from the three normal refrigeration chambers, the two 50t capacity and the 100t. This means that the sale of the product will occur in the same month of July-August, before the arrival of the pears, more specifically, from the first half of July to the first of August.

It is decided that it will be processed in four days, during a half-day shift of 4 hours each, in order to have the same personnel on both days. In this way, each of the four days the peach departure will be 50 tons as in the case of pears. As can be seen in table 4, the fourth day will be stored directly in chamber 2 but under normal cooling conditions, they do not need to be subjected to the forced air tunnel because they will be sold relatively quickly.

Tabla 4. Timeline of the organization system of the first part of the process for the 240 t of peaches.



The second part of the process corresponds exactly to the case of the pears explained in the previous point and simplified in the schedule of *table 3*.

4. Workers planification

The approach of the personnel will be to reduce the equipment to the minimum necessary to achieve the processing of the product in the established target term. In addition, the factory workers will be subcontracted through temporary work agencies, since, as explained, the first part of the process (until storage), will last less than two weeks. Regarding the second part of the process (from emptying the chamber to its dispatch), if a fixed template of flexible working hours will have to be carried out. It points out the members of the staff that must have fixed:

- Manager: Maximum responsible for the management of the company.
- Auxiliary Administration: Those of administrative charge both in the agronomic department for the management and negotiation of purchase and sale of raw and auxiliary materials; as those in charge of general administration.
- Commercial: Those in charge of expanding the number of clients.
- Maintenance: Responsible for supervising, repairing and controlling all the plant's machinery and facilities.

- Laboratory technician: There should be a person in charge of everything related to the microbiological analysis of the product, taking samples, washing water analysis ... etc.
- Production manager: He is responsible for planning the production that he / she touches according to the needs of the company's clients. It will be organized according to convenience per week and will dictate when and how much product of the camera has to be taken out to prepare it before its commercialization.
- Operators: Will be divided into shifts of 8 hours, and four. In addition to their tasks on the line, they are responsible for supervising and removing what is in poor condition, for reporting any inconvenience that may occur, for cleaning the lines, etc.

Regarding the number of operators needed for each manual operation of the process, it will be:

- Drencher management (supervision, placement and removal of wooden crate): 2 operators
- Selection: 4 workers in each selection tape
- Forklifts: 4 operators
- Embedded: 3 operators

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PROCESS DESIGN OF A FRUIT INDUSTRY

ANNEX 6. INDUSTRY LAYOUT

Content

1. Introduction

The objective of the distribution in plant is to find the best arrangement of work areas and equipment in order to achieve maximum comfort and ease in work, as well as the highest possible safety and satisfaction of workers.

This implies the ordering of spaces necessary for material movement, storage, equipment and production lines as well as administration offices and services for personnel, etc. The objectives of the industry layout are:

1. Global integration of all the factors that affect the distribution.
2. Fluid circulation of work in the industry.
3. Minimum distances in the movement of materials.
4. Efficient use of the entire space.
5. Security for both workers and the product.
6. Flexible arrangement that can be easily readjusted or expanded if necessary.

2. Basic principles of distribution

The basic principles of distribution are thus based on the objectives previously mentioned.

1. Principle of overall integration. The best distribution is that which integrates men, materials, machinery, auxiliary activities or any other factor, in such a way that it results in the best compromise among all parties.

2. Principle of circulation. All other things being equal, the distribution that orders the work areas is considered better, so that each operation of the process is in the same order in which the raw materials are to be transformed.

3. Principle of satisfaction and security. All things being equal, distribution will always be more effective if it makes the work more satisfactory and safe for workers.

4. Principle of cubic space. The economy is obtained using in an effective way all the available space, both horizontally and vertically.

5. Principle of the minimum distance. It is always better that distribution that allows the distance to travel through the raw material is the lowest possible.

6. Principle of flexibility. It will always be more effective that distribution that can be adjusted or reordered with less cost or inconvenience.

3. Industry layout

3.1. Handling and machinery area

The type of distribution that has been raised is online, or what is the same, by product. This means that the product is manufactured in a certain area, where the raw material moves according to the sequence of operations required from its reception to final product.

Each operation is followed by the other and the machinery and equipment are distributed in such a way that the technology flow of the necessary process is followed.

In this way, the positions of the worker are placed according to the order established in the analytical diagram of the process, in such a way that the use of the surface required for the installation is improved. Also, the raw material moves to one post followed by the other, where the transport route is smaller, and the possibility of the degree of automation in the machinery is greater.

In addition, manufacturing times are reduced and labour does not require a high professional qualification. As an advantage also, it allows a simpler monitoring control and reduces the congestion and the necessary surface for storage and corridors.

However, the immediate adaptation to another type of manufacturing for which it has been designed is not possible, although in the case of the project in question, this should not be a problem because in case of changes with a vision of the future, it could be produced simply an enlargement of quantity of product (commented in the document Memory), that is to say, amount of fruit, of different varieties, but of same productive processes and storage. Thus, there will always be availability of a second parallel production line. What does not allow flexibility is in the manufacturing times and the dependence on each other during the manipulation, since the work is in chain.

The technology and engineering with which it is treated in the project is not too complex in terms of machinery and processing, the most important thing and what more space will occupy will be the numerous refrigeration chambers of fruit conservation to keep the items that have arrived and they are not being processed yet.

3.2. Auxiliary services

The auxiliary services that an industry must have are several and allow and facilitate the main activity that takes place in the industry. Among them, are those related to personnel such as the reception area to the industry. There are two different access roads for different entrances, one for cars and the other for trucks, so that workers in the industry do not have to meet or be affected by the occupation of the trucks. Cars can park as soon as they enter, near the offices. The trucks, to facilitate their circulation, would enter on one side, unload the raw material at the back of the building and continue the road surrounding the building to end up leaving the other end of the building. Those who only have to load product, the loading docks are located in the front near the entrance access. At the entrance is also the scale for trucks.

Apart from the area of offices and administration, with its corresponding toilets, there is a locker room and other services for the other personnel who work within the productive process. Also, a laboratory is needed where quality can analyse the samples collected from production, such as phytosanitary products, maturity indexes, firmness, etc. of the fruit both in the reception of the product and in the expedition after storage.

Finally, there is an important space for the storage of auxiliary material such as wheelbarrows, pallets, boxes, palots ... etc.

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PROCESS DESIGN OF A RUIT INDUSTRY

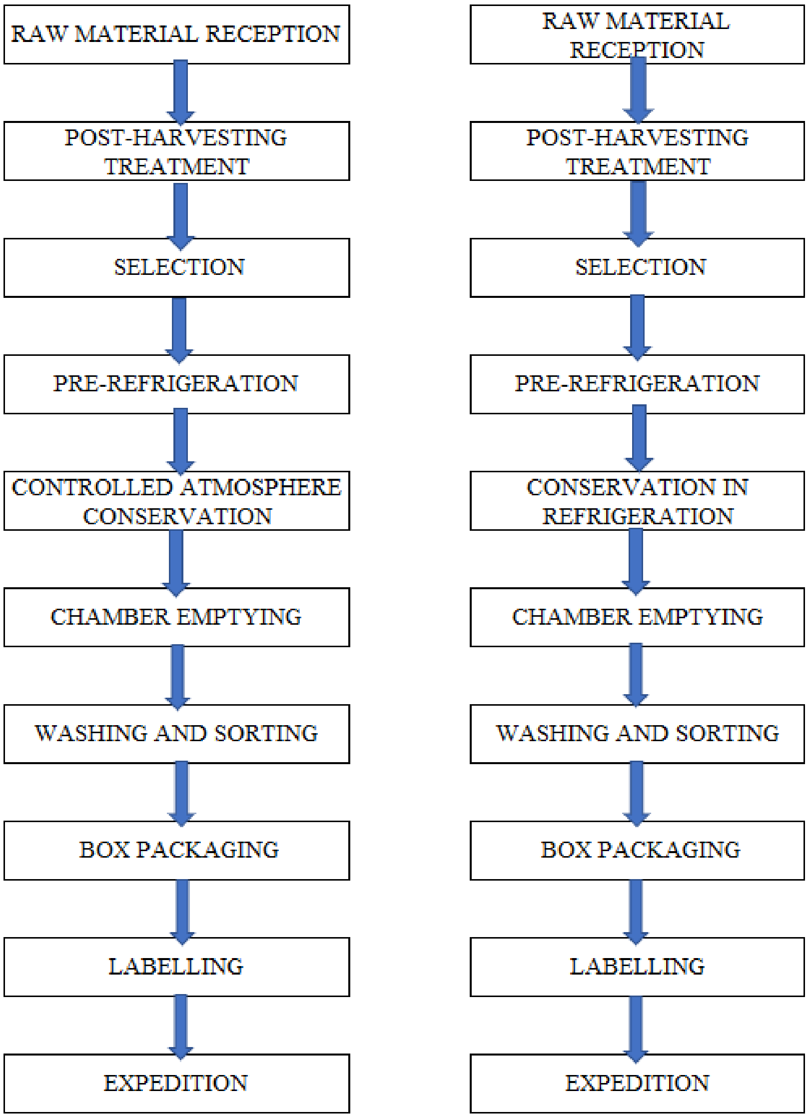
ANNEX 7. PROCESS TECHNOLOGY

Content

1. Technology of the productive process

Through this section we will proceed to explain the different alternatives chosen in each stage of the production process. The same flow diagram will be used for both the pear and the peach, specifying the specifications in case there are.

2. Flow chart



3. Alternatives of process technology

3.1. Raw material reception

The reception of the fruit will be carried out depending on the optimum moment of pear and peach harvest, and therefore, as specified in Annex 4 of the planning of the process, the amount of discharge will be different for each type of fruit, being higher in pears that of peaches. It is intended to supply practically all the year of raw material the power station and thus not to waste the cold storage chambers. The place where the product is unloaded is spacious, fresh and well ventilated so that the newly arrived fruit progressively lowers its temperature.

Being an almost immediate commercialization of the fruit, as is the case of peach because it is a stone fruit, the reception will take place at a time close to the organoleptic maturity, which will be commercialized at the most in 2 months after the collection, since, otherwise, the quality and acceptability of the product would begin to decrease. In contrast, for the pear destined to medium and long conservation in a controlled atmosphere, it will be received from the harvest before reaching the ripeness of consumption, thus allowing the characteristics of the Conference variety (from D.O Rincón de Soto) to develop during the period of refrigerated conservation, so that they reach the consumer in an optimum state of quality and organoleptic maturity. What is the same, according to the Protected Designation of Origin of pears "Rincón de Soto", establishes that the harvest will be carried out at the appropriate time to ensure the development and degree of maturity that allows the fruits to bear their subsequent handling and transport responding in the place of destination to the commercial demands established for them. Said harvesting will always be manual and will be carried out in the best conditions and with the greatest possible care, avoiding lesions in the fruits, eliminating pears that do not meet the quality parameters established in the corresponding specifications.

In this stage we proceed to a first scan of the fruit taking samples of the different wooden crates randomly so that you can check if the raw material arrives in good condition, otherwise the game would be rejected.

3.2. Post-harvest pre-preservation treatment

The fruit that is treated in this process technology are perishable products, so they are subject to intrinsic processes of maturation and senescence and the interaction of organisms such as fungi. That is why it is going to perform chemical-based treatments, based on the use of synthetic phytosanitary products, in order to minimize the incidence of alterations during refrigerated conservation.

Next, the possible alternatives of the different chemical treatment application systems are presented:

3.2.1. Via water, by Drencher or immersion

The drencher is a machine that allows chemical treatments of post-harvest conservation via water, once the product has arrived at the plant, even in the field containers themselves. The water, with the products in solution or in suspension, at the appropriate doses, is recycled through the fruit, pallet to pallet or wooden crate to crate.

Attention should be paid to the water tank, since it should be changed periodically as often as possible, because the water is: all the spores of the different fungi from the field, the trailing residues of the chemical products used in the field and land , leaves, twigs etc. that are incorporated into the shower water that degrade most of the chemical products.

3.2.2. Via air, using fumigants or thermonebulizers

This type of application of fruit postharvest products such as pears and peaches is used both in the disinfection of chambers and in the direct treatment of fruit. In this case, it is the air that is responsible for distributing the product in the chamber with or without fruit. The camera's own fans bring the chemical that is used to the places that the water could not reach in certain cases. That is why, in the case of the cameras, fumigants via air are those used.

3.2.3. Chosen alternative

The treatment is carried out once the fruit arrives at the plant and as an alternative it will be done through the shower system, called drencher, which is responsible for distributing the phytosanitary mixture by the containers full of fruit that run under the system of shower.

To obtain good results, it is necessary to take a series of precautions that can be summarized in:

- Treat the fruits quickly after harvest.
- Check that the temperature of the fruit and water is higher than 10ºC and preferably between 15 and 20ºC.
- Limit the soaking time to 30 seconds and maximum to 1 minute and a half in drenche.
- Make sure that the mixture of the treatment solution is well mixed by starting the pump to drive water before the first fruits pass, in order to avoid the risk of phytotoxicity problems due to over-conservation of the product.

For the preparation of the broth, or what is the same, the mixture of phytosanitary products, it is required to use products of recent manufacture and make a visual assessment of the state of the same to verify that it does not present any abnormal aspect. It will not be necessary to use antifoam. As for the treatment of the drencher shower system, it will be done in less than 36 hours from the reception in the central. The temperature of the fruits will be at room temperature and that of the water will be 20ºC, knowing that if it exceeds 27ºC, phytotoxicities can be produced. In turn, bathing cold fruit decreases the absorption of the product by the fruit. The contrast of temperatures would cause the breakdown of the bath emulsion. Finally, it should be noted that the shower will not last more than a minute and that the machine with fruit under the shower will never stop. In addition, the life of the broth should not exceed 12 hours and the appropriate frequency with which this is renewed, will be a function of the capacity of the raft of the drencher, the dirt of the plastic of the container and dirt of earth and debris of leaves accumulated in the broth.

Only chemical products that are authorized in accordance with current legislation may be used, that is, following the Royal Decree 1311/2012, of September 14, which establishes the framework for action to achieve sustainable use of the phytosanitary products.

The fungicides will be applied as a reinforcement system in case high fungal contamination is detected in the controlled atmosphere chambers, that is, only in those long duration chambers. In the case of the pear, pip fruit with which will be worked mainly in the plant, in addition to postharvest treatments in drencher will be carried out the application of gaseous products in camera, as specified below.

It will be counted with one hour of drying of the fruit in the open air at rest prior to the selection.

3.3. Selection

The non-conformities of the product are removed with respect to the specified quality control parameters that do not meet the necessary requirements. There will be a series of attributes that affect the time of selection and mainly those fruits that show wounds or alterations, either due to insects, rottenness, physiopathies, etc., will be rejected. Also, it will be taken into account in the case of pears, which maintain the peduncle since it is a point of entry of fungi and can cause injuries to the rest of the fruits.

In the case of the pear, as it is Pera Rincón de Soto, with characteristic DO, as specified in its specifications, all the manipulation of the fruit must be carried out manually and with great care, avoiding at all times the possible deterioration of the fruit, eliminating all the pears that are defective or that do not meet the specified quality parameters.

Therefore, there is no alternative but to strictly follow the norms and legislative requirements that are required to obtain the D.O.P "Rincón de Soto" pear product, which implies a manual and non-automatic selection method with its corresponding specific machinery. This translates into a human visual selection, with several operators in the line in charge of removing those pears that do not conform to the tolerances that are sought. Because the pears are the main fruit of the factory and will last up to 8 months on camera, it would not be economical to incorporate a machine for automatic optical selection to apply it in the case of peaches.

3.4. Pre-cooling

The pre-cooling consists of a rapid cooling of the fruits once harvested with the aim of improving the maintenance of the quality of this during its conservation process and extending the duration of its post-harvest life. In this way, the heating of the fruit on arrival at the plant due to the action of the sun and the respiration of the fruit is eliminated. The delay of a day in the drop of temperature of the fruit to treat supposes up to 20 days less of conservation, that is why this stage is fundamental, especially in pear and peach that have a high respiratory rate. With this, a decrease in your respiratory rate will be sought in such a way that your metabolism is reduced and all the senescent processes can be slowed down. Specifically, as a temperature tolerance level in the heart-pulp of the fruit, 0 ° C will be reached in the case of peach and from - 0.5 ° C to 0 ° C for pears.

3.4.1. Pre-cooling in conventional chamber

This alternative consists in allocating a refrigeration chamber to the pre-cooling of the product, widely used commercially, where directly the crates and wooden crates with the product coming directly from the field are stored in a conventional refrigeration chamber. Its main advantage is that the product can be cooled and stored in the same chamber. However, it has the disadvantage that it is too slow, resulting in excessive water loss compared to faster cooling systems. The water condensed in the evaporator and then eliminated to the outside, is extracted from the fruit, and therefore, it is as if kilos of fruit were lost in a certain way.

3.4.2. Pre-cooling in forced air tunnel chamber

The system of rapid cooling by tunnel of rapid cooling in continuous process is based on the joint action of cooling the product by means of a cooling system by forced ventilation, together with the help of a mechanized system for the circulation of the product inside the tunnel. The main advantage of this type of system by air, is the speed of cooling, with the subsequent lower thermal load for stock chambers.

The system consists of the assembly of vertical fans with axial air supply in its upper part and suction in its lower part, which will be responsible for cooling the product.

3.4.3. Re-cooling by water (en *hydrocooler*)

The use of the hydrocooler is one of the most efficient pre-cooling systems and is basically applied to stone fruit varieties. This system consists of applying a shower of cold water to the product at the reception, using water as a cooling medium.

With this, it is possible to reduce the temperature inside the fruit between 5 and 30 minutes maximum, always depending on other factors such as the water temperature, the type of product to be treated, the initial temperature of the fruit, the size, etc. Another advantage of this system is that, since air is not used as a cooling medium, there are no problems of weight loss due to dehydration, although, on the other hand, it is necessary to know the hydropathies that present some varieties of fruit that can be made dismiss the use of this methodology, as with cherry.

Another negative aspect of this system is that, due to the continuous use of water in recirculation, it can be a critical point of contamination, since it can accumulate organic matter, microorganisms, etc., and that, if a product was not used disinfectant, can be a route of contamination of postharvest pathogens for fruit that is cooling.

3.4.4. Chosen alternative

As a chosen alternative, the pre-cooling will be carried out in a forced air tunnel, since it is the most suitable for both fruits, both for pears and peaches. Unlike pre-cooling in hydrocooler (water), which, despite being very efficient, its application is mainly for stone fruits and as a negative aspect it has the possibility of being a critical point of contamination due to the continuous use of water in recirculation, which can accumulate organic matter, microorganisms, etc. On the other hand, cooling in a conventional chamber would not be as efficient as in a forced air tunnel, which will be discussed below:

This technique consists of pre-cooling the fruit in facilities specifically designed with forced air tunnels. The containers will be placed in said tunnels by default, forming two blocks that are covered with a tarpaulin, leaving a distance between the two in order that the extractor located at the bottom of the two blocks can suck the air. As such, a pressure gradient is created between the inside and outside that forces the air from the evaporators to pass through the middle of the fruit blocks, thus increasing the speed of product cooling. In general, in a period of time between five and seven hours the desired indoor temperature can be reached, although this depends both on the temperatures used and the initial temperature of the fruit and on various factors of variety, size, evaporation temperature, etc. The fruit is not kept inside the tunnel longer than necessary to avoid freezing and dehydration problems. In Figure 1 you can see the movement made by the air (considering the corridor covered to force the passage of air through the indicated ventilation holes)

Specifically, in the case of the Conference pear variety, from DO Rincón de Soto, it has a collection period in summer, that is, in hot seasons, which means that the arrival of the fruit to the fruit plant is relatively hot. This condition supposes a high production of CO_2 by the fruit due to its high respiration rate, which can be harmful for its later conservation. That is why the pre-refrigeration acquires an important role since it allows to lower the temperature of the fruit and reduce these high rates of CO_2 quickly, so that the metabolism of the fruit slows down and, therefore, the maturation is delayed and in turn the appearance of physiological alterations

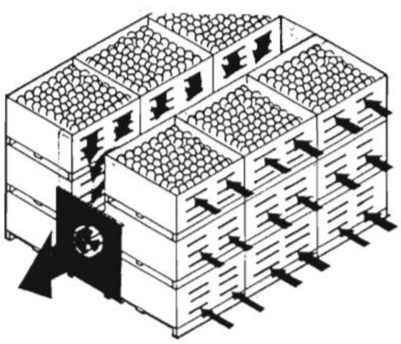


Figure 37. Air movement in forced air tunnel.

3.5. Refrigerating conservation

Refrigerated conservation is especially necessary in the so-called climacteric fruits, such as pears and peaches, which have the ability to continue ripening once separated from the plant. The control of the rate of ethylene production in climacteric fruits favours the control of maturation.

The conservation is done in cold. The fruit, once collected, is still a living organism, which continue to breathe internally and the cold what it does is to decrease that breathing and lengthen the useful life. Depending on this there are two types of conservation depending on the time you want them to last: conservation in normal atmosphere and conservation in a controlled atmosphere, where the temperature and relative humidity vary, as well as the percentage of oxygen and CO2 depending on a type or another, and varying slightly depending on whether, in this case, pear or peach.

The conservation chambers are spacious, clean, watertight and with baseboards so that the product is not in contact with the walls. Before finally closing the chamber, an authorized disinfectant is added to fight against the appearance of *Botrytis, Penicillium, Rhizopue and Gleosporum.*

Stacking and ventilation

The correct conservation of the fruit depends directly on the arrangement of the fruit containers inside the cold room, since, according to this one, it is possible to allow an adequate circulation of the air and an optimal use of the ventilation provided by the fans. the evaporators. Thus, two basic objectives are achieved: the transfer of cold air that leaves the evaporator inside the chamber so that it comes in contact with the fruits and keeps its temperature within the set values, and get homogenize the temperature and concentration of gases at different points in the atmosphere of the chamber.

To make this possible, a series of guidelines must be carried out:

- The containers are not placed in front of the evaporators as they would act as a barrier and the air would collide returning to the evaporator and avoiding its passage through the fruit to conveniently cool it.
- The first three or four rows of containers, the top of the load will be below the evaporator, and the height of the next rows of containers will gradually increase so that the air left from the evaporator can be channelled to the bottom of the chamber without create any diversion or alternative air flow.
- Distances between the containers and the wall opposite the evaporator: more than 30 cm; between roof and the last row of containers: more than 50 cm; between containers and wall on the side of the evaporator: 50 cm and, between the containers and the side walls: 20 cm.
- Respecting the mentioned distances is fundamental for the correct circulation of air, which is divided into 3 phases: impulsion (space in front of the evaporator and between wooden crates and the roof), return (guarantee of space between the crates and the wall of the bottom) and suction (guarantee of a certain space under the evaporator, which allows the air to be collected from all the heights of the chamber).
- Different types of containers are not mixed inside a chamber since the difference in height between one and the other causes the air passages to become clogged and thus prevents a correct circulation of the air.

- Before closing the chamber, both the arrangement of the containers and the verification that the air is evenly distributed throughout the chamber must be checked visually.

Management of the temperature

Throughout the refrigeration conservation, the temperature of the fruits must be kept as uniform and homogeneous as possible. Therefore, it is very important to choose the number and situation of each one of the probes in order to measure the temperature.

Two probes are used. The first located in the suction zone, below the refrigeration equipment, since it is the most representative area of the average temperature of the fruits in the chamber; and the second will be in the upper part and opposite the evaporator. The first one is responsible for activating and deactivating the refrigeration circuit and would be placed at a medium height, not very close to the evaporator, nor close to the wall or the containers. On the other hand, the second probe is located in the upper and opposite part of the evaporator, which area is the largest temperature fluctuations (minimum when the evaporator is put into operation and maximum when it stops). To prevent the temperature from decreasing excessively, a minimum thermostat will be used as safety.

Management of humidity

Humidification needs are changing throughout the conservation process and therefore must be taken into account at two different times to optimize their management: in the filling of chambers and during conservation.

Where there are more losses due to dehydration is during the pre-cooling and filling of the fruit because the fruit enters the cold rooms with a very high temperature creating a deficit of high water vapor pressure between the product and the environment, thus favouring perspiration and dehydration of the fruits. This is why it is convenient to have a high water supply at the entrances. As for the probes, they will be placed in the same place as the temperature.

3.5.1. Conservation in normal atmosphere

This conservation consists of normal refrigeration chambers, and will be applied in the case of peaches, since they will be marketed in less than a month and therefore it is not necessary to subject them to controlled atmosphere conditions since the conditions of refrigeration in Normal atmosphere are enough to preserve the food in good condition.

The optimum conservation parameters for the yellow peach variety Catherina consists of a temperature between 0 and 0.5 ºC, with a relative humidity between 90 and 95%. With these conditions they can last up to 3 weeks.

In addition, for the case of pears, the three normal refrigeration chambers will also be used (Annex 4. Planning of the process) since they can last up to 3 months. Its optimal conditions of conservation are: 0.7 / -1.0 ºC with a relative humidity between 90/96%.

3.5.2. Conservation in Controlled Atmosphere (CA)

The controlled atmosphere is a refrigeration conservation technique in which the gas composition of the atmosphere is modified in a cold room, in which a regulation control of the physical variables of the environment is carried out, that is, temperature, humidity and circulation. from air.

Thanks to the dynamic controlled atmosphere technique, it is possible to maintain the vegetable product in a poorer environment in O_2 and richer in CO_2 than would correspond to a normal atmosphere. Therefore, this specific denomination of controlled atmosphere (CA) occurs when the composition of the atmosphere is controlled accurately and by external means. This supposes a series of beneficial effects such as the delay of the maturation processes, with its consequent reduction of those associated physiological and biochemical changes (such as the decrease in ethylene and respiration production), and changes in the composition of the fruit, so that this allows to slightly delay the harvest and thus achieve greater organoleptic quality in the tree itself. It also reduces the sensitivity of the fruit to the action of ethylene, relieves certain physiological disorders related to cold damage, reduces the growth of pathogens and consequently the incidence and severity of rottenness, and, finally, also reduces the control of insects in certain products. However, on the other hand, CA presents certain harmful factors such as the onset and / or development of certain physiological disorders such as the brown heart in pears, according to the level of oxygen lower than 2% and carbon dioxide greater than 5%, it can give an irregular maturation as in the pears. Also, anomalous odours can develop as a result of the development of an anaerobic metabolism at low oxygen concentrations or very high CO_2 levels and, finally, the susceptibility of the product to fungal rot can be increased in those fruits physiologically damaged due to a low O_2 high CO_2 For a good efficiency it is important that the setting of oxygen and carbon dioxide conditions be immediate once the fruit has reached the regime temperature and is adapted to the specific needs of each type of fruit.

Once the cameras are at the right temperature according to the variety of fruit used, with this stage of conservation in a controlled atmosphere you have to lower the oxygen levels as quickly as possible, at most between two and three days. For this, the moment of the setting of the cameras will stop the oxygen reducing equipment when it reaches levels of 3-5%, in such a way that the level of oxygen from there will be diminished by the respiration of the oxygen. Fruit. It should be borne in mind that an inadequate application of atmospheres that are very poor in O_2 can lead to hypoxia phenomena in the tissues, translated into an anaerobic metabolism of the fruits, resulting in damage to the epidermis, pulp and heart of the same, with its corresponding losses of quality and quantity of the harvest.

Finally, in order to maintain good fruit quality, the CA chambers should not be opened more than three times and should have the most suitable temperature, humidity, oxygen, and carbon dioxide values at all times.

In the case of pip fruits, such as pears, it is necessary to carry out the application of gaseous products in the chamber, as well as post-harvest treatment in drencher. This will consist of an anti-scalding treatment where the firmness is fixed through the active material 1-MCP (Methylcyclopropene) is applied gaseous in the already filled chambers during the 5-7 days after the start of filling the chamber. This method of application via air is easy to apply, effective (without any interference), safe (do not spill, or exploit), dosified (knowing the amount of active material per container), economic (all the purchased product is used), and low residue.

There are no alternatives in this stage of storage of the process. The conditions that must be fulfilled are necessarily:

- Conference Pears: They have the following conditions in camera: 2.5 / 3% of O2 and 1.4 / 1.7% of CO2, and can be kept for up to 6 months; the temperature has been between -0.7 / -1.0 ° C and the relative humidity of 94-96%.
- Yellow peaches, Catherina variety requires: 2.5% O2, between 4/5% CO2 and 90/95% RH; the temperature should be maintained between 0 and 0.5 ºC. Under the conditions, the peaches can be kept for a period of 4 to 5 weeks. Although, as it has been stated previously, this is not necessary.

3.6. Chamber emptying

Once the product is ready to be commercialized, the product chambers will be emptied with the help of carts and taken to the washing and sorting tape, before being packed in boxes, since the product over the time elapsed in the camera has suffered some kind of deterioration that will have to be reviewed.

3.7. Washing

The washing is added to this technology of fruit processing since it is intended to leave the product in an optimum state of quality and the fact of having remained long periods of time in the chamber can be sometimes harmful to the food and present accumulated dirt or remains of fungicides. For this reason, it is decided to make this stage once the fruit has been removed from the chambers and prior to packaging in boxes for marketing, instead of once arriving at the plant.

3.7.1. Wet washing

This type of wet washing is a process that produces little food deterioration. It is usually used for soft fruits and vegetables, and one of its functions is the elimination of pesticide residues. It must be taken into account that specific washing times must be applied because if they are prolonged in excess, alterations of a chemical and microbiological nature can be produced.

There are different types of wet wash differentiated: by shower, brush scrubbers, drum scrubbers, fingers, and flotation tanks.

3.7.2. Dry cleaning

Dry cleaning consists of a separation operation that removes contaminants of different sizes (greater or less than the raw material) through the passage of the smaller particles through sieves or meshes with perforations of certain dimensions. There are many designs of these: drum, rotary, flatbed, etc. The method only works when the finer part to separate (that can be the pollutant or the raw material) is spherical or it can pass through the perforations of the mesh.

This washing alternative is usually more common in foods of greater mechanical consistency, smaller size and lower water content such as cereals, nuts or hazelnuts.

3.7.3. Chosen alternative

The alternative chosen for this stage is wet washing since it is the one that most fits with the fruit that is treated in the plant being the one that produces less food deterioration. For dry cleaning, the raw material must support the operation, since it can mistreat unsteady fruit, as is the case with peaches and produce dust. In addition, as already mentioned, wet also serves to eliminate pesticide residues that may have remained in the product.

At the end of the wash, the fruit will follow the review line where a second product selection will be made in the product to remove the product that is deteriorated and is not in accordance with the desired quality specifications that are very likely to occur after having long periods of storage time have elapsed. The classification will be visual and therefore the product will be removed manually, based mainly on the size of the fruit, colour, surface and peduncle.

The fact that the classification is visual also in this case is because the Specifications of the D.O.P of "peras Rincón de Soto" so dictates. For this reason, the same procedure will be applied for peaches since it would not be profitable to have an automatic optical sorting machine, taking into account that the main product of the plant is the pear, which triples the tons of storage.

3.8. Packaging

The packaging must be completely manual following the specifications of the specifications of pears "Rincón de Soto" and it will be done with great care, having previously eliminated those fruits that have suffered some kind of deterioration during the conservation process.

They are also manually deposited (coming from the previous conveyor belt), in plastic boxes and with ventilation grilles, in a single layer, so that the fruits of the lower level are not in contact with the fruits of the higher level, making them obligatory an accommodation with a base with alveoli so that they remain immobilized inside the package and that do not cause damages during the periods of transport and distribution, such as the alveoli.

In turn, in the case of pears that are of Denomination of Origin, the stamp of said differentiation will be placed in each unit as an individual marker.

3.9. Expedition

Finally, loading docks prepared for efficient product entry to the conditioned refrigerated truck for transport and subsequent distribution of fruit will be available. At this point there are no alternatives in terms of process technology.

4. General cleaning and disinfection

In the fruit plant, the prophylaxis of both the facilities and the containers destined to the conservation of the fruit is a fundamental part of the management to avoid the contamination of the same during its central storage. Said practice consists of an initial cleaning followed by a disinfection process, being effective to reduce and maintain controlled levels of inoculum of the main fungal species that cause losses in the refrigeration conservation of the fruit, which can survive from one season to another. , both on the surface of the premises and on the containers. It is for this reason that prophylaxis should be carried out in containers and facilities before each beginning of harvesting prior to storing.

The success of this process is due to the previous cleaning that has been carried out properly, the disinfectant used to be used according to the manufacturer's recommendations and finally the effectiveness of said product against the different fungi.

It is essential to pre-clean each campaign for the correct disinfection of the chambers since in the presence of organic matter many disinfectants are not able to act. Therefore, surfaces must be clean before disinfection.

The operations to perform a correct cleaning are the following:

- Elimination of remains from the previous campaigns (rotten fruits, papers, plastics, remains ...)
- Sweep the whole chamber using sweeping machines, so that it is controlled not to raise dust since many fungal spores that can be found in the soil could be spread through the air.
- Through pressure water, wash the floor and walls up to 2-3 meters high. Detergent is added to the water to facilitate the dragging of organic matter.

4.1.1. Prophylaxis in storage chambers

Once the cleaning has been carried out correctly following the mentioned guidelines, we proceed to disinfection, whose disinfectant product that is most suitable will depend on the degree of contamination and the type of fungi present in the previous campaigns.

4.1.1.1. Flavouring of high pressure liquid

It consists in the application of an aqueous disinfectant solution that projects with force on the surfaces. This practice allows a high reduction of contamination in walls and floors, although in some cases, environmental contamination may increase as a result of the dispersion of spores from the surfaces of the chamber to the environment.

4.1.1.2. Flavouring of high pressure liquid

This alternative consists of the application of some foams on the surfaces, taking advantage of the effect by dragging, it offers a high reduction of the contamination with walls and floors, without causing dispersion of spores to the environment.

4.1.1.3. Treatments by air

This treatment consists of a process by which air serves as a vector of transmission of the biocide. They can be carried out in the form of smoke (through smoke cans), nebulized or thermospray.

4.1.1.4. Chosen alternative

The alternative chosen as a disinfection system will be through the atomization of liquid at low pressure. Although the atomization of liquid at high pressure also offers a high reduction of contamination, it has as a disadvantage the possibility in some cases that environmental pollution may increase due to the dispersion of spores from the surfaces of the chamber to the environment. On the other hand, in the case of treatments by air, the process by which air serves as a vector of biocidal transmission, has a lower efficiency because they have less penetration and drag on the surfaces on which they act, in such a way that it would have to be applied as an additional measure of disinfection.

Finally, it is advisable to carry out a post-disinfection control in order to ensure that the process has been effective and that the source of fungal inoculum has been reduced to non-hazardous levels, the fruit that will be retained in the chamber. , in case of not being it, it will be possible to repeat said disinfection until satisfying the required needs.

4.1.2. Packaging prophylaxis

It is necessary to clean and disinfect the collection containers as a preventive measure to avoid contamination of the fruit and thus improve the conservation for a long period of time.

The variety of mushrooms that can be found in the packages are very varied since, in addition to the own ones of the power station, they also contain many coming from the field since much of the time they spend it in it. Depending on the sensitivity to the development of rotting of different fruit species, the risk that can be assumed by the presence of fungi in the packaging is different, proceeding to establish different frequencies of disinfection. In this case, as much as for pear as stone fruit, the peach, must be disinfected annually, especially for pear containers destined for conservation in controlled atmosphere chambers.

Disinfection is carried out at the end of the campaign, but it is also advisable to check the hygienic condition of the containers from time to time as they are being emptied of fruit because it can accumulate dirt and it may be necessary to re-disinfect them. The disinfectant product in the presence of organic matter loses efficiency and that is why a prior cleaning is essential.

The disinfection of the containers will be carried out after its cleaning through an automatic machinery. Said disinfection is done by means of a dilution of disinfectant in water. The alternatives for this are with a pressurized water system or through a shower system. The disinfection of the containers in the chamber by means of smoke, nebulization or thermospray cans will not be used since it creates an irregular distribution of the disinfectant in the chamber as well as having a low penetration power of these systems on its surface. Therefore, the shower application system is chosen by means of a drencher equipment since it is the more efficient of the two and in addition it already has that machine in the previous stage of post-harvest chemical treatment. Thus, you only need to change the broth for the corresponding disinfectant.

It is important to bear in mind that peach containers should not be used to store pears in a controlled atmosphere chamber due to the risk of cross-contamination by mucoral fungi.

5. Wastes

The waste generated in the industrial plant, although not going to be excessive due to the type of simple processing required in the fruit, will be destined, in the case of solid waste, for animal feed or processed while the effluents will be discharged to the industrial wastewater treatment plant. This will be done in compliance with Regional Decree 12/2006, of February 20, which establishes the technical conditions applicable to the implementation and operation of activities susceptible to water discharges to public sanitation collectors.

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PUBLIC UNIVERSITY OF NAVARRE

Agricultural, Food and Rural Environment Engineering

PROCESS DESIGN OF A FRUIT INDUSTRY

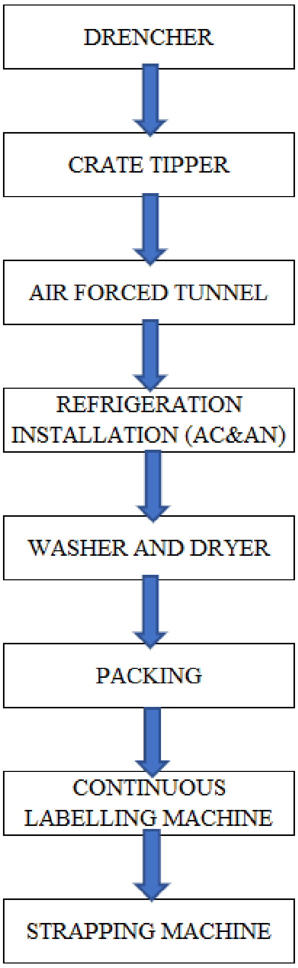
ANNEX 8. PROCESS ENGINEERING

Content

1. Introduction

This part of the project describes the machinery and its corresponding specifications that are necessary to carry out the production process of the fruit plant.

2. Flowchart



3. Equipment in each process step

3.1. Raw material reception

The reception of the raw material will be carried out in the loading dock and will be placed directly in the process line so that the product handling begins. There are no alternatives to be taken into account at this stage.

3.2. Pre-conservation treatment

The drencher equipment will be placed at this stage of the process, once the raw material has been received, in such a way that the chemical treatment of preservation and, in a certain way, cleaning is applied as soon as possible, since the fungicides are mixed in water in the shower system. Thus, it is possible to compensate the expense of the small percentage of shrinkage of product that can be removed in the next stage of selection (already treated), since the dirt that can be brought from the field is removed and helps to differentiate and identify that raw material that yes that is in bad state of simpler way. In turn, the treatment partly allows the raw material to cool, which is also essential to carry out as soon as possible.

With the objective of eliminating or reducing, as far as possible, pollution problems, the drenchers that are used today have an automatic dosing device attached. The main advantage of this dispenser is that the machine works with a minimum of litres of water and it is cheaper to replace it with a clean one when necessary. The operating method is very simple. The amount of water carried by each pallet of fruit or pile of wooden crate is known, and the amount of water needed by the pumps for their operation (between 350-400 litres) is also known. Therefore, you will have to start the treatment with 400 litres for example, plus 10% water, with the chemicals, at the dose that will be used. The dispenser is graduated with the different products and the water inlet, depending on the litres carried by the pallet and, automatically, the entrained water is replenished, with its dose of product.

3.2.1. Compartments Drencher

Compartments drencher consists of two adjoining cabins, with a mobile door that closes the cabin where the fruit is being treated, through a water pipe that moves with the door. Meanwhile, the other cabin is free to put pallet to treat or remove the treaty. The capacity of the tank is 2000 litres, with capacity viewer.

It has the advantage that the fruit is treated standing on some platforms, that with the weight of the pallet, through a few detectors start the door, which when closed activates the pumps that recycle the water, showering the fruit. Special attention must be paid so that the water in the tank is changed as frequently as possible.

3.2.2. Chain Drencher

This continuous-working Drencher It is developed to work in large volumes and performs a very good draining of fruit, to save liquid and avoid environmental pollution.

This consists of chains through which the wooden crate moves, a cabin with a static applicator and a decanter. The wooden crates are fed to the chain by means of trucks and move to the shower cabin. Once finished the shower the wooden crates are driven by the same chain to the decanter, where they are overturned at an angle close to 45º to eliminate waste water; then they continue the movement towards the end of the line where they are picked up by a wheelbarrow.

The machinery has a triple safety system and built-in timers for operation and safety. To handle the operator deposits the wooden crate with the help of pallet truck o fork lifts.

3.2.3. Chosen alternative

It´s decided to use chain drencher due it´s the most used in the industry due to the easy adaptation of the volume of production with the machine and its treatment speed.

3.3. Selection

Taking into account that you have to apply the Specifications of the Denomination of Origin pears "Rincón de Soto" that requires a manual selection, there are no other alternatives to consider.

As peach production is much lower than pears, manual selection by plant personnel will be used.

Prior to the start of the selection, a wooden crate will be used to deposit the raw material on the selection tape.

Crate tipper

The crate tipper have a padded lid to avoid damaging the fruit and a 45º movement to achieve an easy flow of the fruit. Through a connection with the rest of the line, the dump speed is determined to achieve a constant feeding of the fruit.

The same single switch performs lifting, tilting and emptying operations. Once the wooden crate is empty, the reverse cycle begins, which leads to the wooden crate to the original position to be replaced by a full one. Once it reaches its original position, the oil pump switches off automatically to avoid unnecessary noise.

3.4. Fruit pre-refrigeration. Air forced tunnel

The cooling rate is determined by the cooling capacity and circulation of the cold medium around the product, by the cooling medium used, in this case, by air, and by the physical characteristics of the product. The cooling of the product is due to the transmission of heat from its interior to the surface (conduction), and between this surface and the surrounding cold medium (convection). The air system used for this case will be the forced air tunnel, in such a way that the air distribution can be improved and the cooling speed of the product increased. This is perfectly suited for both pears and peaches that are going to be treated at the plant. It is necessary to control the initial phase of reduction of the temperature of the fruit so that they do not remain excessive time subjected to a very strong ventilation.

In the forced air tunnel, the product pallets are placed in two rows, or one on each side, and an open channel in the centre. At the same time, a tarpaulin is placed over said product covering the open channel, and a fan dries the hot air from the channel, forcing cold air to pass through the packaged product. Thus, the hot air is directed to the coils of the evaporators, sucking it and injecting it into the cold room.

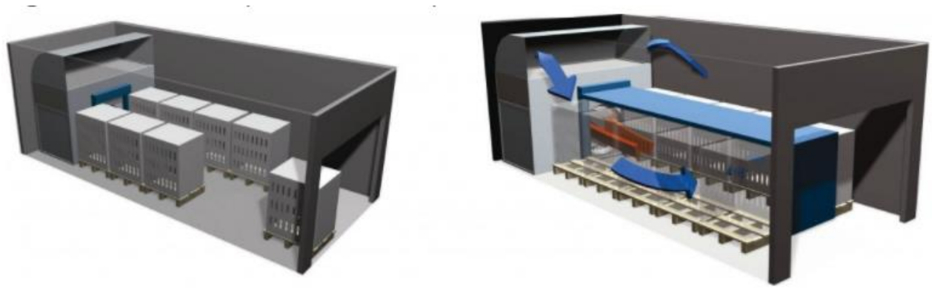


Figure 38. Air forced disposition.

With this system it is possible to cool large loads of product in a single batch, without having to handle a specific temperature for individual boxes in the loads of the pallets. Basically, the machine will be equipped with a speed control in the engine, and, as the air returns, the temperature of the engine will drop during the process; the fan will decrease its speed, thus reducing the use of energy, as well as the loss of moisture.

The speed at which the temperature drops will be relative to the temperature difference between the product and the cold air. The temperature drop per hour, at the beginning of the cooling is fast and it becomes slower as the product approaches the final temperature (in this case, between -0.7 and -1 ºC for Pear Conference and 0 - 0, 5ºC for the peach). This process approaches the time required in which the temperature of the product falls to half the difference between the initial temperature of the product and that of the cold air. At the same time as this first period, a second occurs where the product also loses half the difference between the temperature of the product at the beginning of the cooling period and that of the cold air. Since the temperature is half the difference of the first period, the fall of the second half period is only 5 ° C. Cooling periods, as has been discussed, will only last 3-4 days.

Recommendations to be followed:

- The set value of the probe that governs the cold must be close to the conservation temperature of each variety, but it is preferable to use several safety probes stuck in the fruits located at different points to avoid freezing problems.
- It is necessary to work with a high fan speed in order to optimize the process, specifically about 15 m / s and with an air flow of about 1-2 liters / (s.kg).
- The arrangement of the containers inside the tunnel must be optimal to create the necessary pressure gradients (distance between the blocks, lower the canvas, etc.)
- Sufficient levels of humidity must be reached, that is, greater than 95%, despite the time the fruit remains in the chamber since the working conditions are extreme, especially the speed of the fans.

3.5. Controlled atmosphere installation

The detailed description of the components of the refrigeration installation itself with its corresponding alternatives, used both for pre-cooling in the chamber and in the controlled atmosphere, as the main equipment of the plant, is specified in more detail in the Annex 8 Refrigeration installation, in addition to its full calculation.

Adequate tightness is necessary in the walls and ceiling of the controlled atmosphere chamber so that the ambient air intake from outside (with 21% of O2) into the interior of the chamber is limited. The main materials used to ensure an airtight layer along the perimeter of the chamber are: plastic fabrics, polyester, polyurethane, metal coatings and sandwich panels. As each material presents its advantages and disadvantages, it will be necessary to carry out periodic waterproofing tests.

As for the installation of cold, it must be avoided that the operation of it causes excessive overpressures / depressions that prevent us from adequately maintaining the low levels of O2 required. For this purpose, aspects such as recirculation of the air should be taken into account, once the loading and cooling stage of the product has finished and the maintenance step has been carried out, in addition, in order to maintain high levels of relative humidity and thus be able to reduce the losses of weight and to avoid wilting, the thermal jump has to be small between the evaporator and the atmosphere of the camera, limiting the suction of external air towards the interior of the chamber. Pressure-compensating lungs will be installed to prevent the modification of gases in the atmosphere of the chamber, due to the gaseous exchange with the outside. They are located on the outside of the chamber, connected to the inside of the chamber, deflating and swelling with the same atmosphere of the chamber when there is overpressure or depression in it, avoiding the exchange with external air.

The phase of generation of the atmosphere is also called pull-down and occurs once the product has been closed and cooled in the chamber correctly. It uses equipment that reduces the concentration of O2 from its initial value of 21% to the desired end, in a period of time less than 48-72 hours. An O2 of approximately 5% is achieved and it is expected that the respiration of the stored fruit will be responsible for reaching the final oxygen value of between 1 and 3%. The equipment to be used for said oxygen reduction will be through the elimination of O2 by a physical method based on the sweep of the atmosphere with nitrogen obtained with air separators. Its main technical advantage is its rapid elimination capacity of said gas through a sweeping action that in turn eliminates other volatile gases that are harmful to the conservation and quality of the fruit. The operation of the same can be easily automated so that, safely can come into operation before any variation of the levels of gases of the chamber with respect to the desired and thus be able to maintain them. The air separators allow obtaining nitrogen productions of the order of tens to a few hundred m3 / h, with purities of 95-99%. Within this type, the equipment used is based on a membrane separator instead of the PSA (Pressure Swing Adsorption) separator because the maintenance costs are lower. This membrane separator is based on the selective permeability of different gases present in the air through a semipermeable membrane, so that they have a high permeation rate compared to nitrogen that is slower. Briefly, this consists of compressing the ambient air first, then passing it through a heater and a filter to remove impurities, from where it enters into circular fibers of hollow shape, in such a way that the pressure gradient between the interior and outside of these forces the permeation of gases through the wall thereof. At the exit a gaseous current rich in nitrogen is obtained that passes through an accumulator tank from where the cameras will be taken to carry out the sweep of the atmosphere in the chamber.

On the other hand, in order to maintain and reach the level of CO2 determined in the atmosphere, it takes advantage of the CO2 released by the respiration of stored fruits and accumulates in the atmosphere of the chamber. However, decarbonising equipment (scrubbers) based on adsorption by activated carbon is needed in order to eliminate the accumulated excess of CO2.

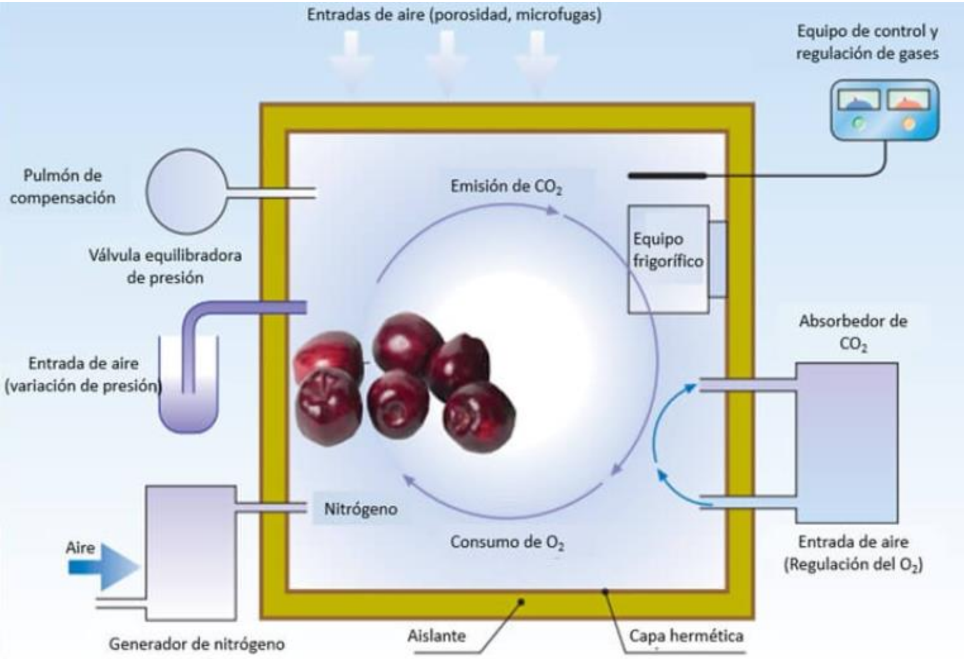


Figure 39. Diagram of facilities and equipment needed in a cold storage room of Controlled Atmosphere.

3.6. Washing

As has been mentioned in Annex 7 of the process technology, the type of washing that is going to be carried out is wet. These washes allow the particles to be removed either from dust, dirt or any other substance that may have been generated in the food through the use of detergents and sanitary products. Within this type of wet washing, the following alternatives are presented:

3.6.1. Spray washing

Spray washing consists of passing the raw material through sprinklers or pressurized water showers, which efficiently removes dirt and drags it with water, reducing the possibility of contamination. The efficiency of this washing alternative depends mainly on the water pressure, the temperature and the time used among other factors, such as the distance of the product to the spray jet and the number of these employed. In general, applying small volumes of water at high pressures achieves maximum efficiency.

3.6.2. Immersion washing

This type of washing is the simplest method of wet cleaning, is often used as a previous step to other washing methods such as spraying or even as an appropriate way to receive the raw material from large containers and introduce it to the processing line, without causing physical damage by hitting.

3.6.3. Chosen alternative

The alternative chosen is the washing by aspersion, since it is the most suitable for the fruit. In addition, there are automatic equipment where the machine itself washes and followed in continuous dry through air.

3.7. Selection and packing

Both the selection and the boxing have been chosen manually and no other alternative is presented since the requirements of the D.O Rincón de Soto pears specifications are fulfilled.

3.8. Labelling

The equipment chosen for the labelling of boxes with product is a continuous equipment, with a capacity of 21000 boxes per hour. The labelling machine is simple and does not take up space. The mechanism consists of a sensor attached to the conveyor belt that detects the box pass, and at the time that happens, proceeds to paste.

The labels that will accompany the boxes of pears with DO, will be numbered labels, in such a way that the expense of the label carried out in each establishment will be controlled, corresponding to the quantity of certified product issued, thus avoiding that they can be labelled with the logo of the denomination not covered by the Protected Designation of Origin.

On the other hand, the labels on peaches will also be distinctive with the integrated production marker, to give quality to the product.

3.9. Strapping

At that stage the boxes will be placed in euro pallets and they will be strapped to secure the cargo during transport. The automatic strapping machine is the most convenient for the boxes of fruit since it needs to breathe and therefore through other alternatives such as film wrapping machines, respiration of the product would not be possible.

4. Machinery chosen

DRENCHER				
Description	Drencher of chains for continuous treatment of fruit packed in palots or PVC bins. Profile and stainless steel sheet. Stainless chains.			
Dimensions	Length (mm)	9750		
	Height (mm)	4500	Height palos (mm)	1100
	Width (mm)	2000	Capacity (kg/h)	30000

CRATE TIPPER				
Description	Adjustable crate tipper with a hydraulic dump and dump system, with protective barriers and a progressive emptying. 45º of turn.			
Dimensions	Length (mm)	2000		
	Height (mm)	700		
	Width (mm)	2500	Capacity (palets/h)	40

AIR FORCED TUNNEL CHAMBER				
Description	The forced air tunnel corresponds to the pre-cooling of the raw material, which must be 7 hours in order to reduce the temperature of the fruit to the desired one. A canvas is placed between the corridor of the palots arranged in two rows to facilitate air flow.			
Dimensions	Length (m)	17		
	Height (m)	4		
	Width (m)	11	Capacity (t)	50

CONTROLLED ATMOSPHERE CHAMBER				
Description	Hermetically sealed chamber where the conservation technique consists of the modification of the gaseous composition of the atmosphere in the cold room, in low O2 conditions and enriched in CO2.			
Dimensions	Length (m)	17		
	Height (m)	4		
	Width (m)	11	Capacity (t)	100

WASHER AND DRYER				
Description	Complete line of washing by aspersion and drying for fruits. Entrance conveyor, washing, rinsing, blowing and drying module. Output conveyor.			
Dimensions	Length (mm)	10000		
	Height (mm)	1500		
	Width (mm)	800	Capacity (tn/h)	15

SELECTION AND TRANSPORTING CONVEYOR				
Description	Machine designed to transport products through the movement of a thermodrive band. They can be used to be able to select the product.			
Dimensions	Length (mm)	2500		
	Height (mm)	500		
	Width (mm)	900	Capacity (kg)	135

STRAPPING MACHINE				
Description	Máquina automática para el flejado de palets en vertical, sin limitación de tamaño de palet. Tensión ajustable mediante pinza. Control electrónico de toda la operación de tensión, soldadura, corte y lanzamiento del fleje.			
Dimensions	Length (mm)	700		
	Height (mm)	2400		
	Width (mm)	2100	Capacity (palets/h)	70

5. Auxiliary machinery

5.1. Forklift

They are called forklift trucks to those that move on the ground, motorized traction and intended primarily to transport, push, pull or lift loads. That is, it is an autonomous device capable of carrying cantilevered loads. It sits on two axes: motor, front and directrix, and rear. They can be electric or with internal combustion engine.

The use of these devices is essential in the plant as it has various functions such as loading and unloading trucks, filling and emptying wooden crate in storage chambers and transporting auxiliary material.

The trucks will be electric, with an elevation of up to 8 meters and with 180º rotation of the forks to allow the turning of the wooden crate.

Figure 40. Forklift

5.2. Pallet truck

The pallet truck is the simplest and most widely used medium in modern warehouses. There are two versions, the manual and the electric. It's about transportation equipment, not lifting equipment.

The pallets truck will be manual, without any electrical device, so that the movements of displacement are carried out by dragging them manually. The parallel platforms that hold the load (skids) can be raised slightly to lift the pallet from the ground and facilitate its movement.

They are essential in addition to having a low acquisition cost, solving situations in all storage activities and auxiliaries. Its versatility allows for work such as short distances transfers of pallets and containers, or as auxiliary means for transporting materials such as cartons, boxes, pallets, etc.

Figure 41. Pallet truck

5.3. Scale

The scale is essential in the reception and loading of trucks since it has the function of tare raw material trucks to calculate the kilos of each item and thus be able to invoice the supplier the corresponding amount, besides being able to identify it with the delivery note to be able to take carried out a traceability monitoring of the product. Also trucks loaded with it are weighed, essential to control that the truck does not exceed the maximum load allowed.

This equipment consists of a stainless-steel weighing platform and will be located at the entrance of the factory.

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PROCESS DESIGN OF A FRUIT INDUSTRY

ANNEX 9. REFRIGERATION INSTALLATION

Content

1. Introduction

The cold room is basically a thermally insulated warehouse in whose interior heat is extracted or what is the same, thermal load through a refrigeration system of mechanical compression. These cameras are cubic in shape. They are hermetically closed so that the refrigeration system is maintained in order to conserve the raw material in the best possible conditions, delaying the possible physiological alterations.

It is necessary to understand that the fruit that is to be stored is deteriorating as time passes due to the breathing process, being more vulnerable and faster if they are subjected to high temperature. For this reason, we want to keep temperatures low enough inside the chamber to ensure that the breathing process is almost null, keeping the fruit in good condition.

As it has been commented throughout this project, the storage of the fruit will be done in controlled atmosphere (AC) chambers so that they last as long as possible. Before that, they will also first pass through the pre-cooling chambers for a period of 7 hours with a forced air tunnel system in order to lower the temperature of the raw material.

The fact that they are stored in one type of chamber or another, means that the conditions of relative humidity, temperature, oxygen and carbon dioxide varies, and in turn depending on the type of fruit, these conditions also change slightly. (Annex 3) That is to say, there are optimal storage conditions for both the type of fruit to be stored and the type of atmosphere that will exist inside the chamber.

The AC cameras will work 18 hours while the pre-cooling cameras will work 24 hours.

2. Raw material storage chamber

The installation of isolation in camera will be the same in all cameras. To begin with, the rigid polyurethane foam (PUR), 10 cm thick, will be the insulating material used in the chambers since it has a small value of the coefficient of thermal conductivity and the possibility of on-site fabrication, especially suitable for the perfect sealing of joints. In addition, it has good characteristics of low gas permeability, being very useful for the desired tightness in controlled atmosphere chambers. Along with said insulating material, an anti-vapor barrier is needed to prevent the diffusion of water vapor from the external environment into the interior of the chamber; diffusion which is created by the difference of partial pressures of water vapor on both sides of the walls, ceiling and floor. If this vapor barrier is not installed or is not properly installed (it must be on the hot face of the insulation), there would be negative consequences such as heat entering the interior of the chamber, the increase in defrosts of the evaporators and the detachment or breakage of insulators, etc. Finally, the assembly system will be prefabricated or sandwich panel, which consists of a central part with coating on both sides.

The capacity of the AC chambers will be 100 tons, while the pre-refrigeration capacity will be 50 tons each.

Next, the different thermal loads that have been taken into account for the calculation of the refrigeration installation are presented.

2.1. Physical characteristics of the product

The characteristics of the raw material that must be taken into account to carry out the design of the refrigeration storage chambers are the following.

Table 37. Characteristics of raw material.

	Pear	Peach
Storage density (kg/m3)	140	140
Freezing temperature (°C)	-2	-1,6
Cp before freezing (KJ/Kg °C)	3.81	3.77
Respiration heat at 25 °C (KJ/kg day)	13.82	12.14
Respiration heat at 0 °C (KJ/kg day)	1.05	1.67

2.2. Characteristics of the product in camera

The characteristics of the product in the camera will vary depending on whether the camera is intended for pre-cooling or is controlled atmosphere.

Table 38. Characteristics of the product inside the storage chamber.

	CA	PR
Entry temperature (°C)	8	22
Regime time (h)	24	8
Capacity of the storage chamber (t)	100	50
% daily entrance	50	50
Pallet (% weight)	5	5
Specific heat (KJ/Kg °C)	2.72	2.72

As can be seen in table 2, the percentage of entry into the chamber every day is 50% since it is considered that all the product that enters the same day, that is, 50 tons, is destined half to one of the cameras of pre-refrigeration and the other half to the second, as well has been specified in Annex 5 of planning of the process. Likewise, in both cases a pallet weight percentage of 5% with a specific heat of 2.72 KJ / kgºC is also considered. Regarding the regime time of each chamber, the capacity of the same and the entry temperature of the raw material varies considerably as shown in the table. The temperature of the pre-cooling chamber is this high because the fruit that arrives comes from the field directly and occurs in a hot season, so it is estimated that the product could reach 22 º C temperatures at the entrance of the camera. On the other side, in the case of the controlled atmosphere, the temperature is thus low since the fruit that enters it is that which has previously been 7 hours of pre-cooling with a forced air tunnel system to reduce its temperature.

2.3. Chamber designs

The thermal conditions inside the chamber are 90% relative humidity and all of them except the two pre-cooling, have the same dimensions: 4 m high, 11 m wide and 16.4 m long. By having the pre-cooling chambers half the capacity, the dimensions are smaller: 4 m high, 8 m wide and 12 m long.

In addition, the following table shows the construction characteristics considering equal walls and ceilings.

Table 39. Constructive features of the chamber.

Chamber side	Material	Thickness (cm)	Conductivity (W/m2 °C)	Heat losses (W/m2)
Walls and ceiling	Expanded polyruethane	10	0.221	5.7
Floor	Reinforced concrete + expanded polyruethane	12 + 6	0.397	5.1

2.4. Calculations and results

The calculations of the camera have been carried out taking into account a series of charges that cause the loss in power since they generate a certain amount of heat that the camera has to be able to solve.

Therefore, it is considered a load due to normal air renewal, that is, the opening of doors for the entry of the product by the personnel. The volume of renewed air will be 89.30 m3 / h with a temperature of 35.4ºC and 26% relative humidity.

Second, it is considered a small load for people, which in this case will be considered one, which will be one that enters the chamber to deposit product in trucks, which means a thermal power of 0.28 kW. In the same way, it takes into account the power of machines and motors that will be of 10kW and a load by illumination of 8 W / m2, creating a power of 1.76 kW the latter. The sum of these thermal powers in total results in 12.00 kW, in addition to the thermal power lost of 3.56 kW by a small percentage per load of fans of 6%.

Table 40. Final results of the chamber calculations.

PRE-REFRIGERATION

	Loads	Thermal power kW
Products	Product cooling	43
	Product respiration	4.89
	Pallets cooling	1.53
	Total	49.4
Installation	Walls, ceiling and floor	3.39
	Ventilators	3.76
	Air renovation	1.1
	Illumination	1.44
	Personnel	0.224
	Machines and engines	7
	Total	16.9

CONTROLLED ATMOSPHERE

	Loads	Thermal power kW
Products	Product cooling	19.8
	Pallets cooling	0.708
	Total	20.6
Installation	Walls, ceiling and floor	4.5
	Ventilators	2.09
	Air renovation	1.06
	Illumination	1.44
	Personnel	0.278
	Machines and engines	7
	Total	16.4

Final results	CA	PR
Total load of the chamber	36.9 kW	66,3 kW
Total load of the chamber majored	40.6 kW	73 kW
Refrigeration power of the chamber, during 18 and 24 h	54.2 kW	73 kW
Installed power per m3	75.1 W/m3	101 W/m3

3. Selection of refrigeration equipment

The refrigeration system of mechanical compression consists of 4 basic elements: the compressor, the condenser and condensate, the expansion valve and finally the evaporator.

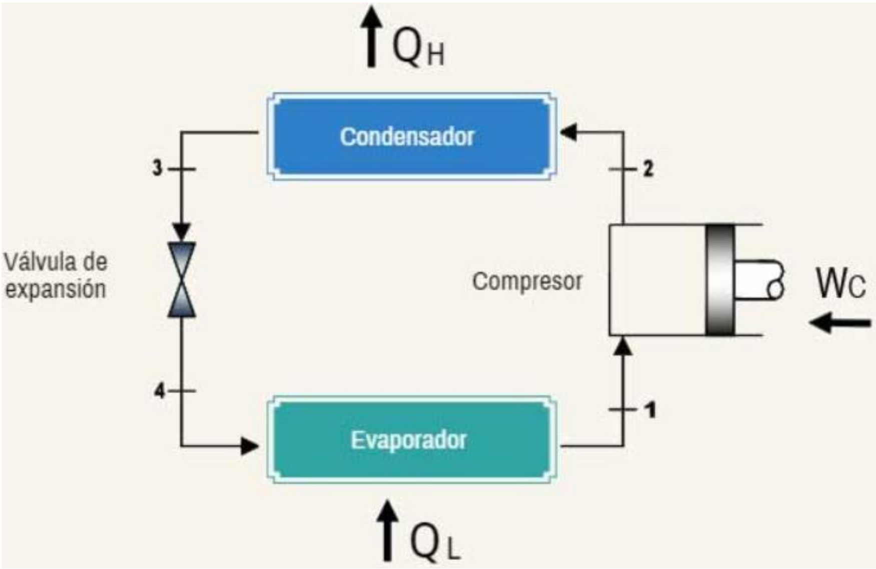

Figure 42. Esquema de una instalación de produccón de friío por compresión mecánica.

3.1. Refrigerant

The choice of the type of refrigerant has been carried out taking into account a series of thermodynamic, technical and economic properties. In this case presented, the refrigerant that will be used for the refrigeration system will be R-134a, since it is the best accepted to date, thus restricting HCFC (hydro chlorofluorocarbon) since 2010. Ammonia will not be used in spite of have very good thermodynamic properties since steel facilities would be required and the safety and toxicity characteristics are worse. Thus, possible refrigerant leaks will be avoided with the consequent risk of explosions or poisoning.

3.2. Compressor

The compressor ensures that the refrigerant in the gas state is compressed. This allows the production of cold by sucking the refrigerant fluid in the form of vapor from the evaporator at low pressure and at low temperature, compressing it to high pressure and high temperature conditions so that the said vapor can liquefy in the condenser.

This machine has to work in conditions close to its maximum capacity to be able to have good energy efficiency and proper operation. The chosen compressor will be a screw because it allows high compression rates, it more easily tolerates liquid blows with respect to the piston compressor and its power regulation is continuous, which makes it particularly suitable for replacing several piston compressors. In addition, as it is a rotating machine, the mechanical problems will be smaller, thus allowing greater longevity and a decrease in maintenance. Its sound level is lower than the piston compressor

.

3.2.1. Selection

The compressor selected for the atmosphere controlled chamber with 100 tons of capacity is the KM15103 with 15 kW of power. It is compact, equipped with electronic controller and designed for continuous operation with direct drive and various operating pressures, in addition to great efficiency with electric motors and insulation. It is silent, clean and easy to use and maintain.

For the case of the 50-ton capacity cooling chamber, a SLDF 40-3 compressor with 30 kW of engine power is chosen. In terms of its characteristics, the screw compressor is lubricated directly coupled with frequency regulator and dryer and with a cooling fan regulated by frequency.

3.3. Condenser

In the condenser, the refrigerant is cooled by an external medium and is condensed to a liquid state at a high pressure (condensing pressure). The air condenser requires a large exchange surface in addition to a high flow rate, making it difficult to lower the condensation pressure to improve the performance of the installation, while, on the other hand, the water condenser produces better thermal transfer and it is possible to work at low condensing pressure levels. However, for the latter, rigorous maintenance is needed. Therefore, the evaporative condenser is the intermediate solution between the water and air condenser, taking advantage of both advantages and limiting its drawbacks. It is saved from the point of view of water consumed especially.

3.3.1. Selection

The model of the condenser chosen for the case of the atmosphere controlled chamber with 100 tons of capacity is the CC122-63 with 73.70 kW of power, made of pre-cast steel sheet, with motor support panels and direct-drive fans.

On the other hand, for the refrigeration installation of the 50 ton capacity refrigeration chambers, the selected condenser is the CRH802HP3P with 110.1 kW. It is made of galvanized steel sheet and painted in white with epoxy polyester polymerized in the oven, with stainless steel fasteners and clamping rings on the side plates; dilatations are allowed and prevents breakage due to fatigue of the materials. External rotor fans with thermal protector and speed options.

3.4. Evaporator

The evaporator is constituted by a coil inside of which the liquid refrigerant evaporates at a low pressure (evaporation pressure), absorbing in said change of state the heat of the environment, so as to maintain the desired low temperature in the camera to enable the preservation of the product. The flow rate with which the evaporator is fed is regulated by the expansion valve, which causes the pressure drop of the refrigerant. This equipment is the main one from the point of view of the exploitation of the camera. The location of this will be in such a way that a correct recirculation of the driven air is obtained throughout the total space of the chamber.

The evaporator will be dry expansion or, in other words, direct expansion, through which the mass flow of refrigerant supplied to the evaporator is limited to the amount that can evaporate completely in its path so that only steam enters the evaporator compressor suction. They present great simplicity in design and lower initial cost, and in turn require less refrigerant charge. On the other hand, defrosting the evaporator should not cause fluctuations in the environmental conditions of the chambers if it is carried out at the necessary frequency and period, so that a high relative humidity can be maintained.

3.4.1. Selection

The evaporator selected for the case of the atmosphere controlled chamber with 100 tons of capacity is the GRX-2950 with a cooling capacity of 59 kW. This is made of aluminium lacquered in white with epoxy-polyester and polymerized, stainless steel screws and with separation panels between fans, which are centrifugal direct drive.

Finally, the GRM-4600 model with a power of 78 kW has been chosen for the 50-ton capacity cooling chamber. It has the same characteristics as the previous one since it is from the same house.

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PROCESS DESIGN OF A FRUIT INDUSTRY

ANNEX 10. PIPING INSTALLATION

Content

1. Introduction

In this annex the design and calculation of the plumbing installation will be described. It is part of the general supply network connection Tambarria polygon with which connects the total installation of the fruit plant.

Therefore, from that point, located at the entrance area to the factory, and as can be seen in Map 5, the network of water pipes is designed that will be able to supply all those machinery and areas of water service (bathrooms and toilets for staff and offices) that need water

The pipes designed will be made of stainless steel approved by the ASME B31.1 standard and there will be stretches in which the pipes are buried, glued to the wall and others at a certain height depending on the area through which they have to pass.

First, we will start with the design of the pipes along the plant and from there we will show a diagram in which we indicate the sections and the terminal points with which we will work to calculate everything to the corresponding pipes. That is, water flow demands, necessary diameters for pipes, linear load losses, localized, etc.

The objective is to design the plumbing installation in such a way that water can reach all points with enough flow and pressure to supply the needs of each area.

2. Hydraulic calculations

3. First of all, in figure 1, the simplified scheme of the installation with its corresponding sections and terminal points is represented, as well as the indication of where each of the the pipelines is directed in order to better understand the tables that come next.

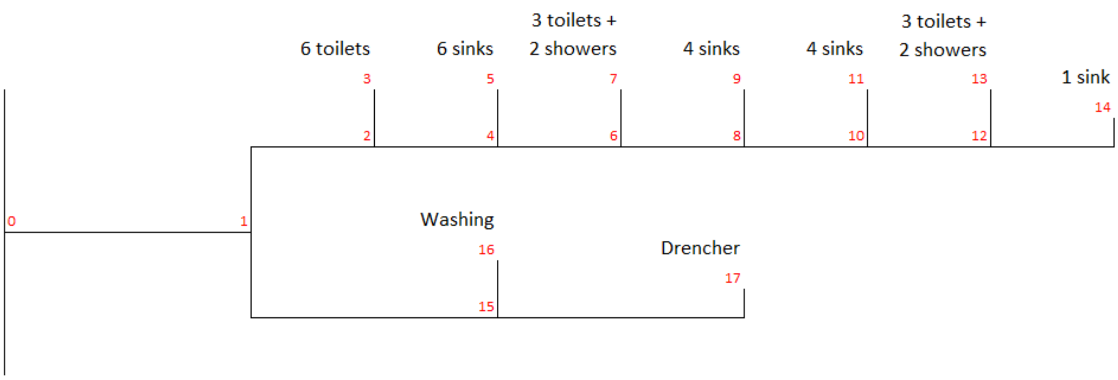

Figure 43. Simplified scheme of the piping installation.

In addition, it takes into account previous considerations of the water of the fruit plant that will be needed throughout the calculation:

- Temperature: 15ºC
- Density: 999.1 kg/m^3
- Viscosity: 0.001148 Pa s
- Roughness: 0.000046 m

Also, a supply pressure of 2.45 bar is estimated so it is sufficient to supply the needs, and the two machines that require water have their own pump so the demand is sufficient, as for bathrooms.

Next, table 1 shows the table with the terminal points represented in the previous figure together with the quantities and the necessary flows for each one.

Table 41. Total flow needed in terminal points.

Terminal points	Element	Nº	Demand [l/s]	K	Partial flow Q [l/s]	Total flow Q [l/s]	Total flow Q [m3/s]
3	Toilet	6	0.1	0.9	0.54	0.54	0.00054
5	Sink	3	0.1	1	0.3	0.3	0.0003
7	Shower	2	0.2	1	0.4	0.67	0.00067
	Toilet	3	0.1	0.9	0.27		
9	Sink	4	0.1	1	0.4	0.4	0.0004
11	Sink	4	0.1	1	0.4	0.4	0.0004
13	Shower	2	0.2	0.9	0.36	0.66	0.00066
	Toilet	3	0.1	1	0.3		
14	Sink	1	0.1	1	0.1	0.1	0.0001

3.1. Calculation of nominal diameter and fluid velocity

In the same way, once you have the data from table 1, the calculation of the sections will start in reverse, that is, from back to front. This is so because the flow rate needed by point 14 is known, which corresponds to the laboratory sink, since it is the last pipe that is needed. In the same way, it occurs with the second branch of the scheme of figure 1, where the last machine reached by the pipe is the drencher machine, therefore, the flow of that point (17) must correspond to that same amount what is needed Therefore, little by little the flows are added to calculate the need for flow at each previous point. For example, the flow of section 10-12 will correspond to the sum of the flow required by section 12-13 and 12-14, and so on.

It is estimated a theoretical speed of 2 m / s maximum initial to be able to calculate the internal and nominal diameters using equation 1.

$$Q = v * A; \quad donde\ A = \pi * \frac{D^2}{4}$$

Equation 1

Being:

- Q = mass flow rate (m^3/s)
- v = velocity (m/s)
- D = internal diameter (m)

Once the diameter is calculated, its corresponding catalogued nominal diameter is calculated. From there, the actual speed in this case is recalculated using the same equation, using the chosen nominal diameter as data. This will have to be less than 2 m / s to verify that it is correct.

The "L" corresponds to the length of pipe that each section has. All the mentioned calculations can be observed in the following table:

Table 42. Calculation of the nominal diameters and the real velocity needed in each tranche.

Tranche	Theoretical velocity [m/s]	Flow Q [m3/s]	D theoretical [mm]	D nominal [mm]	D nominal [inch]	Real velocity [m/s]	L [m]	L/D
12 - 14	2	0.0001	7.979	9.22	1/4	1.498	35.5	3850.33
12 - 13	2	0.00066	20.498	20.96	3/4	1.913	5.5	262.40
10 - 12	2	0.00076	21.996	26.64	1	1.364	4.7	176.43
10 - 11	2	0.0004	15.958	20.96	3/4	1.159	1.95	93.03
8 - 10	2	0.00116	27.175	35.28	1 1/4	1.187	8.44	239.23
8 - 9	2	0.0004	15.958	20.96	3/4	1.159	1.95	93.03
6 - 8	2	0.00156	31.514	35.28	1 1/4	1.596	8.74	247.73
6 - 7	2	0.00067	20.653	20.96	3/4	1.942	5.5	262.40
4 - 6	2	0.00223	37.678	40.92	1 1/2	1.696	11.83	289.10
4 - 5	2	0.0003	13.820	15.76	3/8	1.538	1.95	123.73
2 - 4	2	0.00253	40.133	40.92	1 1/2	1.924	14.42	352.39
2 - 3	2	0.00054	18.541	20.96	3/4	1.565	0.5	23.85
1 - 2	2	0.00307	44.209	52.46	2	1.420	7.08	134.96
15 - 17	2	0.0017	32.898	35.28	1 1/4	1.739	55.15	1563.21
15 - 16	2	0.001	25.231	26.64	1	1.794	0.42	15.77
1 - 15	2	0.0027	41.459	52.46	2	1.249	59.81	1140.11
0 - 1	2	0.00577	60.608	62.68	2 1/2	1.870	22.95	366.15

3.2. Calculation of loan losses

In Table 3, the linear load losses are calculated by sections. For this, it is necessary to previously calculate the Reynolds number (equation 2). Depending on the result, the flow will be classified as laminar (Re <2000), transient (2000 <Re <4000) or turbulent (Re> 4000), the coefficient of friction "f" will have to be calculated in one way or another.

$$Re = \frac{v*D*\rho}{\mu}$$

Equation 2

Being:

- Re = Reynolds number (dimensionless)
- v = velocity (m/s)
- D = internal diameter (m)
- ρ = density (kg/m3)
- μ = roughness (Pa s)

As can be seen in the table, the number of Reynols is greater than 4000 so, being turbulent, the coefficient of friction must be calculated with the following equation:

$$f = 0.3164 * Re^{-0.25}$$

Equation 3

Finally, for the calculation of the linear loss that occurred in each section, the Darcy-Weisbach equation is applied:

$$h = f\frac{L}{D}\frac{v^2}{2g}$$

Equation 4

Being:

- h = pressure drop due to friction (m)
- f = coefficient of de friction (dimensionless)
- L = length of the pipe (m)
- v = average water velocity (m/s)
- g = acceleration of gravity = 9.8 m/s^2

Table 43. Lineal head losses.

Tranche	Reynolds	Type of flow	Friction factor	Lineal head losses [m]
12 - 14	12018.39	Turbulent	0.0302	13.317
12 - 13	34892.32	Turbulent	0.0232	1.134
10 - 12	31612.33	Turbulent	0.0237	0.397
10 - 11	21146.86	Turbulent	0.0262	0.167
8 - 10	36433.98	Turbulent	0.0229	0.394
8 - 9	21146.86	Turbulent	0.0262	0.167
6 - 8	48997.42	Turbulent	0.0213	0.685
6 - 7	35420.99	Turbulent	0.0231	1.164
4 - 6	60387.41	Turbulent	0.0202	0.856
4 - 5	21093.19	Turbulent	0.0263	0.392
2 - 4	68511.28	Turbulent	0.0196	1.301
2 - 3	28548.26	Turbulent	0.0243	0.073
1 - 2	64846.61	Turbulent	0.0198	0.275
15 - 17	53394.62	Turbulent	0.0208	5.020
15 - 16	41595.18	Turbulent	0.0222	0.057
1 - 15	57031.22	Turbulent	0.0205	1.858
0 - 1	102005.60	Turbulent	0.0177	1.156

On the other hand, it is necessary to calculate the localized load losses, that is, the load losses for each singularity that exists in the plane, in this case, the elbows and the T. For this, in the following table (4) observe the number of elbows and T that they have in each section, and the corresponding constant "K" in each one. This K is a value dependent on the type of singularity. In order to calculate the localized load losses of each singularity and in each section, the following equation is applied:

$$h_{LOC} = K\frac{v^2}{2g}$$

Equation 5

Table 44. Located head losses.

Tranche	Elbow 90º	T in line	Located head losses in elbows	Located head losses in T
K	0.33	0.4		
12 - 14	2		0.076	
12 - 13	1		0.062	
10 - 12		1		0.038
10 - 11	1		0.023	
8 - 10	1	1	0.024	0.029
8 - 9				
6 - 8	1	1	0.043	0.052
6 - 7	1		0.063	
4 - 6	1		0.048	
4 - 5	1		0.040	
2 - 4	2	1	0.125	0.076
2 - 3	3		0.124	
1 - 2		1		0.041
15 - 17	2		0.102	
15 - 16	1		0.054	
1 - 15	3	1	0.079	0.032
0 - 1		1		0.071

Finally, to see the total load losses, linear and localized load losses are added in each section:

Table 45. Total head losses.

Tranche	Total head losses [m]
12 - 14	13.393
12 - 13	1.196
10 - 12	0.435
10 - 11	0.190
8 - 10	0.446
8 - 9	0.167
6 - 8	0.779
6 - 7	1.228
4 - 6	0.904
4 - 5	0.432
2 - 4	1.501
2 - 3	0.196
1 - 2	0.317
15 - 17	5.122
15 - 16	0.112
1 - 15	1.969
0 - 1	1.228

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PROCESS DESIGN OF A RUIT INDUSTRY

ANNEX 11. PLANNING AND CONTROL OF PROJECT EXECUTION

Content

1. Introduction

One of the most important parts of the project is the planning of its execution over time. In this case, the industry consists of a fruit plant in a building already built which already has the electrical installation made as well as the access doors.

During the realization of the project, a series of resources and funds necessary for its execution have been taken into account. In order to carry out an adequate control, the Gantt diagram has been used as a representation, created through the Microsoft Project 2010 program. For this, it has been necessary to estimate the time it would take to complete each of the different activities. The program also presents the possibility of showing those activities that are linked one after the other or those that can be carried out simultaneously.

Thus, the following section describes the conditioning activities of the ship prior to the start of production of the industrial activity

2. Planning of activities

2.1. Conditioning of the building

As mentioned on previous occasions, the construction of the plant is not part of the scope of this project, so it is necessary to simply condition the existing plant to the line of work of the fruit plant. To do this, we will try to achieve the widest possible space to facilitate the mobility of workers through the plant.

The duration assigned for this activity is one week.

2.2. Piping installation

During this phase the installation of the corresponding plumbing will be carried out in order to supply water to the different parts of the line where necessary, such as the disinfection zone in drencher and washing.

The duration of this installation would take two weeks.

2.3. Refrigeration installation

The refrigeration plant is the fundamental basis of the fruit plant, as thanks to the numerous controlled atmosphere chambers and normal refrigeration, the fruit can be kept in good condition almost all year round. This will require cold equipment of considerable size since for each chamber there will be a capacity of 100 tons of product.

It is estimated 3 weeks for the complete installation of the equipment and cold rooms.

2.4. Machinery set up

Once the conditioning of the building has been achieved, the assembly of the equipment that makes up the work line will be carried out. They will be placed and assembled by modules and the assembly is carried out by the company that distributes the machinery.

It will start with the drencher system, the pallet dumper and the conveyor belts and selection, followed by the previous step to the expedition with the washing machine and the box strapping machine.

Once everything is ready, the equipment will be connected to the already installed water and electrical outlets until the water circuit is completed.

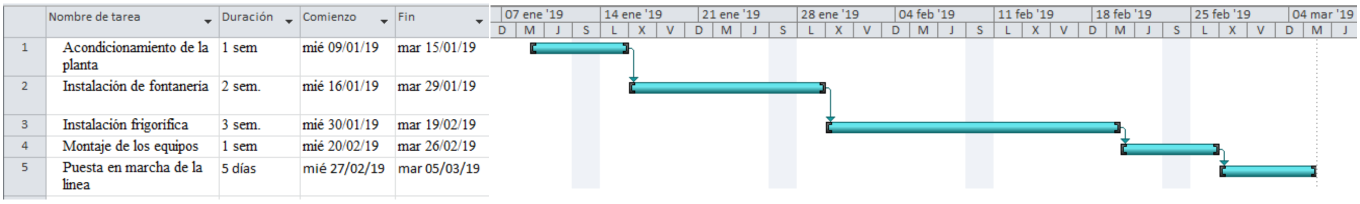
Since the machinery is not excessive and the cold rooms, which is what most space and time occupies, is part of the previous refrigeration installation, it is estimated only one week of assembly of the machinery.

2.5. Machinery conditioning

Once everything is connected, all the activity is started up to check if everything works correctly, while the atmosphere of the cold rooms is conditioned, the time management with the raw material. This will last another week.

3. Gantt diagram

Through the Gantt diagram you can observe in a clear and concise way the activities necessary for the execution of the project just commented in chronological order. As indicated by the arrows, each activity is linked to the next, that is, in order to start with one of the activities, the previous one must have finished.



	Nombre de tarea	Duración	Comienzo	Fin
1	Acondicionamiento de la planta	1 sem	mié 09/01/19	mar 15/01/19
2	Instalación de fontanería	2 sem.	mié 16/01/19	mar 29/01/19
3	Instalación frigorífica	3 sem.	mié 30/01/19	mar 19/02/19
4	Montaje de los equipos	1 sem	mié 20/02/19	mar 26/02/19
5	Puesta en marcha de la línea	5 días	mié 27/02/19	mar 05/03/19

Figure 44. Gantt diagram

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PROCESS DESIGN OF A FRUIT INDUSTRY

ANNEX 12. STANDARDS AND LEGISLATION

Content

1. Introduction

Through this annex all the rules and legislations that have been taken into account and applied when carrying out the project are presented.

2. Standards

2.1. Storage and transport

- Real Decreto 2483/1986, November 14th, which approves the Technical-Health Regulations on General Conditions of Terrestrial Transportation of Food and Food Products at a regulated temperature.

- Real Decreto 237/2000, February 18th, which establishes the specifications that must be met by special vehicles for the ground transportation of products of regulated temperature and the procedures for the control of conformity with the specifications.

- Real Decreto 1202/2005, October 10th, on the transport of perishable goods and special vehicles used in these transports.

- Real Decreto 168/1985, February 6th, by which the Regulation on General Conditions of Refrigerated Storage of Food and Food Products is approved.

2.2. Water

- Real Decreto 140/2003, February 7th, establishing the sanitary criteria for the quality of water for human consumption.

- Decreto foral 12/2006, February 20th, which establishes the technical conditions applicable to the implementation and operation of activities susceptible to discharging water to public sewage collectors.

- Real Decreto 1311/2012, September 14th, which establishes the framework for action to achieve a sustainable use of phytosanitary products. (Used in washes of chemical treatments of the process).

2.3. Commercialization

- Reglamento (CE) Nº 1221/2008 de la Comisión, December 5th of 2008, that it modifies, as far as marketing standards are concerned, the Reglamento (CE) Nº 1580/2007 laying down detailed rules for the application of the Reglamentos (CE) Nº 2200/96, (CE) Nª 1182/2007 of the Council in the fruit and vegetable sector.

- Real Decreto 1201/2002, November 20th, regulating the integrated production of agricultural products.

- Orden 6/2011, January 17th of 2011, of the Ministry of Agriculture, Livestock and Rural Development by which the Regulation of the D.O.P Peras de Rincón de Soto, and its management body is approved.

2.4. Hygiene and manipulation

- Reglamento (CE) Nº 852/2004, April 29th of 2004 on the hygiene of foodstuffs.
- Reglamento 191/2011, February 18th, on the General Health Registry of food and food companies.

3. References

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PROCESS DESIGN OF A FRUIT INDUSTRY

ANNEX 13. ECONOMIC STUDY

Content

1. Introduction

Through this annex the economic-financial evaluation will be carried out in order to calculate the cost of the project and be able to conclude if it is economically viable or not.

To do this, it is necessary to study the initial investment necessary to be able to start the project, in addition, the useful life of the project will be studied, that is, the period of time that has to elapse from the beginning of the investment until they are left to produce the anticipated interests.

The study of the cash flow is used with the differences between the revenues and the costs generated in the production to know what will be the profit of the company, estimating in an approximate way the inflows and outflows of money that is going to be given in the course of activity. That is why the flow is divided into profits and expenses.

For income you must know the amount of products that are going to be manufactured, as well as the sales formats and the quantities that will be sold for each one. In the case of expenses, different types of expenses will be considered, such as the purchase of raw materials, boxes, and salaries of workers.

Since the purchase and sale prices may fluctuate over time, at the time of the economic-financial calculation is considered an average price of both purchase and sales.

Finally, the Net Present Value (NVA), which consists of the absolute profit or return of the project and the Internal Rate of Return (IRR) that provides the relative return of the investment, will be used.

2. Project life

A project life of approximately 20 years is estimated.

3. Incomes

3.1. Ordinary Incomes

Ordinary income consists of those obtained from the sale of the product that has been manipulated in the fruit plant.

There is a small percentage of product losses due to different causes. First, the initial raw material that comes in poor condition (and the game is accepted anyway as it is within the limits of agreed tolerance parameters), which will consist of 1%. It is decided to allocate this product to other companies that can use this percentage of fruits to make juices and derivatives so that they do not care that the skin is in worse condition. Secondly, another 1% of losses in possible physical-chemical alterations caused in the fruit during the storage period are taken into account. And, finally, a possible 1% is assumed for problems and material in poor condition, for breakages and bruises occurred during transport, etc. All this makes a total of 3% of losses.

In Table 1, the price of D.O Rincón de Soto pears to which it is sold is € 1.63 / kg. In turn, with the peach Catherina variety, you enter 0.92 € / kg.

It is considered that the first and second year are more likely to not achieve maximum performance, so that the first year gives 70% of income and the second 85%

Table 46. Ordinary incomes.

Product	Kg/year	€/kg	Annual incomes
Pear "Rincón de Soto"	594,000	1.63	968,220.00
Peach (integrated production)	198,000	0.92	182,160.00
		total (€)	1,150,380.00
		97% total (€)	1,115,868.60

3.2. Extraordinary Incomes

The initial raw material is not usable for the plant but it is useful for other companies that make juice. This volume, which is considered 1% of the total, will be sold at 40% of its value.

Table 47. Extraordinay incomes.

Product	Kg/year	€/kg	Annual incomes
Pear "Rincón de Soto"	6,000	0.70	4,200.00
Peach (integrated production)	2,000	0.40	800.00
		total (€)	5,000.00

There is a request to ADER (Economic Development Agency of La Rioja), aid subsidies and funding for the promotion of small and medium agro-food industry whose amount is still pending to be determined (the subsidy is confirmed in December 2018) and which is would add as additional extraordinary income.

4. Costs

4.1. Ordinary Costs

4.1.1. Investment

The initial investment of the project amounts to € 322,323.27, as described in Document 5. Measurements and Budget. To be able to carry out this investment, a bank loan of this amount is requested, granted at 4% interest. The repayment period for the principal is two years, which coincides with the period that has been considered that 100% of production will not be reached as mentioned above. This interest is estimated because, from June to date, the average interest rate of the 250,000 last loans granted to SMEs (small and medium enterprises) has been Euribor + 2.65% according to sources of the INE (National Institute of the Statistics). Even so, for the estimation of the interest rate, it has been increased to 4% in case fluctuations took place until the date of request of the credit.

This means that the fees for the first two years are € 12,892.93, and € 39160.44 for the rest of the years (Table 6).

4.1.2. Raw material

In the ordinary costs of the company, there is the expense of the initial raw material of the plant that is represented in the following table:

Table 48. Raw material expense.

Product	Kg/year	€/kg	Annual incomes
Pear "Rincón de Soto"	600,000	0.60	360,000.00
Peach (integrated production)	200,000	0.39	78,000.00
		total (€)	438,000.00

4.1.3. Auxiliary material

Regarding the auxiliary material, the boxes are taken into account to market the fruit, the fruit palots, the pallets for the dispatch of the boxes, the base of the cells inside it and the strip coils.

Table 49. Auxiliar material expense.

Auxiliary material	Price/Unit (€)	Annual units	Total price (€)
Boxes of fruit	1.49	47,000	70,000.00
Wooden crates	40.00	2,400	96,000.00
Plastic strip coils	88.00	0.5	44.00
		total (€)	166,044.00

4.1.4. Salaries

The following table shows a table with the monthly salaries of the different personnel that is estimated that will be needed in the company for the start-up according to the work shifts and the production time, with which an average since it varies quite a lot throughout the year.

Table 50. Salary expenses.

Workstation	Number/post	Salary/person (€)	Monthly salary (€)	Annual salary (€)
Manager	1	4,000	4,000	48,000
Comercial	1	1,900	1,900	22,800
Administration	2	1,400	3,000	36,000
Laboratory technicians	2	1,150	2,300	27,600
Production manager	1	1,600	1,600	19,200
Maintenance	2	1,400	2,800	33,600
Workers	12	1,000	12,000	144,000
			total (€)	325,200.00

4.1.5. Other expenses

- Rent: 20,000 €/year
- Logistics and transportation costs: 15,000 €/year
- Material costs of the laboratory for analysis, cleaning products, new materials, etc.: € 500 / year
- Insurances: 1,000/year

4.2. Extraordinary expenses.

Possible maintenance and / or replacement of machinery and other fixed assets repairs is estimated to cost approximately 25,000 euros over the 10-year period.

5. Cash flow and profitability indexes

Table 51. Cash flow.

Years	Ordinary income (€)	Extraordinary incomes (€)	Ordinary expenses (€)	Extraordinary expenses (€)	Investment payment (€)	Cash flow (€)	V.A.N	T.I.R.
0					322,323.27	-322,323.27	258,236.0528	15.65%
1	781,108.02	5,000	965,744		12,892.92	-192,528.90		
2	948,488.31	5,000	965,744		12,892.92	-25,148.61		
3	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
4	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
5	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
6	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
7	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
8	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
9	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
10	1,115,868.60	5,000	965,744	25,000.00	39,160.44	90,964.16		
11	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
12	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
13	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
14	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
15	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
16	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
17	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
18	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
19	1,115,868.60	5,000	965,744		39,160.44	115,964.16		
20	1,115,868.60	5,000	965,744		39,160.44	115,964.16		

As it can be seen in the *Table 51*, until the third year, the cash flow will be negative, in other words ,from the third year, the incomes will start to become bigger than the expenses.

5.1. Net Present Value (NPV)

The net present value (NPV) is a financial indicator used to determine the viability of a project. That is, if after measuring the cash flows with future income and expenses and discounting the initial investment there is some gain, the project is viable.

$$VAN = -I_0 + \sum_{t=1}^{n} \frac{Flujo\ Anual}{(1+Tasa)^t}$$

The initial investment (Io) to be able to carry out the project is 322,323.27 €, and the chosen update rate is 10%, the minimum profitability rate that is expected to be obtained. The project will be profitable if the value is equal to or greater than 0. The "n" is the number of time periods, in this case 20 years.

Applying the aforementioned formula, a value of the NPV of € 258,236.0528 is obtained. Therefore, it can be said that the project is viable.

5.2. Internal Rate of Return (IRT)

The internal rate of return (IRR) consists of the interest rate or relative profitability offered by an investment. It can also be defined as the discount rate that equals, at the initial moment, the future flow of leftovers with that of payments, generating a NPV equal to zero.

$$VAN = -I_0 + \sum_{t=1}^{n} \frac{F_t}{(1+TIR)^t} = -I_0 + \frac{F_1}{(1+TIR)} + \frac{F_2}{(1+TIR)^2} + \cdots + \frac{F_n}{(1+TIR)^n} = 0$$

A TIR value of 15.65 % is obtained.

So, as a conclusion, we can say that this project would result economically viable and feasible.

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PROCESS DESIGN OF A FRUIT INDUSTRY

DOCUMENT 3
DRAWINGS

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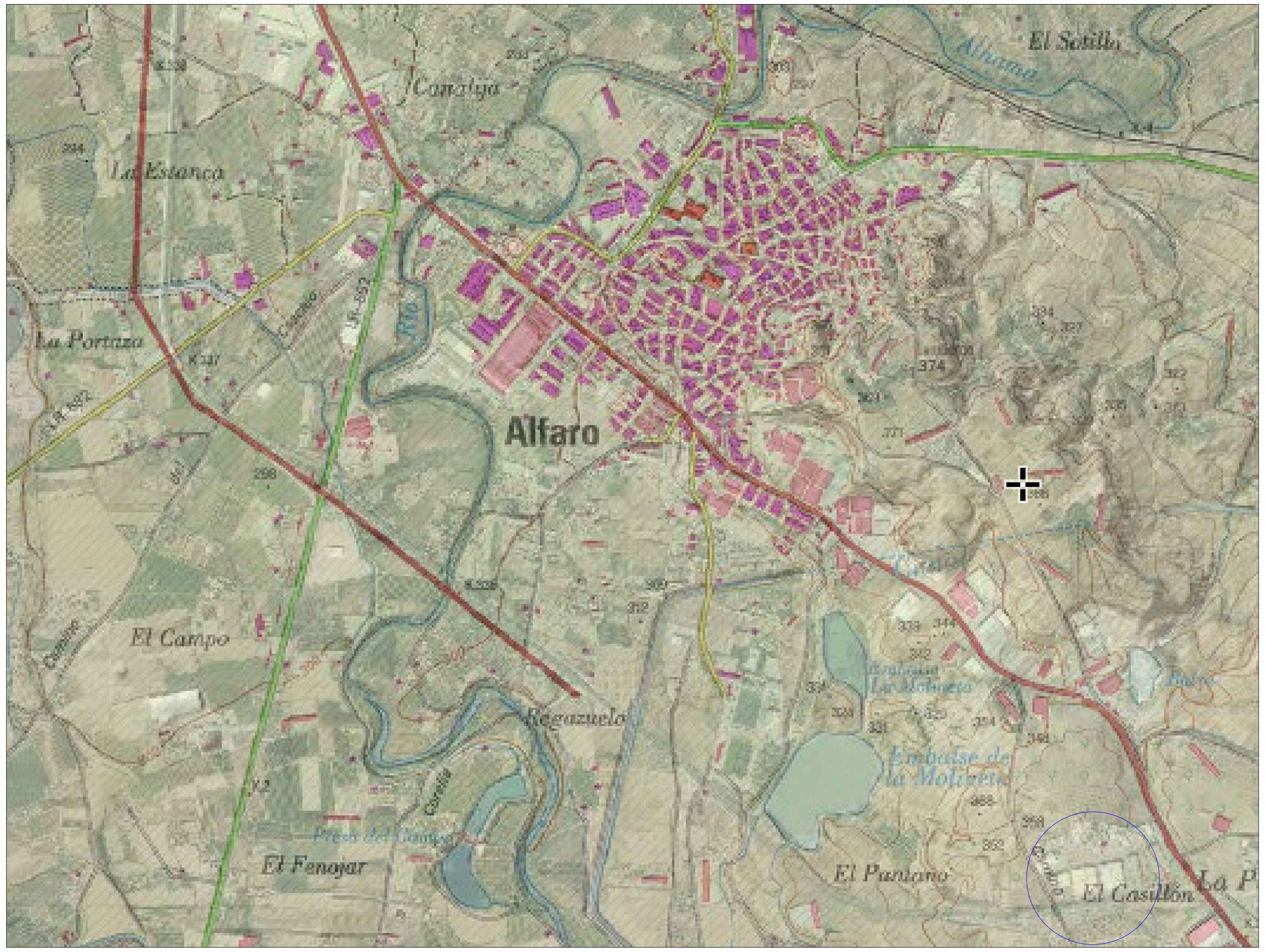
September 2018

Content



SITUACIÓN POLÍGONO INDUSTRIAL TAMBARRIA EN ALFARO
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SITUACIÓN PARCELA PROYECTO EN POLÍGONO INDUSTRIAL TAMBARRIA
ESCALA: 1:3000

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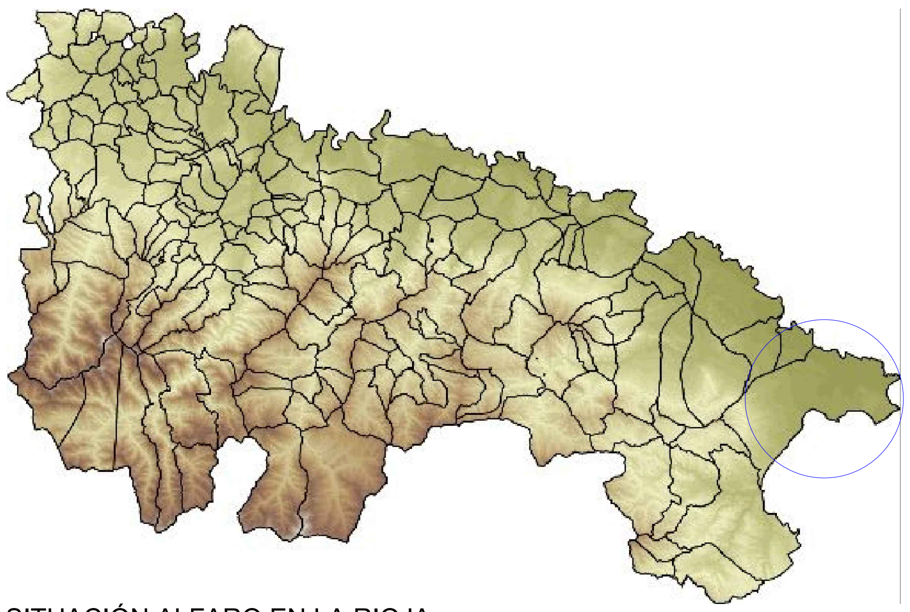

SITUACIÓN ALFARO EN LA RIOJA
ESCALA: S/E

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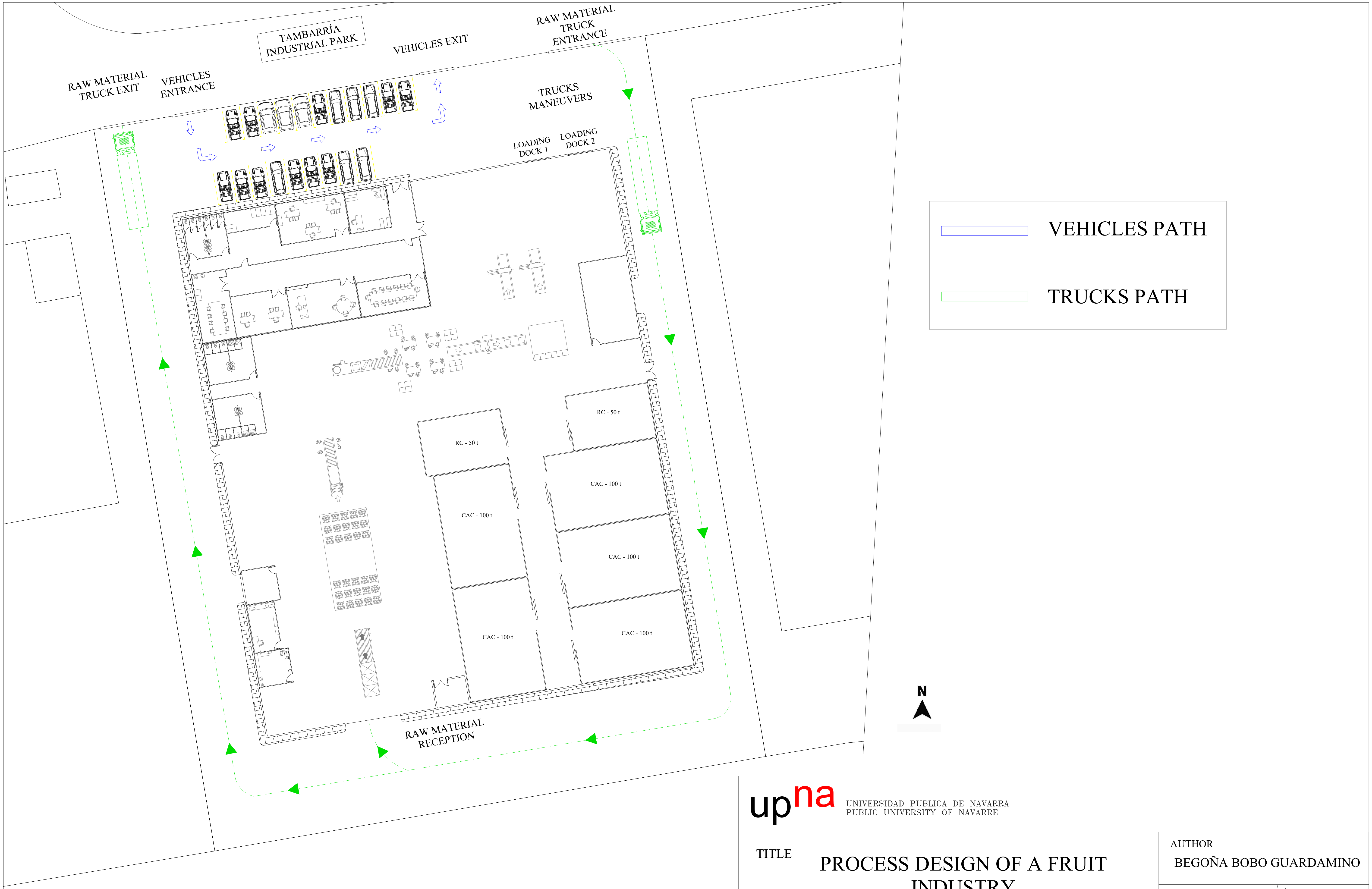
TITLE		AUTHOR		
PROCESS DESIGN OF A FRUIT INDUSTRY		BEGOÑA BOBO GUARDAMINO		
		SIGNATURE		
DRAWING: LOCATION AND SITING	A3	Nº DRAWING: 1/6	SCALE: 1:20000 1:3000	DATE: SEPTEMBER 2018



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TITLE	PROCESS DESIGN OF A FRUIT INDUSTRY		AUTHOR BEGOÑA BOBO GUARDAMINO		
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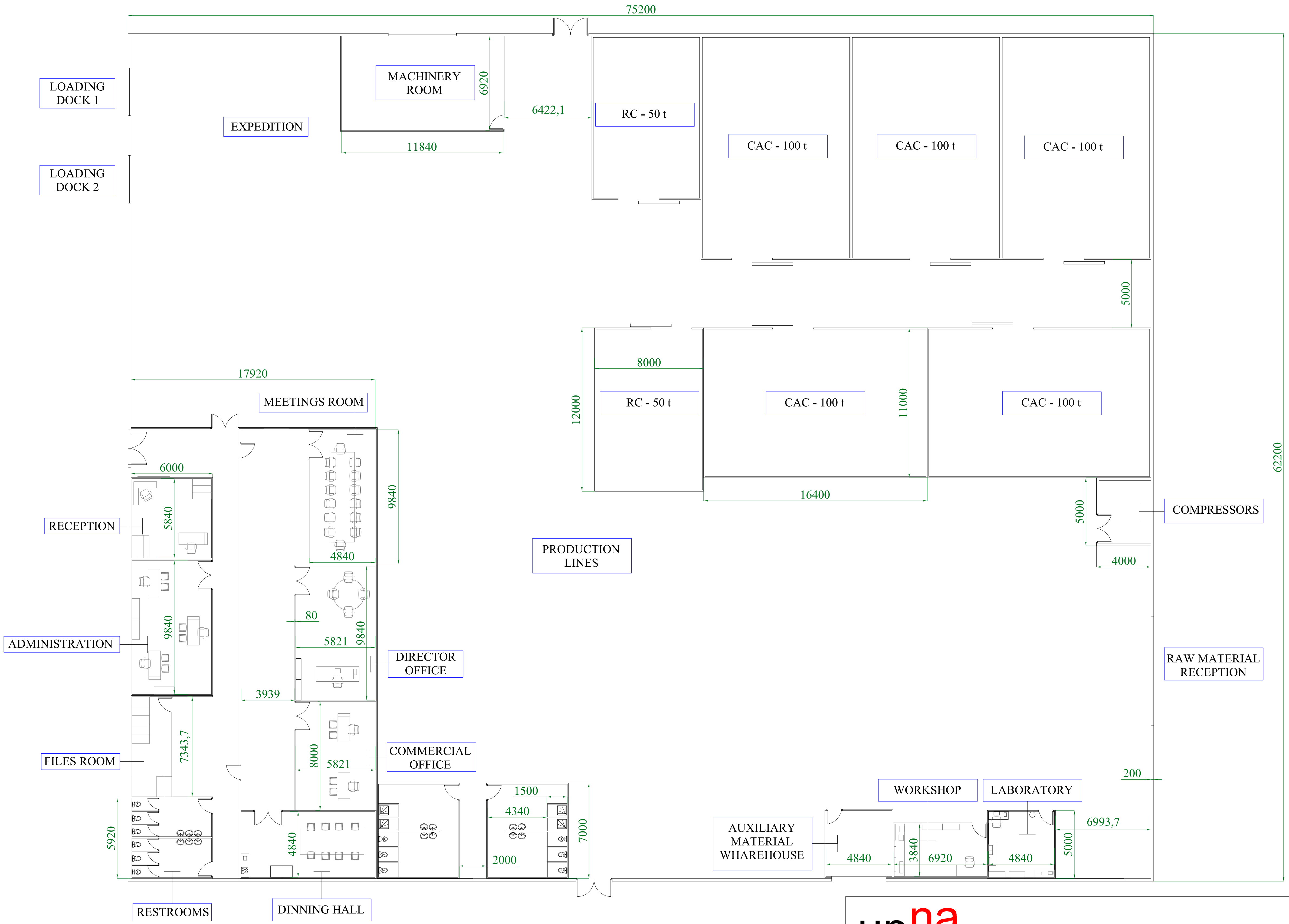

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TITLE	PROCESS DESIGN OF A FRUIT INDUSTRY		AUTHOR	BEGOÑA BOBO GUARDAMINO
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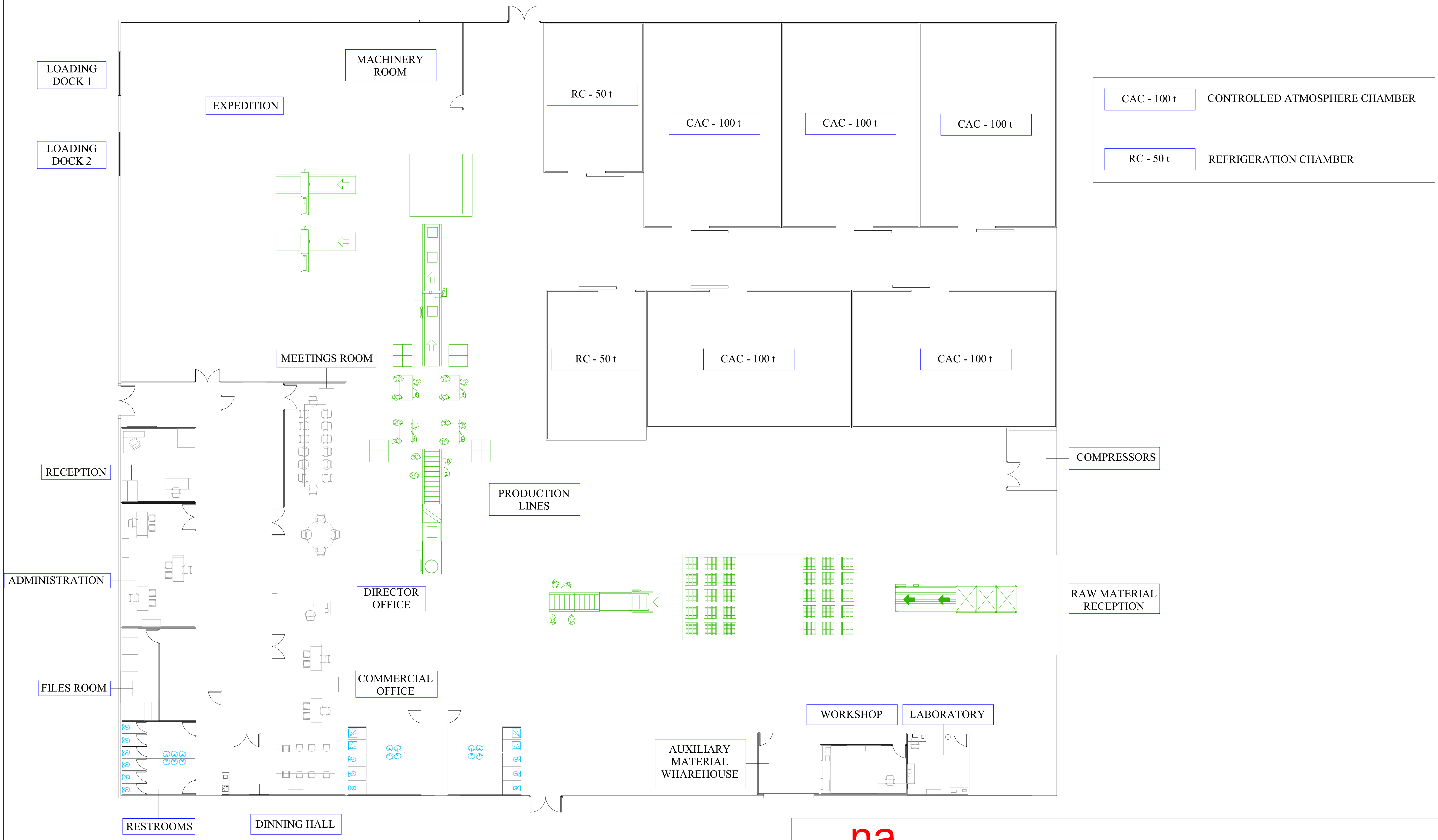

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TITLE	PROCESS DESIGN OF A FRUIT IDNUSTRY		AUTHOR BEGOÑA BOBO GUARDAMINO		
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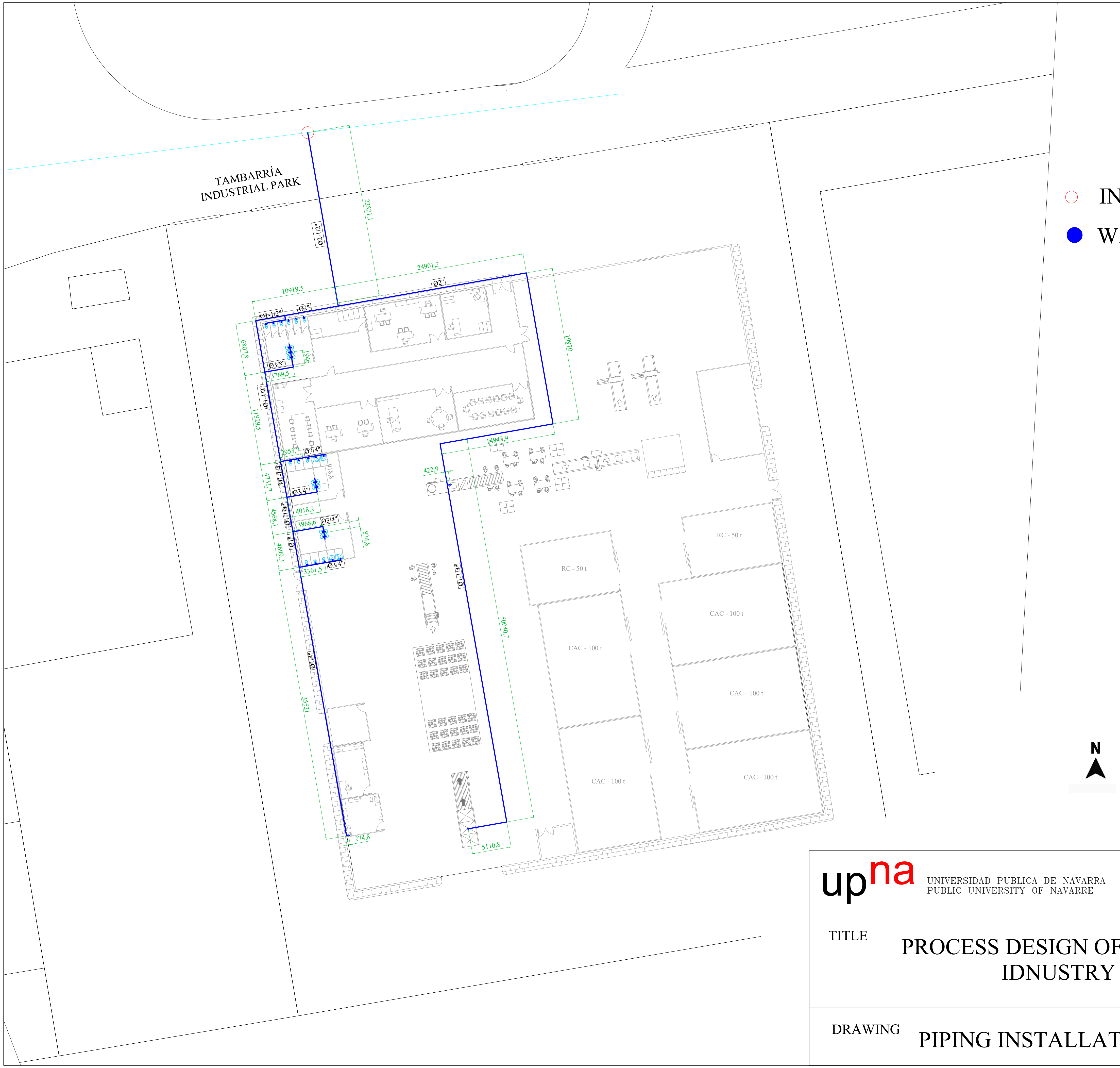
DRAWING	INDUSTRY LAYOUT	A3	Nº DRAWING 4/6	SCALE 1:300	DATE SEPTEMBER 2018



INDUSTRIAL PARK - WATER SUPPLY

WATER CONSUMERS

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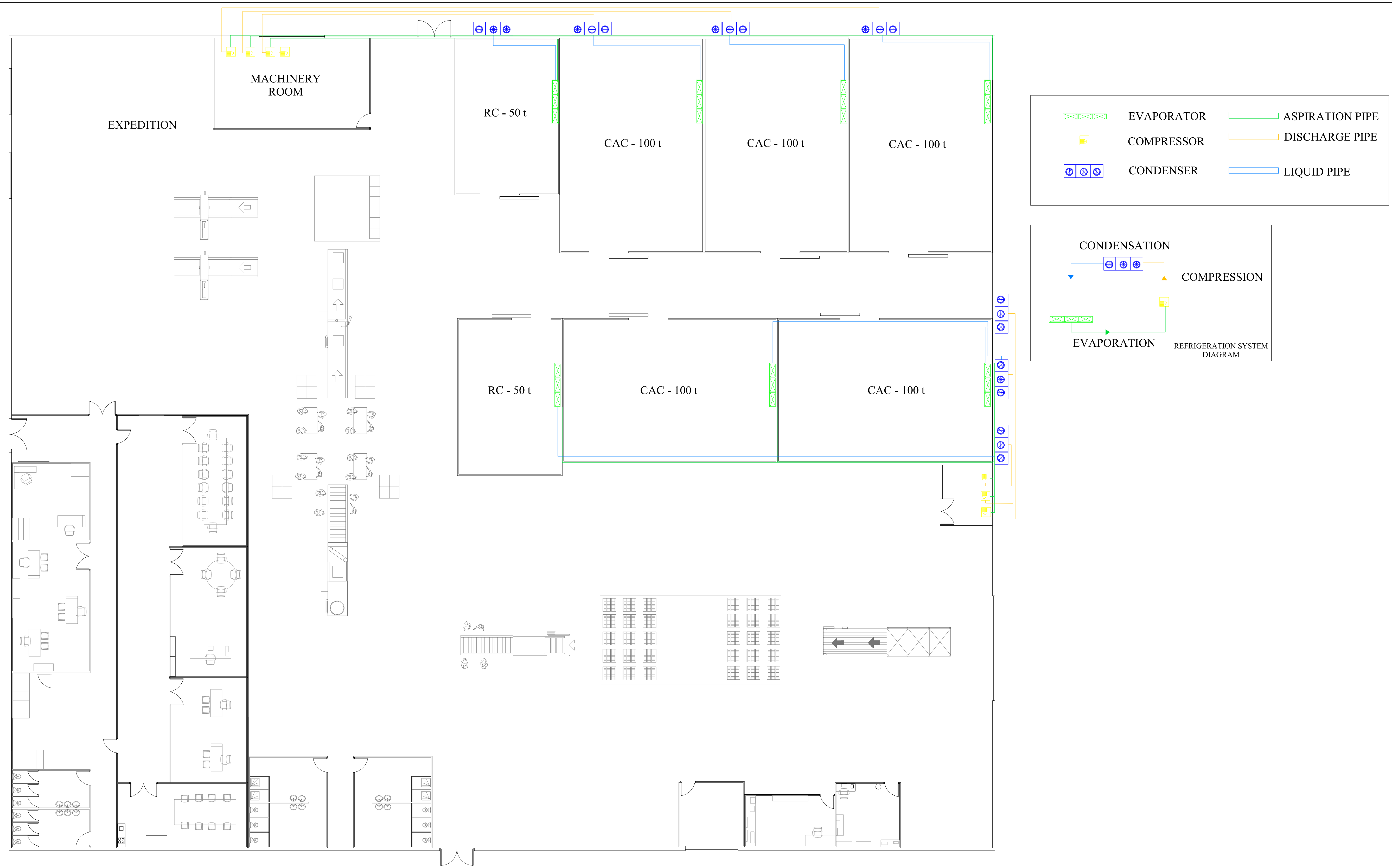
TITLE	PROCESS DESIGN OF A FRUIT IDNUSTRY	AUTHOR	BEGOÑA BOBO GUARDAMINO
		SIGNATURE	
DRAWING	PIPING INSTALLATION A3	Nº DRAWING 5/6	SCALE 1:500 — DATE SEPTEMBER 2018



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TITLE: PROCESS DESIGN OF A FRUIT IDNUSTRY		AUTHOR: BEGOÑA BOBO GUARDAMINO		
		SIGNATURE		
DRAWING: REFRIGERATION INSTALLATION	A3	Nº DRAWING: 6/6	SCALE: 1:300	DATE: SEPTEMBER 2018

PUBLIC UNIVERSITY OF NAVARRE

Agricultural, Food and Rural Environment Engineering

PROCESS DESIGN OF A FRUIT INDUSTRY

DOCUMENT 4
SPECIFICATIONS DOCUMENT

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Content

1. Introduction

This document describes all the conditions and recommendations that must be fulfilled rigorously in the company both in general and in particular, since part of the production is handled raw material of Protected Designation of Origin and it is strictly necessary to carry out its own specifications.

2. Industry requirements

2.1. Hygiene and installations maintenances

2.1.1. Manufacturing and environmental conditions

The food manufacturing and handling industries must always be suitable for the use to which they are intended, with the corresponding appropriate location, allowing broad and easy access, located at a correct distance, away from any cause of contamination or insalubrity and separated of the area dedicated to employees for their personal needs (dining room, changing rooms and bathrooms). Therefore, all the areas and spaces destined to the elaboration, handling, washing and fitting should be isolated from any other raw material or unrelated to their specific tasks.

Regarding the construction or repair, the suitable materials will be used to avoid poisoning or contamination. The floor will be waterproof, washable and fireproof, thus providing the precise drainage systems.

The walls and ceilings should be constructed with materials that allow their conservation in suitable cleaning conditions. In addition, drainage systems should have hydraulic closures when they discharge to contaminated water collectors and will be protected with grids or perforated plates of resistant material.

All companies must have a laboratory with the personnel and the necessary methods to perform the raw material and finished product controls in order to evaluate, maintain and correct the requirement with which they intend to work and commercialize, fulfilling with the corresponding regulations.

As for the testing of packaging, manufacturing lots and in general, as many tests require a guarantee of correct manufacturing, will be made according to the methods to be published by Resolución de la Dirección General competente del Ministerio de Sanidad y Seguridad Social.

In relation to the environmental conditions of industry, ventilation and lighting, both natural and artificial, will be those tha comply the regulations and, in any case, appropriate to local capacity and volume, according to the purpose for which it is intended. Running water will be available at all times, in sufficient quantity for cleaning and washing facilities and industrial elements, as well as for personal hygiene.

The temperatures, the circulation of the air and the humidity in the areas of the power station will be the necessary and convenient to avoid that the products suffer alterations or changes in their characteristics. These will be protected against the direct action of sunlight, when it is harmful to the products.

Any other technical, sanitary, hygienic and labor conditions established or established in their respective competencies by the Public Administration Bodies.

2.1.2. Cleaning and disinfection

All the premises must be kept constantly in neat condition, adequate to their corresponding function, which will be carried out by means of appropriate methods so as not to raise dust or produce alterations or contaminations during the cleaning process.

There will be adequate services and facilities in its construction or location to ensure the conservation of its products in the best conditions of hygiene and cleanliness and non-contamination by proximity or contact with any kind of waste or sewage, dirt and foreign matter, as well as by the presence of insects, rodents, birds and other animals.

A cleaning and disinfection plan should be implemented, based on a hazard analysis and associated risk assessment. These should be specified: objectives, personnel responsible for carrying out the cleaning, the used products and their instructions, the areas to be cleaned and / or disinfected, elements to be cleaned and their frequency, cleaning chemicals and its concentrations, the cleaning materials that will be used and the cleaning records.

The cleaning and disinfection tasks will only be carried out by qualified workers and this will have to receive training and maintenance courses to carry out the cleaning plans.

Cleaning products must be allowed and properly labeled. In addition, they will be authorized for the agri-food industry. The necessary resources must be available to carry out the cleaning tasks, that is, in case it is necessary to dismantle equipment or access the interior of these, which may be possible without problem.

Regarding the surfaces that are in contact with food, environmental processing and cleaning equipment in special care or high-risk areas, they should be defined as acceptable and unacceptable limits regarding the performance of cleaning.

Finally, the cleaning will be checked before the equipment returns to operation by means of visual, analytical and microbiological checks, which must be recorded.

2.1.3. Waste disposal

There must be a waste disposal procedure, respecting the legal requirements in force for the disposal of waste. Food waste and any other equipment will be removed as soon as possible from areas where food is handled.

In the cases of the elimination of classified waste, it is legally required to have a license, the elimination must be done by authorized companies, taking a record of said elimination.

External containers and waste collection facilities must be used in such a way that the risk can be reduced to a minimum. To do this, they must: be clearly identified, be easy to use and clean properly, stay in good condition and remain closed.

Each waste must be collected in its corresponding containers.

2.1.4. Strange waste

There must be procedures in place to avoid contamination by foreign materials, based on a hazard analysis and evaluation of associated risks. The contaminated products will be treated as non-conforming.

It must be excluded from the presence of glass and brittle material in all those areas in which a hazard analysis and associated risk assessment has identified a potential for product contamination (such as handling, storage, and packaging).

2.1.5. Surveillance and pest control

The site as a whole must have a preventive pest control program in place to minimize the risk of infestation. This requires covering the environment of the factory, the installation plan with points of application, the identification of the baits in the installation, the external and internal responsibilities, as well as the products and agents used and their instructions for use and safety.

There will be an external company in charge of the treatments that include the elimination of insects, the control of the flies and the crawling insects, as well as the placement of the different traps and their corresponding revision and control.

In addition, a sheet will be filled in by the members of the quality department, specifying the incidents that have arisen during the time. All documentation and records of pest controls should be kept and include, as a minimum, the plan of the entire site where all the devices for that control are represented and in which locations, the identification of each bait / device, the detailed report on the products used for pest control and information on treatments applied to pest control.

The mouse traps will be placed in the perimeter of the factory and also in entry points to the production area. On the other hand, pheromone traps should be placed in the proper places and be working permanently.

In the moments of harvest of receipt of raw material, the absence of pests will be verified.

2.1.6. Industrial requirements

2.1.7. Reception area

The area of reception and discharge of raw material will be specially protected so that there is no contamination in case of adverse environmental conditions (rain, vehicle gases, etc.) and reduce the air currents from outside to inside to the minimum possible.

The area must be spacious enough to receive the raw material and allow manoeuvring of trucks and wheelbarrows, as well as work progress.

2.1.8. Storing chambers

The storage chambers that are of Controlled Atmosphere and Refrigeration type. In addition, there is a warehouse for auxiliary materials such as boxes, palots, wheelbarrows, etc.

The fruit can be kept in a normal refrigeration chamber for a maximum of three months, while in controlled atmosphere it can be kept for up to eight months.

Thorough cleaning of the chambers is strictly necessary between the end of the storage of the stone fruit and before the pip fruit enters to avoid cross contamination.

Once the controlled atmosphere chamber has been completed, it will be completely sealed and it is forbidden to re-open until the product needs to be commercialized, or a maximum of three times. For this, a week of conditioning of the parameters of oxygen, carbon dioxide and relative humidity will be required in order to enter. It is forbidden to enter without the authorization of the person in charge of them.

The storage arrangement will respect minimum safety distances between walls and floors, allowing the cleaning and disinfection tasks to be carried out correctly.

It is also necessary to maintain a record of the control of temperatures, humidity and gas levels periodically to verify that there are no variations in these in order to avoid physical-chemical alterations in the fruit. In general, the following common conditions will be fulfilled:

- Distribution of the fruit in stacks of palots that keep the proper distance between them, and between walls, floors and ceilings.
- Use of space on the surface and height and storage system suitable for movement.
- Periodic recognition and inspection of the conditions of the area and the state of the food (in refrigeration at least).

2.1.9. Manipulation and labelling areas

The production lines will be distributed in such a way that crossings are avoided, that is, in the most linear way possible.

The surfaces of equipment and materials intended to be in contact with food should be easy to clean and disinfect. The materials of the same must be smooth, washable, resistant to corrosion and non-toxic. There will be a suitable area for the storage of equipment and work tools.

The materials of the boxes, palots, machines and conduction pipes destined to be in contact with the product will be made of materials that do not alter the characteristics of their content or theirs. In the same way, they must be unalterable against the products used for cleaning.

Water that is tolerable from the physical-chemical and microbiological point of view must be available at all times, in order to be able to use it in sufficient quantity both for fruit washing and disinfection mixed with fungicide products in the drencher, as well as for the use Plant staff (at any temperature).

The labelling and the methods of carrying it out should not be of such a nature as to mislead the tester, especially on the characteristics of the food product and in particular, on its nature, identity, qualities, quantity, duration, origin or provenance and method of obtaining it. or attribute to the food product effects or properties that it does not have. To do this, follow "General rule of labelling 1334/1999 of July 31.

Mandatory information of box labelling

The information that must appear compulsory in the labelling of food products is:

1. Designation of sale of the product. The denomination of sale of a food product will be that provided for that product in the provisions of the European Community that are applicable to it. In the absence of provisions of the European Community, the name of sale will be the name provided for by the laws, regulations or administrative provisions that are applicable in Spain.
   For this reason, the denomination will be constituted by the name used in Spain or by a description of the product and its use. If necessary, the purchaser will be informed of the nature of the product in order to distinguish it from other similar products with which it could be confused.

1. Lot. The indication of the lots will be made in accordance with the provisions of "Real Decreto 1808/1991 del 13 de diciembre, por el que se regulan las menciones o marcas que permiten identificar el lote al que pertenece un producto alimenticio."

2. Place of origin or provenance. Regarding the products coming from the European Union, the place of origin or provenance should be indicated only in the cases in which its omission could mislead the consumer about the origin or real origin of the food product.

2.2. Workers

2.2.1. General hygiene

In the event that a worker has any health reason or disability that could affect the healthiness of the product or their own safety, you will have the obligation to inform your manager. Thus, it may be placed in a position that entails a lower risk for the contamination of the product.

It is forbidden to smoke inside the factory, that is, inside the entire enclosure limited by the fence of the plot, whether or not it is outdoors.

Before the start of the day, the hands should be clean and the gloves should also be used. To do this, wash with soap and rinse well in the sink as many times as you start and return to work.

Sneezing or coughing on food or work surfaces is prohibited. It is also mandatory to wear a head cap and cover beards if necessary.

You can not deposit work tools or work clothes on machines, baseboards or anywhere that may be a source of product contamination.

2.2.2. Changing romos hygiene

In the bathrooms, in the same way as in the canteen, the workers should detach themselves from the outer part with which they work and wash their hands and gloves after using the toilet.

At the box office, each user will have their own for personal use and this should be taken care of, without being painted or forced. Clothing should be well ordered by differentiating work clothes with street clothes.

2.2.3. Canteen hygiene

Before entering the canteen, workers must remove the outermost garment they wear in the production area (jacket, jacket, cap) and it must be kept in the locker.

All containers, wrappers or food waste must be deposited in the corresponding bins and nothing must be left on the table, so that the dining room is kept clean and tidy.

The doors must be closed and the lights turned off in case it is the last one to leave.

It is forbidden to eat and drink, as well as to carry any kind of jewel that could come off within the work zones.

2.2.4. Clothing

All those people who are going to be in contact with food (workers, visitors, subcontractors ...) must wear adequate protective clothing provided by the company. It can never be used outside the company.

You must take the work clothes and the appropriate individual protective equipment according to the position.

There will be a vending machine to extract work complements such as gloves, earplugs for noise, etc., available through the work card.

Clothing that is in poor condition will be replaced by a new one. All work clothes must be washed efficiently and frequently either by the company, by contracting the service or by the worker.

2.2.5. Training

All the personnel of the company that is in contact with the manufacturing process will receive initial training, which will include the standards of behaviour of the company, the quality and prevention policy, the general risk sheet of the company, the data security card for each position held and the functions for each position.

The industry visit is carried out in order that the workers can locate the risks in situ and so that they understand the production process.

Workers should be informed periodically about cleanliness and hygiene and food safety.

3. Raw material requirements

3.1. D.O pear “Rincon del soto” requirements

The pears protected by the Designation of Origin "Peras de Rincón de Soto" are fruits of the species *Pyrus Communis* L., coming from the varieties *Blanquilla* and *Conference*, of the categories "Extra" and "I", destined to be delivered to the consumer as a table pear in physical condition. Thanks to its numerous differential characteristics, this pear appears larger, elongated, sweeter and its skin has a more greenish colour, which allows it to achieve greater value in the market.

Parameters at collection time:

The parameters that the pear must gather at the time of its collection must be the following:

- Hardness: Value between 5.44 - 6.12 kg / cm2, values higher than the usual intervals that oscillate approximately between 5.2 - 5.67 kg / cm2
- Soluble solids: Content in soluble solids of 13-19 ºBrix. Values above the usual intervals range between 12.5 - 13.5 ºBrix.
- Minimum calibre: The calibre determined by the maximum diameter of the equatorial section, will be 58 mm for Blanquilla and 60 mm for Conference.
- Organoleptic characteristics: Woody consistency with a high flavour, intense and balanced in terms of acidity and sweetness. They have to present high juiciness and a high content of sugars, a component that greatly conditions the taste quality of the fruit.

- They must belong to the category "Extra" and "I", complying with what is specified in the "Reglamento (CE) Nº 1619/2001 de la Comisión de 6 de agosto de 2001 por el que se establecen las normas de comercialización de las manzanas y peras y se modifica el Reglamento (CEE) Nº 920/98, de 11 de abril de 1999, por el que se establecen las normas de calidad para las peras, o en cualquier otra legislación aplicable".

3.1.1. Elements that prove that the product is native to the area

- Origin of the raw materials: The Rincón de Soto pears will come from the plantations and horticultural centres located in the protected geographical area, they are registered in the corresponding Registry when they comply with the specific conditions in the Regulation of the Denomination and in the specifications.
- In addition to the self-control carried out by the " Asociación para la Promoción de la Pera de Rincón de Soto", all natural or legal persons holding property registered in the Registries (facilities and / or producers) will be subject to control by a "Entidad Externa de Control y Certificación Autorizada", contracted by the Association itself, in order to impartially verify that the Pears that hold the Denomination, meet the requirements of the Regulations and these Terms and Conditions, complying with the UNE EN 45.011 standard.
- The own Hortofrutícola fruit industry must request its registration to the Association for the Promotion of Pears of Rincón de Soto. Of all the municipalities of La Rioja, only Alfaro, Aldeanueva de Ebro, Calahorra and Rincón de Soto, located in the region of Rioja Baja, delimit the area of production, conservation, packaging and packaging, hosted by the Protected Designation of Origin.

3.1.2. Production

- The plots must be located within the protected geographical area, and produce or condition pears of the Blanquilla and / or Conference varieties.
- Harvesting must be carried out at the appropriate time, thus ensuring the development and degree of maturity that allows the fruits to bear their subsequent handling and transport, responding in the place of destination to the commercial requirements established for them.
- The horticultural centre itself must perform all the manipulation of the fruit manually with great care, avoiding at all times the possible deterioration of the fruit, eliminating all pears defective or that do not meet the specified quality parameters.
- Both the exploitations and the horticultural centres registered in the Association Registry for the promotion of the Rincón de Soto Pear, will have a "Book of Claims", in which the claims made by the clients will be recorded, the way to solve them and the estimated time for its resolution.
-

3.1.3. Product traceability

The traceability of the product will be guaranteed by its identification in each of the stages of production and commercialization.

To achieve this, the technicians of the " Asociación para la Promoción de la Pera de Rincón de Soto ", in addition to carrying out the control of the productions in the field and determining the exact date of collection, carry out their own self-control in the area of conditioning, ensuring so that the control in the whole chain, obtaining reliable data at the time of granting the qualification and thus assure the traceability of the covered products.

In the same way, when the certified product leaves the fruit industry for his commercialization later, it will be elaborated the corresponding delivery note and will control the labels and certificates of expedition.

The labels that will accompany the "Rincón de Soto" pears will be numbered labels, in such a way that it will be controlled that the label expense that is made in each establishment, corresponds with the quantity of certified product issued, thus avoiding that they can be labelled with the logo of the denomination, pears not covered by the Protected Designation of Origin.

Regarding the distribution companies of the finished product, they must have a list of the sale products to which the certified product is distributed. The suppliers must establish the minimum conditions to be met by establishments that sell the certified product to the consumer.

3.1.4. Controls and analysis

The fruits will be harvested at the right moment of maturity, neither too green nor too mature. For the determination of the date, a field follow-up of the plantations to an analysis of soluble solids and the hardness of the fruit will have been previously carried out.

To measure the hardness of the pulp, 10-12 fruits are taken, at the height of the head, in two opposite situations of the external part of 5 different trees representative of the plantation. The equipment measures the hardness of the pulp in kg / cm2. It is performed the average of the two values obtained and the hardness of that fruit is calculated. Once it is obtained the readings of the whole sample, the average value is calculated and purchased with the recommended value of 5.44 - 6.12 kg / cm2.

To determine the soluble solids, due to the great importance of the position of the fruit, the sample must be taken from an intermediate zone between the trunk and the periphery of the cup. All samples will be taken in the same trees. Obtained the results are compared with the recommended value of 13-19 ºBrix.

Regarding the samples taken to analyse those parameters that the Control Bodies, both internal and external, require, only laboratories certified by the UNE EN-45.001 will be analysed.

3.1.5. Raw material reception

- Systems will be available to guarantee the separate discharge of the pears covered by the denomination of the rest, thus avoiding the mixing of qualities during their subsequent handling.

- A spacious, fresh and well-ventilated place will be available so that the newly arrived pear progressively lowered its temperature.

- The horticultural centre is the one who will give the farmers the wood palots previously disinfected and coated, where they will have to deposit the pears once collected.

- The filled palots, once deposited in the warehouse, will be marked with the name of the farmer, the date and the farm number. These data will remain in the palots during the entire conservation process until packaging.

- Then, a first manual selection will be carried out where the defective pears will be eliminated or those that do not meet the specified quality parameters.

- All operations will be carried out manually, with great care and delicacy, avoiding at all times the deterioration of the product.

3.1.6. Conservation in chambers

- The production destined for conservation may be sold later in the season.
- Before each season, all the chambers will be disinfected conveniently, together with wooden palots, with low toxicology products for humans and terrestrial and aquatic fauna.
- The conservation chambers must be spacious, clean, watertight chambers and are sockets so that the product is not in contact with the walls.
- When the chambers are completely filled, you have to leave a corridor with sufficient width for a correct air circulation.
- Before closing the chamber, an authorized disinfectant will definitely be added to fight against the appearance of Botrytis, Penicillium, Rhizopus and Gleosporum.
- The average temperature of conservation and relative humidity will be adequate to maintain the initial characteristics of the product during the entire conservation process.
- The controlled atmosphere chambers should never be opened more than three times and must have the most appropriate temperature, humidity, oxygen and carbon dioxide values at all times.
- Before entering the product in the chambers they will shower with chemical products as soon as they arrive at the centre, proceeding to their decontamination, avoiding possible losses.

3.2. Peach requirements with integtrated production

According to the "Real Decreto 1201/2002, por el que se regula la producción integrada de productos agrícolas", the integrated production it is defined as the agricultural system for obtaining plants that makes the most of natural resources and production mechanisms and ensures sustainable agriculture in the long term, introducing biological and chemical control methods, and other techniques that make the demands of society, the protection of the environment and agricultural productivity, as well as the operations carried out for the handling, packaging, transformation and labelling of plant products under the system.

A series of general rules of integrated production for the mandatory transformation industries are established:

- Transport of the vegetable product and containers: The receptacles and containers of the vehicles used to transport the vegetable products must be clean and in proper conditions of maintenance.

- Reception of the plant product and facilities: Record the items you enter and visual inspection of the items of plant products at the reception, establishing a system to check the quality of incoming products. There will be a record of incidents in case of non-compliance. Sampling of the same.
- Conditioning of the vegetable product, weighing, sampling and quality control: The techniques and storage facilities will maintain the quality and organoleptic characteristics

of the vegetable product. The items that are received will have a quality control, maintaining traceability through records and representative sampling procedures.

- Storage of the plant product and facilities: The waste evaluation will be carried out in exclusive containers for this purpose, and a cleaning plan must be established for this purpose
- Process of transformation and elaboration of the vegetal product: The transformation and elaboration facilities will tend to the maintenance of the quality and organoleptic characteristics of the product. All the vegetable products that are used in the elaboration of the transformed product must have fulfilled the conditions of the “Real Decreto 1201/2002, de 20 de noviembre así como los tratamientos que se realicen y los coadyuvantes que se empleen, deberán estar autorizados e incluidos en las normas técnica específicas correspondientes”.
- Storage, packaging and transportation of processed products: conservation treatments must be authorized. Methods that have the least possible toxicity and preferably physical methods or with natural products, rather than synthetic ones, will be used.
- Characteristics of the materials: All the materials used in the facilities must be suitable for food use, adapting to the different specifications and needs according to the Spanish Food Code and current regulations. All those specified in said code (zinc, iron, ceramic products with coverings, etc.) and current regulations will be prohibited.
- Equipment: The companies or transformation centres must establish and carry out the maintenance of the equipment to ensure its correct operation and take the necessary measures to avoid the contact of the products with chemical substances or foreign objects (protectors, trays, etc.) The working surfaces will be kept in good condition and will be renewed when necessary, and the work tools will be in good condition and will be safe.

3.2.1. Identification and traceability of the origin of plant products and by-products or processed products

At each reception and / or handling centre there must be an entry check, which includes the product, quantity, parcel of origin, crop unit with homogeneous treatment and date of entry, signed by the person making the delivery.

It will be prohibited to market products covered by this standard from those that do not comply with the provisions of “Real Decreto 1201/2002, de 20 de noviembre, en toda su producción”.

4. Control of industrial operations

All the horticultural farms or plants registered in the Control Plan will have the obligation to allow the inspectors to enter their establishments to perform a few audits, verifications and sampling as deemed necessary.

4.1. Audits

The activities of the "Audit Plan" of the External Control Entity and Authorized Certification, will reach:

1- Documentary audit of the system

2- Inspections of productive areas, weighing areas and horticultural centres, making field visits in order to verify the compliance and degree of implementation of the requirements of the denomination of origin and integrated production.
3- Sampling The inspectors will proceed to the taking of samples of the products under control for their later analysis in the laboratory for those parameters that require it, and to the sampling and / or measurement in situ, for those other parameters that are easily measurable. Sampling is done in such a way as to allow the performance of contradictory analyzes for the resolution of conflicts and disagreements.

4- Issuance of the report, based on the conclusions drawn from the audit of the documentary system, the inspections and the results of the analysis and measurements. Mention will be made of the non-conformities in the production against the requirements of the specifications that will be categorized under the following types:

- Non-conformities Very serious

- Serious non-conformities

- Mild non-conformities.

If the decision is favourable, the Product Certification will be granted, otherwise, new corrective actions will be requested which, once submitted, will be evaluated again by the Association.

4.2. Industrial inspections

Pre-planned factory inspections will be carried out on a regular basis. The frequency of inspections of each area and each of the activities must be based on a hazard analysis and associated risk assessment as well as on the history of previous cases and experiences.

5. HACCP

The basis of the company's food safety control system will be through the Hazard Analysis and Critical Control Point (HACCP) system, based on the principles of the Food Codex. All legal requirements related to production must be taken into consideration.

The HACCP system must be implemented in all areas of production and handling of the fruit and vegetable center. This should cover all the raw materials, products, and processes from the reception to the shipment, including the packaging of the product.

The HACCP system has to be checked and the necessary changes will be made to it when it is convenient due to any change of any kind. The critical points that arise during the production process must be determined and evaluated, analysing their severity and frequency, that is, serious or mild and high, medium or low frequency.

Once the analysis of each stage of the process has been carried out, the following points are defined for each:

- Critical points CCP
- Control measures
- Critical limits
- Surveillance
- Corrective actions

5.1. HACCP analysis

1- Product description: A complete description of the product must be available, including all the information applicable to product safety: composition, physical, chemical, organoleptic and microbiological parameters, legal requirements for food safety of the product, treatment methods, packaging, commercial life of the product, storage conditions, methods of transport and distribution.

2- Determination of the intended use of the product.

3- Elaboration of a flow diagram where the critical control points are clearly assigned with their corresponding number in each stage.

4- Performance of risk analysis in each stage: All physical, chemical and microbiological hazards are analysed.

5- Determination of the critical points: the determination of the critical control points is made through the application of a decision tree.

6- The critical limits are established. This means that, for each critical control point, appropriate critical limits will be defined and validated to clearly identify the moment in which a process is out of control.

7- Establishment of a surveillance system for each CCP: specific monitoring procedures will be established for each CCP in order to detect any possible loss of control of the CCP.

8- Corrective actions are established: When monitoring indicates that a CCP is out of control, appropriate corrective actions should be undertaken and documented.

Location: Alfaro, La Rioja

Date: September 2018

Begoña Bobo Guardamino

PUBLIC UNIVERSITY OF NAVARRE

Agricultural, Food and Rural Environment Engineering

PROCESS DESIGN OF A FRUIT INDUSTRY

DOCUMENT 5
MEASUREMENTS AND BUDGET

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Content

1. Measurements

1.1. Chapter 1. Production line

Code	Concept	Description	Quantity	Unit of measurement
01.01	Drencher	Equipment used for post-harvest treatment. It consists of a cabin with chains through which the crate is moved and where the treatment is applied through a shower system, being able to distribute the mixture of the phytosanitary products in an appropriate way. Capacity	1	Unit
01.02	Crate tipper	A machine that manages the receipt of stacks of full crates and automatically tips them, extracting the product for it to be processed and, at the same time, removing the empty crates.	1	Unit
01.03	Washer and dryer	Machine able to wash and dry the fruit in a continuous manner. Able to process 10 to 15 tons per hour.	1	Unit
01.04	Automatic strapping machine	Machine especially suited for strapping voluminous packs and pallets. Automatic roller conveyor and sealing head movable.	2	Unit
01.05	Selection and transporting	Convenyor able to transport the fruit and where the fruit is selected manually. Dimensions: 0.9x2.5 m	3	Unit
01.06	Labelling machine	Automatic labelling machine	1	Unit

1.2. Chapter 2. Refrigeration installation

Code	Concept	Description	Quantity	Unit of measurement
02.01	Compressor	KM15103 (15 kW)	1	Unit
02.02	Compressor	SLDF 40-3 (30 kW)	1	Unit
02.03	Condenser	CC122-63 (73.70 kW)	1	Unit
02.04	Condenser	CRH802HP3P (110.1 kW)	1	Unit
02.05	Evaporator	GRX-2950 (59 kW)	1	Unit
02.06	Evaporator	GRM-4600 (78 kW)	1	Unit
02.07	Accessories	miscellanous expenses		Unit

1.3. Chapter 3. Piping installation

Code	Concept	Description	Quantity	Unit of measurement
03.01	Pipe	Stainless steel 1/4"	35.5	metres
03.02	Pipe	Stainless steel 3/4"	15.4	metres
03.03	Pipe	Stainless steel 1"	5.12	metres
03.04	Pipe	Stainless steel 1 1/4"	72.33	metres
03.05	Pipe	Stainless steel 1 1/2"	26.25	metres
03.06	Pipe	Stainless steel 3/8"	1.95	metres
03.07	Pipe	Stainless steel 2"	66.89	metres
03.08	Pipe	Stainless steel 2 1/2"	22.95	metres
03.09	Accesory	Elbow 90º 1/4" Stainless steel.	2	Unit
03.10	Accesory	Elbow 90º 3/4" Stainless steel.	6	Unit
03.11	Accesory	Elbow 90º 1" Stainless steel.	1	Unit
03.12	Accesory	Elbow 90º 1 1/4" Stainless steel.	4	Unit
03.13	Accesory	Elbow 90º 1 1/2" Stainless steel.	3	Unit
03.14	Accesory	Elbow 90º 3/8" Stainless steel.	1	Unit
03.15	Accesory	Elbow 90º 2" Stainless steel.	3	Unit
03.16	Accesory	T 1" Stainless steel.	1	Unit
03.17	Accesory	T 1 1/4" Stainless steel.	2	Unit
03.18	Accesory	T 1 1/2" Stainless steel.	1	Unit
03.19	Accesory	T 2" Stainless steel.	2	Unit
03.20	Accesory	T 2 1/2" Stainless steel.	1	Unit

2. Budget

2.1. Chapter 1. Production line

Code	Concept	Description	Quantity	Unit	Price/unit €	Total price €
01.01	Drencher	Equipment used for post-harvest treatment. It consists of a cabin with chains through which the crate is moved and where the treatment is applied through a shower system, being able to distribute the mixture of the phytosanitary products in an appropriate way. Capacity	1	Unit	45000	45000
01.02	Crate tipper	A machine that manages the receipt of stacks of full crates and automatically tips them, extracting the product for it to be processed and, at the same time, removing the empty crates.	1	Unit	8000	8000
01.03	Washer and dryer	Machine able to wash and dry the fruit in a continuous manner. Able to process 10 to 15 tons per hour.	1	Unit	55000	55000
01.04	Automatic strapping machine	Machine especially suited for strapping voluminous packs and pallets. Automatic roller conveyor and sealing head movable.	2	Unit	10000	20000
01.05	Selection and transporting conveyor	Convenyor able to transport the fruit and where the fruit is selected manually. Dimensions: 0.9x2.5 m	3	Unit	9000	27000
01.06	Labelling	Automatic labelling machine	1	Unit	4100	4100
					Total	159100

2.2. Chapter 2. Refrigeration installation

Code	Concept	Description	Quantity	Unit	Price/unit €	Total price €
02.01	Compressor	KM15103 (15 kW)	5	Unit	4049.10	20245.5
02.02	Compressor	SLDF 40-3 (30 kW)	2	Unit	10219.9	20439.8
02.03	Condenser	CC122-63 (73.70 kW)	5	Unit	2210.60	11053
02.04	Condenser	CRH802HP3P (110.1 kW)	2	Unit	4110.25	8220.5
02.05	Evaporator	GRX-2950 (59 kW)	5	Unit	8750	43750
02.06	Evaporator	GRM-4600 (78 kW)	2	Unit	11230	22460
02.07	Accessories	miscellanous expenses		Unit	6308.44	
					Total	132477.24

2.3. Chapter 3. Piping installation

Code	Concept	Description	Quantity	Unit	Price/unit €	Total price €
03.01	Pipe	Stainless steel 1/4"	35.5	m	2.05	72.775
03.02	Pipe	Stainless steel 3/4"	15.4	m	2.15	33.11
03.03	Pipe	Stainless steel 1"	5.12	m	2.76	14.1312
03.04	Pipe	Stainless steel 1 1/4"	72.33	m	4.86	351.5238
03.05	Pipe	Stainless steel 1 1/2"	26.25	m	6.9	181.125
03.06	Pipe	Stainless steel 3/8"	1.95	m	2.45	4.7775
03.07	Pipe	Stainless steel 2"	66.89	m	9.15	612.0435
03.08	Pipe	Stainless steel 2 1/2"	22.95	m	10.55	242.1225
03.09	Accesory	Elbow 90º 1/4" Stainless steel.	2	Unit	3.29	6.58
03.10	Accesory	Elbow 90º 3/4" Stainless steel.	6	Unit	4.28	25.68
03.11	Accesory	Elbow 90º 1" Stainless steel.	1	Unit	6.63	6.63
03.12	Accesory	Elbow 90º 1 1/4" Stainless steel.	4	Unit	6.75	27
03.13	Accesory	Elbow 90º 1 1/2" Stainless steel.	3	Unit	6.99	20.97
03.14	Accesory	Elbow 90º 3/8" Stainless steel.	1	Unit	4.15	4.15
03.15	Accesory	Elbow 90º 2" Stainless steel.	3	Unit	7.35	22.05
03.16	Accesory	T 1" Stainless steel.	1	Unit	11.4	11.4
03.17	Accesory	T 1 1/4" Stainless steel.	2	Unit	11.3	22.6
03.18	Accesory	T 1 1/2" Stainless steel.	1	Unit	11.66	11.66
03.19	Accesory	T 2" Stainless steel.	2	Unit	11.85	23.7
03.20	Accesory	T 2 1/2" Stainless steel.	1	Unit	12	12
					Total	1706.0285

2.4. Summary

SUMMARY (€)		
Production line		159100
Installations	Refrigeration	132477.24
	Piping	1706.0285
Direct execution budget		293283.269
Contractual execution budget	Total	24000
	General expenses (13%)	3120
	Industrial benefit (6%)	1440
	Total + I.V.A	29040

Direct execution budget	293283.27
Contractual execution budget	29040
TOTAL GENERAL BUDGET	**322323.27**

THE TOTAL BUDGET IS THREE HUNDRED TWENTY-TWO THOUSAND AND THREE HUNDRED TWENTY THREE WITH TWENTY SEVEN CENTS.

Location: Alfaro, La Rioja

Date: September 2018

Begoña Bobo Guardamino