FOOD SCIENCE PRINCIPLES
serie I

Ahmed El Salous
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compÁs
Grupo de capacitación e investigación pedagógica

Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura

Cátedra UNESCO « Paz, Solidaridad y Diálogo Intercultural », Universitat Abat Oliba CEU

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Indice

CHAPTER I

FOOD DETERIORATION FACTORS AND CONTROL

Consumers do not accept fruits and vegetables that have been affected in taste, color, aroma, nutritional value that are changes caused by various chemical, physical and biological factors [De Polio, 1993]. Between them we have:

ENZYMATIC CHANGES

According to Valdés (2008) the enzymatic control factors are: temperature, water activity, pH, chemical inhibitors of the enzymatic action, alteration of substrates, alteration of the product and the control of pre-processing; states that the enzymes that are endogenous to the plant tissue sometimes have effects such as: post-harvest aging, decaying of fruits and vegetables; oxidation of phenolic substances in plant tissue by the action of phenolase (causing browning); sugar-starch conversion in tissue due to amylase; and, the demethylation of postharvest peptic substances that softens the tissues during ripening and strengthens while processing.

CHEMICAL CHANGES

Lipid oxidation: its speed and reaction can be reduced by controlling light, oxygen concentration, high temperature, the presence of catalysts such as Fe and Cu, and the action of water.

Maillard reaction or non-enzymatic browning: It is one of the main causes of spoilage that occurs during storage of dehydrated foods. The Maillard reaction has 3 stages:

- Early Maillard reaction: chemical reactions without browning.

- Advanced Maillard reaction: causes formation of volatile or soluble substances.

- Final Maillard reaction: generates insoluble brown polymers [Valdés, 2008].

These chemical changes occur during the processing and storage of foods, which cause deterioration in quality and nutritional value that will be rejected by the consumer. Affected by the following factors: temperature (the temperature increases, the reaction rates also), water activity (0.60-0.70), pH (the reaction occurs in an acid or alkaline medium) and the presence of sugars (reducing sugars are essential to trigger the reaction). During dehydration, the sugars are removed to avoid darkening within the process [Barreiro and Sandoval, 2006].

COLOR CHANGES

Among the most important changes in color are:

• **Phenotinization: chlorophyll** pigmentation can deteriorate on storage.

• **Anthocyanins:** (red plant pigments) the rate of destruction of anthocyanins depends on the pH, being higher with higher pH.

• **Carotenoids:** soluble compounds of the red and yellow colors of vegetables and animals. Oxidation is the cause of carotenoid degradation and depends on factors such as the presence of pro-oxidants, high temperatures and light.

According to Barreiro and Sandoval (2006) the degradation of chlorophyll is affected by factors such as light, pH, temperature, oxygen and also by enzymatic action such as the chlorophylase enzyme. Molds also produce superficial color changes such as: whitish, greenish and blackish, depending of the involved mold.

FLAVOR CHANGES

Enzymatic oxidation occurs in plant tissues producing the characteristic aromas of some ripe fruits and tissue breakdown. To retain the desirable volatile components within the packaging and prevent undesirable components from permeating the material from the outside, the permeability of the packaging materials is important [Valdés, 2008].

NUTRITIONAL QUALITY

Light, oxygen concentration, temperature, and water action that affect nutritional degradation can be controlled by packaging. The stability of ascorbic acid (vitamin C) depends on environmental conditions, pH and the concentration of traces of metal and oxygen. An important factor is the effectiveness of the packaging material as a moisture and oxygen barrier.

PHYSICAL CHANGES

An undesirable physical change is the absorption of moisture when it has penetrated the package.

BIOLOGICAL CHANGES

There are two biological changes: microbiological and macrobiological.

• **Microbiological changes** occur when microorganisms appear in food such as bacteria (they grow faster) and fungi (yeasts and molds). Valdés (2008) mentions that the microorganisms that cause decay are mainly influenced by two factors:

- Intrinsic parameters (the nature of the food): pH, water activity, nutritional content, antimicrobial constituents and biological structures.

- Extrinsic parameters (the environment): environmental storage properties such as temperature, relative humidity, gaseous composition, and atmosphere.

• **Macrobiological changes**, insects and their excreta deteriorate the product, degrading its nutritional quality. Usually, most of insects do not incubate if the temperature is greater than 35 °C or less than 10 °C and do not reproduce if the humidity is greater than 11 %.

The penetration of the packaging material depends on several factors: thickness, type of resin, loose (higher strength) or tight packaging, combination of materials, package structure, insect species and stage of development. The packaging must be unbroken, have a good seal and resistant to the penetration of microorganisms. If the thickness of the material is greater, the frequency of perforations will be less and these will be smaller.

ALTERATIONS OF MICROBIAL ORIGIN.

MICROBIOLOGICAL CONTROL IN CANNED

Heat treatments for canned foods are sometimes not enough to stop the contamination of microorganisms, because some survive after this treatment; also, by cracks or pores in the container through which the microorganism enters or by water to cool that is not chlorinated. When contamination occurs before treatment, it is possible to know about the responsible microorganism and the conditions to which the food has been subjected [Sánchez-La Fuente and Martínez, 2012].

Canned foods can have viable microorganisms due to various causes:

● **Due to insufficient heat treatment.** Two things can happen:

1. That the sterilization scale applied was correct. If contaminated raw materials are used, heat-resistant spores of *Bacillaceae* will be found in the conserve, such as species of the genera *Bacillus* and *Clostridium*. This is of greater risk since there is the possibility of the presence of spores belonging to the species *Cl. Botulinum*.

2. That the sterilization scale was insufficient so that heat-resistant *Bacillaceae* and other heat-sensitive germs of a varied nature could be found [Pascual and Calderón, 2000].

● **By microfuge in the containers.** It is possible to find micro-leaks in a deformed container caused by blows, which facilitate the entry of flora from outside.

SPORULATED BACTERIA

The saccharolytic anaerobic bacteria are responsible for simple fermentation. Among these bacteria, *Clostridium pasteurianum* stands out, which produces the gaseous alteration of canned fruits and tomatoes and which does not develop at a pH lower than 3.7. *C. Butyricum* which also affects canned fruits. *Bacillus coagulans* is responsible for simple fermentation in canned tomato juice, is thermophilic, and develops at a pH of 4.2. *B. Macerans* produces gaseous alterations in canned fruits and together with *B. Polymixa* in canned fruits and vegetables.

According to Bello (2000) says that bacteria die by the action of heat at a rate proportional to the amount present in the food, this thermal destruction is logarithmic, destroying the same percentage of bacteria for each equal time interval, it means that with a given heat treatment destroys 90 % of the microbial population in the first minute, in the second minute it will destroy 90 % of those that have survived; and so on.

The *D* value represents the time required in minutes at a given temperature to destroy 90 % of the microbial population. For the tabulation of these data, the temperature (D_t) known as the decimal destruction time is written as a subscript, equivalent to the reduction of the microbial population in a logarithmic cycle. Thermal destruction times are determined for different treatment temperatures from the so-called thermal death curves obtained for each specific microorganism found in a food treated by heat [Bello, 2000].

The heat treatment for destruction is determined by several factors: physical and chemical nature of the environment, the number of microorganisms present, their age, etc. Therefore, the lethal conditions that affect microorganisms cannot be established, resulting in insufficient knowledge of the working temperature and exposure parameters. For a given microbial culture, the temperature of heat treatments is represented against the corresponding *D* values, it is a logarithmic scale, according to Bello (2000) a straight line is obtained that establishes two parameters: The z value and the *F* value.

The z-value, given by the slope of the line that represents the degrees required to travel a logarithmic cycle, on a specific thermal destruction curve. These values vary according to two factors which are the species of the microorganism and the nature of the medium in which they are heated. And the *F* value, which are the minutes required at a specific temperature, is able to destroy a certain number of microorganisms that have a specific z-value. Due to the dependence on the working temperature, a reference value F_0 is established. For this, it has been defined as (the number of minutes that are required at a temperature of 121 °C to achieve the destruction of a specific number of microorganisms with a z-value of 10). Ex: If microorganisms can be destroyed at a temperature of 121 °C in six minutes, it means that the treatment to be applied corresponds to an F_0 value of 6 [Bello, 2000].

NON SPORULATED BACTERIA

They are bacteria that develop with low oxygen tension, produce gas, plant fermentation and Gram positive lactic acid producing bacteria (cocci and bacilli). They are destroyed with heat treatment at less than 100 °C. Among the most important are *Lactobacillus brevis*, *Leuconostoc pleofructi* and *Leuconostoc mesenteroides*. All lactic acid bacteria have their own reactions and niches, requiring little oxygen to function.

The *leuconostoc* species produce less acid and the heterofermentative of the *Lactobacillus* produce intermediate amounts of acid and the homofermentators of the *Lactobacillus* species produce more acid. Homofermenters convert sugars to lactic acid and heterofermenters produce around 50 % lactic acid, plus 25 % acetic acid and ethyl alcohol and 25 % carbon dioxide (taste and aroma to the final product). *Leuconostoc mesenteroides* is a bacterium associated with the fermentation of sauerkraut and brine. It tolerates high concentrations of salt and sugar up to 50 % [FAO, 1998].

ALTERATION BY THERMOPHILIC SPORULATED BACTERIA

In a can, these bacteria can cause acidification, bulging and blackening.

ACIDIFICATION

Also known as *flat sour* (acid decomposition), it occurs in canned legumes due to the development of thermophilic and mesophilic *Bacillus* (*stearothermophilus*) whose spores have withstood the heat treatment applied to the product. In acid preserves, *B. Thermoacidurans* and *B. Thermoaceticum* intervene, both species are made up of thermophilic sporulated bacilli with very active metabolism, rapidly altering the conserve.

If the thermophilic sporulated bacteria develop very actively in the canning, it undergoes a frequent <self-sterilization> in thermophilic microorganisms. The container does not present deformation, the content is acid by the production of lactic acid, but not gasogenic, for this reason the cans do not swell. This deterioration occurs when the cans are kept at temperatures higher than normal, allowing the growth of bacteria whose endospores are not destroyed in a normal procedure [Tortora, Funke and Case, 2007].

Bulging

Pascual and Calderón (2000) explain that bulging is an internal over pressure of the container due to the production of gas, causing it to explode. It is due to the growth and multiplication of a bacterium called *Clostridium thermosaccharolytycum* (strict anaerobic thermophilic sporulated bacillus) that produces gas at the expense of the constituents of the packaged food. Bulging by thermophilic sporulated bacteria occurs in low-acid or medium-acid canned foods. It is observed when the metal container or the capsules of the glass container swell due to gas production; the content is acid and smell of butyric acid.

Browning

It is due to the growth of *Clostridium nigrificans* (thermophilic anaerobic sporulate that produces SH_2), it has very little heat- resistant spores. The blackening is due to the production of hydrogen sulfide (SH_2) and reaction with Fe. In slightly acidic preserves; here the container is slightly domed and its content is black and its smell is putrid.

ALTERATION BY MESOPHILIC SPORULATED BACTERIA

According to Pascual and Calderón (2000), these bacteria cause acidification and swelling, which can be caused by butyric fermentation and putrefaction; these alterations are consequences of faulty heat treatments. Mesophilic bacteria alter canned foods when they have not been properly treated or there are leaks in the cans. For Tortora at al (2007) an incorrect treatment produces endospore-forming microorganisms and the presence of non-endospore-forming bacteria is due to the loss of the can. Poorly sealed cans often become contaminated in the cooling process after heat treatment.

ACIDIFICATION

This alteration is similar to that produced by thermophilic bacteria; it occurs more frequently. It is caused by *Bacillus subtilis*, *Bacillus licheniformes*, and *Bacillus pumilus*.

Bulging

It is caused by several mesophilic sporulated germs and they are of three types.

►**Butyric fermentation overflow:** it occurs when bacteria (sporulated anaerobic mesophilic saccharolytic) such as *Cl. Butyricum*, *Cl. Pasteurianum* and *Cl. Perfringens* develop. The bulging of the container and its explosion is due to the fermentation of the food with acidification and release of a large amount of gas (H_2 and CO_2), it occurs in family-type canned goods with low heat treatment and in products with a pH <4.5.

►**Pulding with putrefaction:** contaminating bacteria from cold water are drawn into the can with the water, causing putrefaction, especially in foods with high protein content at ambient storage temperatures. Bacteria (putrid mesophilic anaerobic sporulates) such as *Cl. Sporogenes, Cl.*

Putrefaciens, Clostridium perfringens, Cl. Bifermentans, Cl. Carnofoetidum, Cl. Carnis, Cl. Aerofoetidum and Cl. Hystolicum; These bacteria produce the decomposition of proteins releasing the compounds of putrefaction: indole, ammonia, skatole, amines, hydrogen sulfide, mercaptans, etc. It is found in canned fish and meat with low heat treatment [Pascual and Calderón, 2000].

►**Pushing with nitrogen release:** reduction of nitrates to nitrites, and nitrites to nitrogen. The bacteria that produce this bulge are *Bacillus circulans*.

The bacteria *Cl. Botulinum* type A, B and E, when multiplying, elaborate toxins causing a putrid odor and gas release that bulges the container. If the growth of these bacteria is moderate, the content is apparently normal, although it could cause poisoning. *Cl. Botulinum* type E produces toxin at 3.3 °C, produces botulism due to the ingestion of canned fish since it is of fish origin, there is no alteration of the container or the packaged product. See table 1 on the conditions that influence the development and multiplication of *Cl. Botulinum*.

Table 1: Conditions that influence the development and multiplication of *Cl. Botulinum.*

►**Food capacity** **the substrate.** **The pH value.** **develop into it.** **material of**	**• The nutritional quality of** **for the bacteria to •** **• Characteristics of the** **packing.**
►**Toxigenic characteristics of the *Cl. B*.**	
►**Amount of inoculum present in the canned food.**	
►**Possibility of microbial association, when growing, modify the pH of the substrate and allow the growth of *Cl. Botulinum*, inhibited by the primitive pH.**	
► **Inhibition due to** **(aw).** **causes other than pH.** **nitrite content** **the growth of *Cl. B.*** **of sugar, etc.**	**• Low water activity** **• Sodium chloride and** **incompatible with** **• High concentration**

Source: Pascual and Calderón, 2000.

NON SPORULATED BACTERIA, YEASTS AND MOLDS

Non-sporulated bacteria include: *Pseudomonas fluorescens*, which produces rancidity. *Streptococcus liquefaciens*, which causes the gelatin in canned ham to liquefy. *S. Faecicum* (higher heat resistance) and *S. Faecalis* are fecal streptococci that produce abnormal odors and flavors in canned hams. The

Enterobacteriaceae (*coliforms, Aerobacter, Proteus sp*., etc.) are responsible for the bulging of canned ham.

Yeasts

Yeasts occur when there are leaks in canned and canned goods that have received sub-heat treatment, but not in containers that have been heat treated. They are responsible for the fermentation of acidic sauces, jellies and products that depend for their preservation on acids, sugar and salt. Yeasts are sensitive to a lack of oxygen. The yeasts that develop in condensed milk (preserved due to its high sugar content) are: *Torula globosa* (loosening of the lids of cans). *Torula lactiscondensis* (bursting of cans in a few days).

Molds

Molds alter foods with low pH, especially yogurts, juices, fruits, etc., and those with high atmospheric pressure. Among the species of molds, we have: *Byssochlamys fulva* (Canned and bottled fruits) and *Byssochlamys nívea* (canned strawberries), cause the disintegration of the fruit by decomposition of the pectin material. Due to the carbon dioxide, it causes the cans to bulge, resistant to heat, the optimum temperature for growth is 30 - 37 °C. *Penicillium* (canned gooseberries) is highly heat-resistant. *Aspergillus* (canned strawberries) and is also heat- resistant. *Rhizopus nigricans* causes spoilage in canned fruits. *Rhizopus stolonifer* (apricots) causes softening (See Table 1).

Aspergillus repens gives rise to the formation of buttons on the surface of condensed milk.

Table 1: Classification of foods according to their acidity and groups of microorganisms that cause alterations in canned foods.

Groups according to degree of acidity	PH range	Food groups	Microorganism
Group 1: low acid	≥ 5	Meat products. Sea products. Milk. Vegetables.	Sporulated aerobes. Sporulated anaerobes. Non-sporulated yeasts, molds and bacteria.
Group 2: semi-acids	4,5 ≤ pH < 5,0	Mixes of meat and vegetables. Soups. Sauces.	
Group 3: acids	3,7 ≤ pH < 4,5	Tomatoes. Pears Figs Pineapple. Other fruits.	Sporulated Bacteria. Bacteria no Sporulated. Yeasts. Molds.
Group 4: Very acidic	pH < 3,7	Pickles. Grapefruit. Juices. Citrus.	

Source: Cameron and Esty, 1940. Cited by Mieles and Escalante, 2008.

CLASSIFICATION OF MICROORGANISMS

According optimum temperature level

- Psychrophiles (they grow between 10 °C to 20 °C).
- Mesophiles (they grow between 20 °C to 45 °C).
- Thermophiles *
  - Obligate thermophiles (grows at 55 °C).
  - Optional thermophiles (55 °C and 37°C).

* Cameron y Esty, 1926.

According oxygen needs

- Aerobic (require the presence of oxygen, are molds, yeasts and bacteria).
- Anaerobes (develop in the absence of oxygen, some bacteria).
- Facultative anaerobes (grow under conditions of empty, belong those who behave in the aerobic and anaerobic, depends on the environment).
- Microaerophilic (grow in oxygen tensions very low).

Source: Barreiro and Sandoval, 2006.

MICROORGANISMS IN LOW AND MEDIUM ACID FOODS

In a comparison of the *D* value for the different microbial populations made by Heldman and Hartel (1997), the *D* values vary depending on whether they are vegetative cells or spores. Table 2 shows that low-acid foods are at higher risk and need more stringent treatments. According to Orrego (2003) he says that the limit between medium and low acidity is the pH of 4.5 and that *Cl. Botulinum* does not grow or produce toxins at a pH> 4.6. The D_{65}, means *Decimal Decay Time* at 65 °C, vegetative bacteria such as *Lactobacillus*, *Leuconostoc*, fungi and yeasts are between 0.5 and 1.0 minutes, for various types of spores the D_{121}, is between 2 and 5 minutes.

Table 2: Comparison of the *D* value for the different microbial populations of Heldman and Hartel, 1997.

BACTERIAL GROUP RESISTANCE APPROXIMATE (MIN)	THERMAL
Low acid or semi-acid foods (pH > 4.5)	D_{121}
Thermophiles	
Stable acidity group (*B. stearothermophilus*)	4.0 - 5.0
Gaseous spoilage group (*C. thermosaccharolyticum*)	3.0 - 4.0
Sulfur producers (*C. nigrificans*)	2.0 - 3.0
Mesophiles	
Anaerobic putrefactors	0.10 - 0.20
C. botulinum (Types A and B)	0.10 - 1.50
Group *C. sporogenes* (including PA, 3679)	
Acidic foods (pH 4.0 - 4.5)	
Thermophiles	
***B. coagulans* (facultative mesophilic)**	0.01 - 0.07
Mesophiles	D_{100}
B. polymixa* y *B. macerans	0.10 - 0.50
Butyric anaerobes (*C. pasterianum*)	0.10 - 0.50
High acid foods (pH < 4.0)	D_{65}
Non-sporulated mesophilic bacteria	
***Lactobacillus spp.*, *Leuconostoc spp.*, fungi and yeasts**	0.50 - 1.00

Source: Orrego, 2003.

Hossahali at al. (1997) states that in addition to the acidity or pH of the food substrate there are other factors that determine the time of thermal treatment such as heating conditions, thermophysical properties of the food, the storage of the product after being treated, size and shape of the container [Orrego, 2003].

SPORULATED AEROBES

Bacillus is found in canned raw materials, they grow between 28 °C and 40 °C, although some thermophiles develop between 55 °C or 70 °C. The alterations that we find are: gas production, simple fermentation, and acid and gas.

Simple fermentation attacks carbohydrates with acid production and without gas production. The causative thermophiles are: *B. Stearothermophilus*, present in low acid products (peas, vegetables), it does not grow with a pH> 5, it requires intense heat treatment, rapid cooling and cold storage, the alteration does not occur. *B. Coagulans* is aciduric (pH up to 4.2), they occur in canned meats because the heat treatment is lower than in vegetables. It requires a light heat treatment.

Gas production is due to nitrate denitrification in canned cured meats, corn, peas, etc. The causes are: *B. Cereus* and *B. Mesentericus* appear in salmon, crabs and prawns. **The production of acid and gas**, the causative species are: *B. Macerans* and *B. Polymixa*.

SPORULATED ANAEROBES

They come from the ground. They appear in milk, vegetables, meats, etc. The most important species is *Clostridium*. Saccharolytic thermophiles produce large amounts of gas from carbohydrates such as carbon dioxide and hydrogen causing the cans to bulge. They have a butyric odor and do not produce hydrogen sulfide. These develop at 55 °C. Thermophiles can cause a sulphurous alteration with the production of hydrogen sulphide.

Among the mesophilic organisms, *Clostridium botulinum* stands out, which is a bacterium, anaerobic and sporogenic, it is found in the soil, in the intestines of man, animals and in sludge. Its spores are heat- resistant [Salas-Salvadó et al, 2008]. To destroy it, a sterilization of 2.8 minutes at 121.1 °C is required. Its growth is inhibited at a pH> 4.5. The growth of mesophilic organisms ranges between 20 and 50 °C (usually 37 °C).

Cl. Botulinum it occurs in a vegetative form, it is easily destroyed at temperatures below 100 °C. They vary in their resistance to heat, have proteolytic and saccharolytic powers. Botulinum toxin is one of the most powerful known to be soluble in water and extremely dangerous to man (types A and B). The spores germinate producing a vegetative cell that produces the toxin. Proteolytics or putrefactants are the cause of gaseous alterations with food degradation and production of unpleasant odor compounds. The culprits are: *C. Hystolyticum, C. Sporogenes and C. Bifermentans.* And the saccharolytics are: *C. Butyricum, C. Pasteurianum, C. Perfringens* and others.

CHAPTER II

OXYGEN AND FOOD ALTERATION

The inhibition of microbiological, chemical and enzymatic reactions related to oxygen allows an increase in the useful life of foods packed in Modified Atmosphere (MA). Oxygen is the gas that produces the alteration in food, allowing the growth of aerobic microorganisms (bacteria, molds and yeasts), oxidative rancidity of lipids, some enzymatic reactions, modifying the color and destroying some nutrients or vitamins [Silla, 2004].

It destroys fat-soluble vitamins, especially vitamins A and E. Oxygen favors the action of enzymes in foods such as catalase and peroxidase, responsible for the browning of vegetables, chopped vegetables, and odor. In the table we observe the variables and effects of non-enzymatic browning.

Table 2: Variables and effects of non-enzymatic browning.

Changes typical sensory	Changes nutritional typical	Main variables environmental that affect the reaction
- Reduction of solubility in proteins and ability to retain water. - Darkening, browning. - Aged flavor.	**- Degradation of vitamin C or loss of vitamin activity. - Loss of amino acid bioavailability in**	**- Temperature. - Water activity. - Composition of the gas phase inside the container.**

- Typical flavors of cooked, roasted, baked goods, etc.	**condensation reactions.**	

Source: Hernández and Sastre, 1999.

The growth of species that cause alterations such as Pseudomonas, *Psychrobacter, Acinetobater, Moraxella*, etc. they are inhibited at concentrations greater than 5 % carbon dioxide (CO_2). Pseudomonas (refrigerated protein foods). *Micrococcus and Bacillus* (sensitive to CO_2). Molds (depend on oxygen and sensitive to high levels of CO_2), yeasts (grow in the absence of oxygen and resistant to CO_2).

In fresh meat packed in MA, the species causing the alterations are ***Pseudomonas:*** *P. Fragi, P. Lundensis, P. Fluorescens, P. Putida and the* **enterobacteriaceae***, B. Thermosphacta, Psychrobacter, Acinetobacter and Moraxella.* In vacuum packed meat, the lactic acid bacteria causing the alterations are ***Lactobacillus:*** *L. Sake, L. Curvatus, L. Bavaricus and Lactobacillus spp.* ***Carnobacterium:*** *C. Piscicola and C. Divergens.* ***Leuconostoc:*** *L. Mesenteroides subsp. mesenteroids, L. Carnosum and L. Divergens.* ***Lactococcus:*** *L. Raffinolyticus.*

Bacteria *B. thermosphacta* and enterobacteria are present in pork and sheep meat. *Psychrotrophic clostridia* such as *C. Laramie* produce large amounts of O_2 and CO_2. This alteration occurs rarely and in pH meats with a high BAL number and stored at correct temperatures. Enterobacteriaceae and *Shewanella putrefaciens* and *B. Thermosphacta* and *Aeromonas spp.* produce SH_2 if the pH is <6.

The *Leuconostoc. B. Thermosphacta* produce compounds such as organic acids, acetoin, diacetyl, putrescine, and cadaverine that are associated with spoilage in MA-packed meat stored below 2 °C. *Pseudomonas* and *Enterobacteriaceae,* grow at 5 °C, *Brochotrix thermosphacta* does not multiply in anaerobiosis on the surface of meat with a pH <5.8. At temperatures higher than 7 °C, *Aeromonas spp.* [Moreno, 2006].

BIOLOGICAL HAZARDS IN FOOD PACKAGED IN MA

The biological hazard in foods packaged in MA, mainly in meat products, is due to three factors such as: the storage temperature, the composition of gases in the atmosphere and the competitive flora. Some pathogenic microorganisms do not grow in refrigerated food because they are mesophilic, such as *Salmonella* and *Shigella,* but they can reproduce if there is a change in temperature.

These bacteria can multiply during refrigerated storage as *Clostridium botulinum* type E and non-proteolytic strains of types B and F (growing between 3 °C to 4 °C), *Listeria monocytogenes*, *Yersinia enterocolitica* as well as *Aeromonas hydrophila* and other mobile *aeromonas* that they can multiply at temperatures below 3 °C and 7 °C. Mesophilic bacteria such as *Salmonella*, *Shigella*, *verotoxigenic Escherichia coli* and other groups of pathogenic E. coli, proteolytic types of *C. Botulinum*, *Clostridium perfringens*, *Bacillus cereus*, *Staphylococcus Aureus* (they produce toxins greater than 5 °C to 10 °C), etc. ; they can multiply in MA if the temperature fluctuates [Barreiro and Sandoval, 2006].

The pH, aw, addition of preservatives, these factors influence a good packaging. Botulinum toxins are the greatest risk in foods packaged in AM. The species *C. Botulinum* and *C. Perfringens* are not affected by CO_2, the storage temperature is important, *C. Botulinum* type E in fish products (smoked) grows and produces toxin at a temperature> 3.3 °C. Types B and F are also psychrotrophs and traces of intoxication do not necessarily appear. The inhibitory action depends on the CO_2 concentration and the temperature in vacuum packaging and other types of packaging.

Y. Enterocolitica multiplies at very low temperatures around 0 °C in vacuum packed meat. Low concentrations of CO_2 (10 %) have a stimulating effect and higher concentrations have an inhibitory effect at lower temperatures. Tables 3 and 4 show the alteration of perishable and semi-perishable foods.

Table 3: Typical forms of alteration of the different types of food: Perishable foods.

Grupo de alimentos	Forma de alteración (*)	Factores ambientales críticos	Durabilidad media (**)
Milk and liquid dairy products	-Bacterial growth. -Loss of Vitamin C. -Rusty flavor. -Hydrolytic fastness.	Temperature. Oxygen.	5 to 30 days to 0 – 7 °C.
Fresh baked goods	-Retrogradation (Staling). -Bacterial growth. -Hardening by drying. -Oxidative speed.	Oxygen. Temperature. Humidity.	2 days (bread). 7 days (cakes).
Fresh red meat	-Bacterial growth. -Loss of red color. -Darkening	Oxygen. Temperature. Light.	3 to 4 days to 0 – 7 °C.
Fresh poultry	- Bacterial growth. -Bad smell.	Oxygen. Temperature. Light.	2 to 7 days to 0 – 7 °C.
Fresh fish	-Bacterial growth. -Bad smell. -Mold flavor	Temperature.	3 to 14 days (ice)0 °C. 6 days to 5 °C. 2 days to 15 °C.
Fruits and vegetables fresh	-Anaerobic respiration. -Changes of composition. -Loss of nutrients. -Wilting. -Crushing. -Bacterial growth .	Temperature. RH. Light. Oxygen. Handling.	According to product: From 4-8 days to sweet corn up 3-8 months for apples in controlled atmosphere.

(*) Without protective atmospheres, vacuum, etc. (**) Supposed intact packaging. **Sources:** Bello, 2000; Ellner, 2000; Del Castillo and Mestres, 2004; FAO, 1993; Barreiro and Sandoval, 2006.

Table 4: Typical forms of alteration of the different types of food: Semi-perishable foods.

Food group	Form of alteration (*)	Environmental factors critical	Medium durability

Pasta for Soup	-Texture changes. -Retrogression. -Loss of quality of proteins and vitamins. -Breaks.	RH. Temperature. Light. Oxygen. Handling.	With egg, 9 - 36 months. Others, 24 - 48 months.
Juices concentrates frozen	-Loss of turbidity. -Yeast growth. -Loss of vitamins. -Flavor changes. -Scent changes	Oxígeno. Temperatura. Descongelación.	18 – 30 meses.
Fruits and vegetables frozen	-Loss of nutrients. -Loss of texture, color, smell and taste. -Frost formation on the container.	Oxygen. Temperature. Fluctuations temperature.	6 - 24 months.
Meats, poultry and fish frozen	- Rancidity -Desaturation of proteins. -Moldings. -Color changes and unpleasant odor. -Surface drying. -Hardening. - Frost in the container.	Oxygen. Temperature. Fluctuations temperature.	Ox, lamb and poultry, 6 - 12 months. Beef 4 - 14 months. Fish, 2 - 12 months. Pig 4 - 6 months.
Dishes prepared frozen	-Rancidity of meats. -Curling of the sauces. -Loss of color, flavor, aroma. -Syneresis of the sauces.	Oxygen. Temperature. Fluctuations temperature.	6 – 12 months.

Foods dehydrated	-Rancidity. -Browning. -Texture changes. -Loss of nutrients. -Color change.	RH Temperature Light. Oxygen.	Vegetables: 3 - 15 months. Fruits: 1- 24 months. Meats: 1 - 6 months.
Milk powder skim	-Deterioration of taste. -Loss of solubility. -Caked. -Loss of nutrients.	RH. Temperature.	8 – 12 months.
Cereals for breakfast	-Rancidity. -Loss of nutrients. -Break.	RH. Temperature. Handling.	6 – 18 months.

Figure: (*) Containers without protective atmospheres, vacuum, etc. **Sources:** Bello, 2000; Ellner, 2000 and Moreno, 2006.

STERILIZATION MEASURES

It is performed after the stability control when there is a positive or doubtful alteration or spontaneously altered preserves. The sterility control is a complete analysis carried out in specialized laboratories to check if the preserved food contains revivifiable microorganisms, and if the result is positive, determine their nature to explain the lack of stability.

According to Pascual and Calderón (2000), the examination verifies three aspects: The morphology of the revivifiable microbial flora; the thermoresistance of that same flora; and the optimal growth temperature. Decheco (2010) indicates that the following recommendations must be followed for the sterility control to be effective and successful:

◀ The examination of canned foods is performed in sterile atmospheres.

◀ The can lid is disinfected with 70 ° alcohol and left for 10 to 15 minutes, the excess alcohol is drained off and flamed (flaming is omitted in bulging containers). The can lid is disinfected on the side that does not have the code printed on it.

◀ The can is opened with a sterile can opener and the lid is removed by replacing it with the base of a sterile petri dish.

◀ 5 ml or g of sample is transferred to tubes with appropriate culture medium in triplicate for aerobic and anaerobic incubation, sterile paraffin is added to the anaerobic one.

◀ Then Incubate at the same incubation temperatures as above. If the samples have been incubated at 35 °C, the tubes are incubated at 35 °C for 48 hours up to 5 days.

◀ The Gram staining of the sample is carried out for microscopic examination, if there is a high number of microorganisms per field (+ 3) except in products obtained by fermentation, it indicates that there were not good hygiene conditions during the elaboration of the product or also the use of polluting raw materials.

◄ After incubation, the tubes are examined for growth. The Gram staining is carried out and it is observed under the microscope, make subcultures on Casoy agar for aerobes and on agar for anaerobes according to Brewer (1940).

MICROBIOLOGICAL ANALYSIS OF CANNED

Pascual and Calderón (2000) state that in the microbiological analysis of canned food there are several stages: preliminary external examination, sampling, pre-incubation and preliminary incubation, but before doing so, the cans should be washed well with plenty of soapy water. and rinse them with drinking water, the day before the exam.

PRELIMINARY EXTERNAL EXAM

Everything related to the can is written in detail: the batch number, the codes printed on the labels, the stamping on the lid, the dimensions of the can and the weight. The can is inspected for mechanical defects, intact saturations, corrosion, dents, or other abnormalities that aid bacteriological findings.

SAMPLING

To carry out the sampling, it is recommended to follow the indications of the ICMSF (International Commission on Microbiological Specifications for Foods). Sampling is the separation of some units (cans) from batches. 6 to 12 cans from each batch are tested. If the cans are bulging or leaking, six are examined and six normal cans are taken from another batch as controls. Alterations due to faulty closure occur only in a small number of cans in a batch, so as many as possible are examined.

PRE-INCUBATION

At this stage, apparently good cans are incubated for six days at 35 °C - 37 °C, favoring the multiplication of small numbers of organisms that may be missed when sampling the contents.

PRELIMINARY INCUBATION

The apparently normal cans are incubated, according to the pH conditions of the product, according to the table of normal ranges of pH of canned foods.

- Foods with pH> 4.6 (medium and low acidity) incubate at 35 °C - 50 °C for 10 to 21 days.

- Canned meat with flour or starch as ingredients, incubate at 55 °C.

- Foods with pH <4.6 (acidic and highly acidic) incubate at 55 °C for 7 - 10 days [Decheco, 2010].

EXAMINATION TECHNIQUES PROCEDURE

PRELIMINARY MACROSCOPIC EXAMINATION OF CONTAINERS

This examination is performed to check the condition of the canned food and to discover possible alterations or defects [Decheco, 2010].

CAN PREPARATION

a. The label is removed from the can.

b. Wash it with soapy water and a brush, rinse with clean water and dry. The next day the analysis is done.

c. It is placed between two sheets of filter paper, ensuring that they are clean to detect any loss of product during incubation.

d. The cans are incubated at the indicated temperature. During the preliminary incubation, the cans should be shaken every 2 days, those showing growth due to bulging or micro-leaks separated and examined as an altered can.

e. At the end of the incubation period, if the cans do not show signs of alteration, a sterility control must be carried out.

CONTENT SAMPLING

When the cans look normal, the upper part of the can is rubbed with cotton wool and methyl alcohol.

Pour 1 ml of alcohol over the can and flame it, wait for the alcohol to burn completely. When the content of the can is liquid, the flamed surface is punched with a 10 cm punch by hitting it with a hammer. The contents are sampled with a Pasteur pipette into culture medium and into a screw-cap flask for germ counts. These punches are sterilized together (10-12).

When the content of the can is solid, a punch with a pointed end is used, this punch is made of 9 - 10 mm diameter brass rod. A large hole is made. A sample is taken from the central part with a 7-8 mm outer diameter glass tube. The core sample is pushed from the glass tube into a screw cap bottle with a piece of glass rod. Glass sample tubes and rods are sterilized together in copper pipette boxes and punches are individually sterilized [Decheco, 2010].

When cans are bulging or leaking, their contents can be dangerous to the handler, therefore, precautions should be taken when opening cans. Decheco says the can is placed on a metal tray and the same rub is done with alcohol. An inverted sterilized funnel is used on the can, its diameter may be slightly larger than that of the can. A sterilized bronze rod is passed through the funnel tube until it rests on the can; both are held firmly and the can is punctured by tapping the rod with a hammer. The brass rod is pushed in and out of the hole in the can several times and then removed.

The hole is sometimes clogged with chunks of food by the internal pressure of the gases and when a sampler is inserted more gases and food are projected. The samples are taken with a Pasteur pipette. After sampling, the can is opened with a household can opener and the contents are examined.

DIRECT EXTENSIONS EXAM

They make smears of the Gram-stained colonies of the sample. Decheco indicates that there is insufficient treatment when there is the presence of Gram-positive bacilli. Germs may be dead, perhaps occurred during treatment, there is no confidence in this test.

CULTURE

Tryptone dextrose agar (with bromocresol purple as indicator) is seeded for general examination and incubated aerobically and anaerobically at 22-25 °C, 35-37 °C, and 55-60 °C for 24-36 hours. The following media are also sown if indicated: iron-sulphide medium (producers of hydrogen sulphide, blood agar, MacConkey) for rot germs, *Micrococci, Leuconostoc,* etc.; Crossley's milk medium (aerobic and anaerobic spoilage sporulates); Sabouraud medium (for yeasts and fungi).

PATHOGENIC GERMS IN CANNED FOODS

TEST FOR PATHOGENIC GERMS

5 % of low acid foods, meats, dairy products and some canned vegetables, allow the growth of enteric, staphylococcal and botulinum germs. In this test, the cans are opened with a sterile can opener. Samples are taken from the parts in front of the seams, where the seams of the covers intersect with the side, when the content is solid. It is grown in a Selenite medium for *Salmonella*.

MATERIALS

-Sterile petri dishes (100 * 15 mm).

-100 ml graduated pipettes.

-Glass funnel.

-Regulatory incubators of 35 °C and 55 °C.

-Sterile room or sterile planting cubicle.

-Microscope.

-Potentiometer.

-Plates with CASOY agar.

-Plates with agar for aerobes sec. BREWER.

-200 * 25 mm tubes.

-Sterile paraffin.

-Mercury bichloride solution.

-Alcohol, ethyl 70 %.

-Can opener.

-Metal stem with a point at one of the ends.

-Brush.

-Detergent.

-Recipient with disinfectant agent.

-Canned samples.

-Sowing handle with kolle handle.

-Sterile Pyrex test tubes with lid.

-Sterile Pyrex petri dish.

-Rack of tubes.

-Clock moons, spatula and loaves.

-Beakers and Erlenmeyers.

-Sterile test tubes and pipettes.

-Bunsen lighter.

-Incubator.

-Stove.

-Autoclave.

-Analytical balance.

-Anaerobiosis Jar.

REAGENTS AND CULTURE MEDIA

- Distilled water.
- Peptone Water.
- Lactose broth.
- Selenite broth.
- Dextrose-tryptone agar.
- Agar Saboraud.
- Agar Macconkey.
- SS Agar-TSI Agar.
- LIA agar.
- Citrato Agar.

Source: Decheco, 2010.

CHAPTER III

PACKAGING FOR CANNED FRUITS AND VEGETABLES

The types of packaging most used for canned fruits and vegetables are aluminum, tin, glass, plastic, tetra pack, dolly pack, aseptic packaging and plastic bags. For Escudero (2011) the most important functions of the container are:

- Resistance to guarantee the product, in weight, breakage, stacking and transport.

- Hermeticity or barrier. You should avoid product damage and spillage.

- Guarantee of hermetic closure, but that the consumer can open without difficulty.

- Protection by sealing to maintain the integrity of the product. Avoid forgeries or fraud and that it cannot be manipulated before it reaches the consumer.

- Compatibility with the merchandise. The container must not cause chemical or physical reactions in the product that deteriorate its quality.

- Ergonomics, good weight and adaptability to the way it will be handled, uncovered, transferred, stored by the consumer.

- Provide information to the consumer about the product such as rules of use, expiration, precautions, environmental considerations, etc.

THE TINPLATE

Tinplate is a very thin, low carbon steel sheet (between 0.14 and 0.49 mm thick) coated on both sides by a layer of tin. Steel is strong, malleable, and hard. The presence of tin, which is the screen that protects the steel.

The main advantages that tinplate offers as a packaging material, as mentioned by Cervera (2003) are:

- Easy deformation as it adapts to new forms of packaging.

- Mechanical characteristics (rigidity and lightness) that allow resistance to shocks during transport and processing.

- It resists the deformations of the internal overpressure (heating) and the external one (cooling) that it experiences in the sterilization process.

- It also supports the loads of stacked containers on transport pallets and in storage.

- Perfect tightness to gases (oxygen, nitrogen, carbon dioxide), water, light and microorganisms.

- Lightness.

- Adequate resistance to corrosion.

- Good resistance to atmospheric corrosion.

- Non-toxic.

- Nice appearance.

- Magnetic condition is useful during transport, in the manufacturing line and in the storage of containers. Once empty they become solid urban waste.

- Good weldability.

- Easy recycling (scrap).

- Ease of application and adherence to varnishes.

- Easy lithography.

- It cannot be opened at the point of sale (Security).

- Moderate price.

There are two types of containers made of tinplates: the three-piece, traditional in food that consists of a bottom, a body and a lid. As can be seen in figures 1 and 2. And the two-piece one, the best known is the beverage can.

Figures 1 and 2: Three-piece container.
Source: El Salous, 2016.

ADVANTAGES OF THE STEEL PACKAGING

The steel can containers are for preserves, beverages and for various uses (Fig. 3). Among the advantages of using the steel container for food that Cervera mentions are:

- Hermeticity and tightness, a barrier between the food and the outside.

- It cannot be opened without the necessary instruments.

- Material very resistant to shocks.

- It is opaque which prevents the destruction of vitamins that are affected by light and radiation.

- You can use lithography and other techniques to decorate.

- Versatility in design, it can be done in different ways.

- Chemical integrity, allows maintaining aroma, flavor and color because there is minimal interaction between the container and the food.

- The steel container disappears in a few months, exposed to the elements, turning into iron oxide, harmless to the ground.

- By electromagnets empty containers can be recovered because it is magnetic.

- 100 % of its material is reused in the manufacture of new steel.

- Thermal stability, the metal does not change its properties with heat, it only expands without affecting the food.

- Supports stacking in storage.

- Longevity, once the food is sterilized it lasts for a long time.

- Efficiently supports varnish coating and printing.

The disadvantages of steel containers are:

- The weight, although aluminum is light.

- Deformation capacity.

- Corrosion and oxidation, due to the chemical reaction of moisture and acids.

- Old-fashioned image [Cervera, 2003].

Figure 3: Beverage container.
Source: Jonathan Petersson,
https://pixnio.com/objects/beverage-container-design-drink-food

In canned food, tin sheets vary from 0.09 mm and 0.49 mm thick, they are coated with protective varnish on both sides, the outside is used for printing. The steel does not absorb the varnish, the sheet is dried in an oven at 200 °C. Depending on the type of container, it is cut into rectangles or circles, shaping the container and welded to make it consistent. This is to fit the background. The lid is given to the canned to put on once the can is full.

The filling and closing of the container are very fast. After the cans are subjected to a high temperature that can reach 130 °C to destroy any contamination, the temperature varies according to its content.

FLEXIBLE PACKAGING

Flexible packaging is made with one or two laminated and / or coextruded materials (2 or more plastic materials with different characteristics in a given configuration), based on materials such as paper, various polymeric resins and aluminum sheets. It is important to preserve the product inside from when it is packaged, during transport, storage, distribution and display, until it reaches the consumer [Careaga, 1993].

PROPERTIES OF FLEXIBLE PACKAGING

The properties of flexible packaging are related to the properties of plastics, among them, we have.

◄ **Mechanical resistance to traction:** Determines the amount of plastic material that is needed to form the wall of a container.

◄ **Mechanical resistance to perforation:** It resists the characteristic shapes such as points or sharp edges of some packaged products (cookies and noodles), being elastic without breaking or deforming.

◄ **Mechanical resistance at low temperatures:** Most packaged foods must be kept refrigerated or frozen to be preserved in optimal conditions.

◄ **Barrier:** They have the lowest possible permeabilityto gases, vapors, oxygen, light and aromas.

◄ **Sealability:** They must be closed by heat sealing; this process uses a TECNOFILM wrap that heat is applied to make it contract hermetically. This technique guarantees the end consumer a complete product without manipulation.

◄ **Printability:** The print must be reproduced clearly, accurately and strikingly.

◄ **Manufacturing versatility:** All common plastics can be made into thin, strong and transparent films.

◄**Durability:** Plastics do not rust and are not affected by common environmental agents, except for ultraviolet rays.

◄**Cost:** It depends on the type of container.

MATERIALS USED IN THE FLEXIBLE PACKAGING

There are several classes of materials with properties that allow wrap manufacturers a type of packaging material for each application.

Polyethylene: Low-density polyethylene (LDPE) is the most used for its versatility and low cost. **Characteristics:** Its sheet is flexible, stretchable, soft to the touch, has good clarity, provides a moisture barrier, has no odor, has no taste and is easily heat sealed, sensitive to oily products.

Polypropylene: Bioriented polypropylene (BOPP) are layers of polypropylene manufactured where one side is shiny and the other opaque. Features: They are resistant to shock, tear, puncture, water, air protection, good-looking. It is the lowest density plastic used in packaging applications. It is much more transparent, rigid and resistant than LDPE. It has lower permeability to gases and humidity and has a higher melting point, very useful for packaging at high temperatures [ITDG, 1998].

Cavitated white bioriented polypropylene (pearlescent): With or without seal, 25 to 40 microns, it is used in food packaging and for soft drink labels.

Polyester: It is a very important packaging material due to its exceptional mechanical characteristics and resistance to high temperatures, it is strong, transparent and lustrous. It is used for films and for rigid containers [ITDG, 1998].

Polyamides (Nylon): Nylon 12 is used in the form of film for food packaging. It is a clear sheet, very resistant to perforation, tearing, at high temperatures, it has excellent barrier properties to oxygen and other gases, its resistance to water vapor is medium, which keeps food fresh for longer in dry environments [Bilurbina and Liesa, 1990].

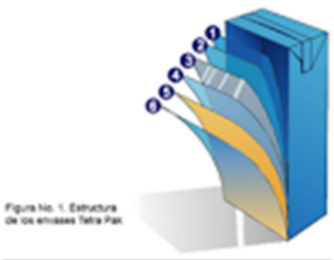
Special polymers: They are plastics with a very specific application. Characteristics: It serves as a barrier against oxygen, odorless and tasteless.

Aluminum foil: It is a complete protection of the product; it serves as a barrier to gases and light. Aluminum foil is used as a component of multilayer structures.

The packaging of some carrots, apples and other vegetables is carried out in micro-perforated polyethylene bags that allow the product to breathe (Fig. 4).

Figure 4: flexible packaging.
Source: https://www.industrialmeeting.club/

ASEPTIC BEVERAGE CARDBOARD



CAPAS QUE CONSTITUYEN UN ENVASE TETRA PAK

#	NOMBRE CAPA	FUNCIÓN
1	Polietileno de baja densidad (LDPE)	Protege el producto de la humedad y el polvo exterior.
2	Papel	Da rigidez al envase.
3	Polietileno de baja densidad (LDPE)	Actúa como adhesivo.
4	Aluminio	Protege el producto de la luz, el oxígeno y los microorganismos.
5	Polietileno de baja densidad (LDPE)	Actúa como adhesivo.
6	Polietileno de baja densidad (LDPE)	Evita la migración de contaminantes del envase hacia el producto.

Fig. 5: Layers of material for cardboard packaging.
Source:
http://proyecto1reciclaje.blogspot.com/2012/02/aprovechamiento-de-los-residuos.html

The cartons for drinks or Brick are manufactured in layers (laminated) (See Fig. 5). These combined layers reduce the weight and volume of the container to a minimum, guaranteeing product protection, functionality and convenience for consumers (See Fig. 6). They are not reusable.

Figure 6: Brik cartons.
Source: Picture 1: https://heli-packaging.en.made-in-china.com/
Picture 2: El Salous, 2016.

The main materials of cardboard for drinks are paper, polyethylene, aluminum and inks. A 1-liter container weighs between 25 and 28 g, it is made up of: 21 g of cardboard; 5.8 g polyethylene plastic and 1.4 g of aluminum [Larraucea et al, 2012].

Cardboard: 75 – 80 % of a beverage carton is paper. The cardboard used is made from fibers that provide strength and rigidity. A 1 m^3 tree provides enough pulp to make 13,300-liter containers. It is a material that does not pollute, it is degradable in nature and recyclable.

Polyethylene: Represents 15-20 % of the weight of the beveragecarton. It does not allow spillage of the liquid content and keeps the different materials of the container together. The layers are thin (the outer layer is 12 microns thick).

Aluminum: Represents 5 % of the weight of beverage carton. It is only used in cartons for UHT / long life products. It is a barrier against oxygen, it can be stored at room temperature, it does not need refrigeration to transport it, insulating from light. Its thickness is 6.5 microns.

Inks: Tetra Pack uses water-based inks, with organic pigments and without heavy metals (See Fig. 7).

Figure 7: Tetrapack container.
Source: https://www.madera21.cl/

GLASS CONTAINERS

There are three types of glass containers: those with a narrow mouth, which are bottles, are used for beverages, soft drinks; bottles for perfumeries, pharmaceuticals, cosmetics, etc. and wide-mouth jars that are used for preserves of fruits and vegetables such as jams, pasta, pickles, and so on.

Glass containers have various shapes, colors and various characteristics that must satisfy the user and the manufacturer [Cervera, 2003]. For both they must be: easily washable, transparent, safe against germs and contamination, does not absorb, does not transmit odors, keeps packaged products unalterable, opens and closes easily, is light, resistant, economical because they can be manufactured in large quantities in one one-time, wide variety of designs, functional, aesthetic, recyclable, allows high speeds in the filling lines and reusable and practical.

The packaged product can be pasteurized, sterilized or lyophilized in the same container and even in beer and soft drink containers or colas they resist internal pressure due to carbonation. In the clear / transparent bottles they allow you to see their content, the brown and green ones allow protection against light. Some disadvantages of these containers are their fragility and weight, the somewhat high cost of transport due to the fact that they can break if not handled with care and a glass splinter can even enter the food [ITDG, 1998]. See figure 8 which shows the various shapes of glass containers according to your needs.

Figure 8: Different forms of packaging.
Source: https://www.elempaque.com/

PLASTIC CONTAINERS

Casein is a plastic derived from milk. There are a variety such as: polypropylene, fluorocarbons, polystyrene, acrylic resin, melanin, polycarbonate, cellulosic resins, polyethylene. See figure 9, a high-density polyethylene container. The most important characteristics that these containers must have been: transparency, resistance to impact, impermeability to oxygen and water vapor, resistance to chemical agents and cracking, softening point, rigidity, ease of printing and smell [Robles, 1996].

Fig. 9: High-density polyethylene (Natural).
Source: https://www.catalogodelempaque.com/

Polypropylene: Greater protection against humidity and air. Recommended for foods that can absorb moisture or are susceptible to the action of air. It is attractive to the consumer. See figure 10 and 11, polypropylene films.

Figures 10 and 11: Polypropylene films.
Sources: www.logismarket.com, http://1pack.eu/

Cellulose: It is puncture resistant and hard, but breaks easily. It has no odor or taste and is biodegradable after 100 days.

Uncoated Chloride Polyvinylidene (PVDC): Good barrier against gas, moisture and odor. Grease resistant and does not melt on contact with hot fats. It is recommended for packaging chicken, ham, cheese for storage, refrigerated food for baking. It is used as a sausage skin (See figure 12) and can be heat sealed.

Figure 12: Uncoated chlorinated polyvinylidene (PVDC)
Source: http://spanish.alibaba.com/

VACUUM PACKAGED

Vacuum packaging allows you to preserve food that is in its natural state or that has been cooked. It consists of the extraction of oxygen from the bag that contains the product and the immediate sealing of the container. After a certain time, the residual oxygen is replaced by CO_2 due to the low permeability of the films, the tissue and microbial respiration in the case of plants. This process prevents or reduces non-enzymatic oxidation.

It is useful for storing fatty foods and foods that are not very suitable for bacterial growth, such as dried products and those with a high salt content [Granados, 1984]. As for meat, there is what is known as "second skin" vacuum packaging, thus avoiding oxidation and putrefaction of the food to be preserved, for Egan et al. (1988) the shelf life of meat: beef (10-12 weeks), pork (4-6 weeks) and lamb (6-8 weeks), meats vacuum packed in films with permeability less than 50 ml/24 h/atm measured at 24 °C and 98 % RH [Moreno, 2006].

In the modified atmosphere (MA) packaging system, air is replaced by a gas or a mixture of gases (carbon dioxide, oxygen and nitrogen). Foods packed with MA are labeled (packed in a protective atmosphere), in vegetables and salads they are known as (fourth range) which are products that are consumed fresh or with little processing (Fig. 13).

Figure 13: Packaged in AM.
Source: https://rinomaquinaria.com/

THE ADVANTAGES OF VACUUM OR AM PACKAGING

Among the advantages of this type of packaging according to Hernández and Sastre (1999) are:

• Prevents oxidation caused by oxygen and the spoilage of food is zero.

• Controls chemical and enzymatic reactions.

• Extends the shelf life of food.

• Microorganisms do not thrive in the absence of oxygen.

• Food retains texture and toughness.

• Maintains the nutritional quality of the products.

• There is no direct contact of cold with the product.

• Maintains the flavor and freshness of food.

• No aromas enter the container.

• Allows you to make volume purchases and rationalize in portions.

• Creates a protection system against cuts in the cold chain.

• Oxidation of fat in meats.

• Weight loss of the product.

• Insulates the product, no other smells or flavors of frozen foods stick to it (Fig. 14).

Figure 14: Carrot vacuum packed.
Source: https://www.dreamstime.com/

DISADVANTAGES OF VACUUM PACKAGING

Among the **disadvantages** we have:

• There are types of bacteria that grow in low oxygen environments (vacuum packed) causing disease.

• Frozen foods must be adequately defrosted to reduce the growth of bacteria.

• The vacuum seal does not kill bacteria. If the bacteria were there when the seal was made, they will be when the package is opened.

• The term <vacuum packed> does not mean that food is safe.

• Bad odors and flavors appear if certain conditions are not controlled.

The Advisory Committee on the Microbiological Safety of Food, UK, 2006 (Advisory Committee on Microbiological Safety of Foods, ACMSF) gives the following indications:

◄ Foods packaged under vacuum and in MA must be kept refrigerated during all marketing stages.

◄ A maximum period of 10 days is recommended for foods packed in vacuum and in MA stored at temperatures between 3 and 8 °C.

◄ When a packaged food is opened for sale in slices, slices, pieces or units, and it is repackaged, the half-life of the original product must be respected.

◀ Those foods whose half-life is set above 10 days should be previously subjected to the following treatments, either one or in combination:

- Heat the food at 90 °C for 10 minutes or at a time/temperature ratio sufficient to kill the spores of *Clostridium botulinum*.

- Acidify the food until it reaches a pH equal to or less than 5.

- Reach a salt level of 3.5 %.

- Achieve a water activity (aw) less than or equal to 0.97.

- Use preservative additives such as nitrites.

CHAPTER IV

NEW TECHNOLOGIES FOR FOOD CONSERVATION

To avoid disease problems caused by food processing with old technologies or methods that are not sufficient for the destruction of microorganisms in food. Heat has so far been the most effective preservation method. But when using these heat treatments, the microorganisms and the enzyme are inactivated, causing chemical changes in the components of the food, resulting in the loss of its nutritional, sensorial and functional quality.

Food industries concerned about changes in consumer habits are developing new minimally processed products trying not to affect product quality. Investigating new methods of preservation and sanitation of food, updating treatments with more efficient heating methods such as microwaves, ohmic heating, etc. and using technologies that reduce the intensity of such treatments and the effects of loss of quality in products.

Among the technologies investigated are ultrasound (See figure 15) and electric fields, they are still in the research phase.

Figure 15: Ultrasound in food safety.
Source: https://www.ift.org/

Ultrasounds

They are sound waves that are not perceived by the human ear due to their high frequency. Ultrasounds generate alternative compression and expansion cycles as they pass through liquid media, gas bubbles appearing in the mass of the liquid. The bubbles grow in continuous cycles reaching a critical size and as they pass, the bubbles implode. The implosion generates areas with very high pressure and temperature that affect the cell structure [Murno, 2006]. This causes the molecules of the liquid to collide, producing pressure waves that are transmitted through the medium, inactivating the bacteria and disintegrating the suspended matter; This effect is called cavitation.

This process is not very effective under normal treatment conditions. See figure 16 in which a scheme of HP treatment is presented.

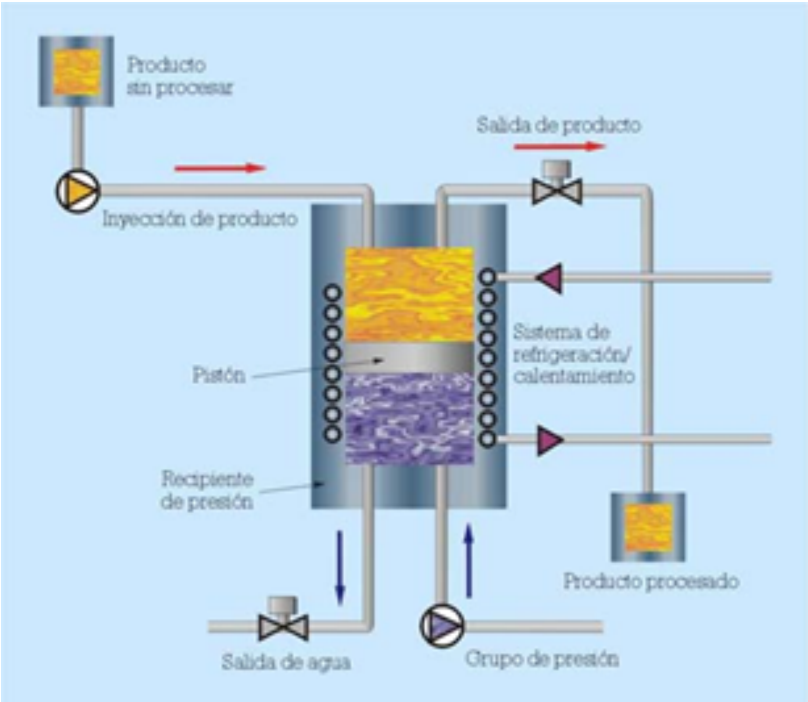


Figure 16: High pressure treatment of liquid bulk products.
Source: Raventós, 2006 http://www.acenologia.com/ciencia102_2.htm

The simultaneous application of ultrasound under pressure (Manosonication) and the application of heat (Manothermosonication) for microbial inactivation. The application of ultrasound and heat with control of temperature, pressure and amplitude of the ultrasonic waves; demonstrates that microbial inactivation by ultrasound increases with system pressure.

Manothermosonication processes (ultrasound under pressure + heat or MTS) further increases the lethality of heat treatments by reducing the time and / or temperature of the heat process [Murno, 2006]. The MTS is used for the pasteurization and sterilization of liquid foods contaminated with highly heat-resistant microorganisms.

Pulsating Electric Fields (CEP)

It is a technique used to preserve food without heat treatment, obtaining a high-quality product similar to the fresh product, stabilizing the food without affecting the original quality. The water and the nutrients in foods with high ion content that allow the transport of electrical charges [Raventós, 2005]. Table 5 shows the reductions of some foods and their authors. High voltage electric shocks are applied under controlled conditions. Electric fields produce the accumulation of charges of different signs on both sides of the cell membranes, the strength of the field reaches a critical value and the attraction between charges overcomes the mechanical resistance of the membranes and pores are produced, causing the death of the cell.

Table 5: Experimental reductions for different food products.

Food	Microbial population	Reduction	Treatment	Source
Phosphate buffer solution	*Lactobacillus brevis*	10^9	..	Jayaram (1992)
Milk	*E. coli.*	10^9	20 °C, 64 pulses of 2 µs to 70 kV/cm	Zhang at al. (1994a)
Solid food model	*E. coli, S. Aureus, S. serviciae.*	5-6 logarithmic cycles	15 °C, pulses of 3 µs to 40 kV/cm	Zhang at al (1994b)
Orange juice and milk	*E. coli, S. serviciae, L. brevis.*	4-5 logarithmic cycles		Grahl at al. (1992)
	Cl. tyrobutyricum	0		Grahl at al. (1992)
Milk	*E. coli*	10^7 - 10^3 ufc/ml	15 °C, pulses of 1.5 µs to 3kV/cm	Martin Belloso at al. (1996a)
Milk	*E. coli*	10^7 - 10^3 ufc/ml	43 °C, 23 pulsos de 20 kV/cm	Dunn y Pearlman (1987, 1989)
Liquid egg	Unspecified inoculated microorganism	10^6 - 10^5 ufc/ml	39 °C (max), exponential decay pulses of 4 µs to 37 kV/cm	Martin Belloso at al. (1996b)
Pea cream	*E. coli*	10^7 -0 ufc/ml	30 pulses of 2 µs ato30 kV/cm	Vega-Mercado at al. (1996)
	B. subtilis	5D	33 kV/cm, a 4,3 Hz y 0,5 ml/min flow velocity	
Apple juice	*S. cervisiae*	19^6 ufc/ml	2 pulses of 2,5 µs to 50 kV/cm	Harrison at al. (1996)

Source: Raventós, 2005.

THE PEAV TREATMENT (HIGH VOLTAGE ELECTRIC PULSE)

It consists of the application of high intensity electric fields (20 - 80 KV/cm) in the form of pulses of short duration (of the order of microseconds). See figure 17, a diagram of the electrical pulses treatment plant is observed. The food is located between two electrodes, the ground electrodes and the high voltage electrodes, and a potential difference is generated between them, which consequently causes an electric field to form in the product [Raventós, 2005].

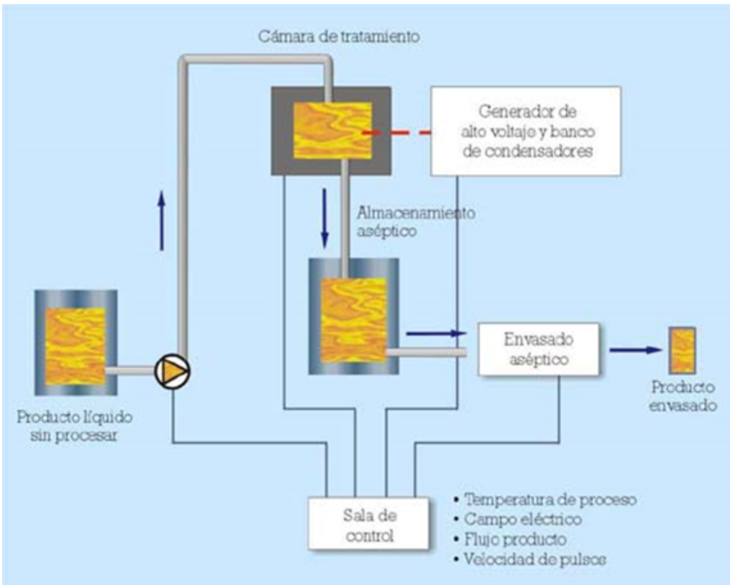


Figure 17: Scheme of a high field intensity electrical pulse treatment plant. **Source:** Raventós M., 2006. http://www.acenologia.com/ciencia102_2.htm

This technique has its limitations. Raventós (2005) states that it has little availability of commercial units; the presence of air bubbles in the chambers can cause foam, damage the product and the chamber; It has a limited application since there are some products that are not suitable for this technique, due to their high resistance, and they need a lot of energy to achieve a specific electric field; The size of the particles must be less than the space of the treatment area, for a good operation of the same and the lack of resources to accurately measure the distribution of the treatment, since the result is not reliable because it is not known precisely which it is the effect of the process conditions.

HIGH INTENSITY WHITE LIGHT PULSES

High intensity white light pulse application is only applicable to the surface of food. These pulses generate changes in cellular DNA, destroying pathogens on the surface of food. The heat does not penetrate into the food, it remains intact.

UV light is radiation that is exposed to the food to be treated for a certain time, causes damage to proteins and breaks the cell membranes of microorganisms. All this damage will depend on the frequency and duration of the light pulses, the wavelength of the light used and the distance from the product to be treated. Of the three types of light, UVC is the one that has germicidal power. Successive pulses of white light (200 nm, ultraviolet to 1,000 nm, near infrared) with a duration of approximately 325 µs per pulse [de Oña and Serrano, 2014].

The treatment chamber has a Xenon lamp that very quickly releases electrical energy in the form of light to the surface of the product in the chamber. This treatment is similar to the flashes of a camera. See Figures 18 and 19, the first shows equipment for pasteurizing food with ultraviolet light and the second a high intensity white light treatment chamber.

Figure 18: Installation for pasteurization of food with light Ultraviolet.
Source: www.heraldo.es

Figure 19: High intensity white light treatment chamber.
Source: www.diariodeciencias.com.ar/los-pulsos-de-luz-en-alimentos-tecnologia-antimicrobiana/

The application of the pulses will depend on the product, since factors such as its color, transparency, depth, fat and protein content intervene. Pulse penetrability is only used to treat surfaces, transparent liquid foods and products packaged in transparent materials.

CHAPTER V

GOOD MANUFACTURING AND HANDLING PRACTICES

Before starting to prepare and process food or products, the food handler must take into account this set of rules that will be given below to maintain good hygiene throughout the process of manufacturing the products and make the correct choices of the products. Products that are safe for food processing. Sick people and improper practices could contaminate food. These steps to keep a clean and pleasant workplace are mandatory so that at the end of food processing an excellent quality product is obtained.

PERSONAL HYGIENE

For food handlers they must follow these rules to prevent health risks and occupational accidents during the different processes.

► Use clean clothes and shoes only for work, do not use them for other tasks.

► Footwear must be closed, non-slip and waterproof.

► Protect the hair with a suitable cap or mesh, so that the hair does not fall on the product. Wear masks.

► Wash hands frequently, use antibacterial soap, and scrub hands well with soap and rinse well. Dry off with paper towels. Wash your hands after:

- Use the toilets.

- Return to work.

- After handling processed food.

- After coughing, sneezing or blowing your nose.

► Keep nails short and clean. Not having nail polish. Do not wear jewelry.

► If they have a wound, they should be covered with a bandage or a waterproof bandage that does not come off easily.

► Preferable to wear gloves.

► Wear a clean apron for protection. Take off the apron when you leave the plant and put it back on when you enter again.

► Aprons and gloves must be washed and disinfected, between handling the product.

► Personnel must undergo a medical examination before working in a processing plant.

► Inform superiors if they have any health problems with the skin, nose, throat and intestine.

► Do not smoke on the premises, or chew, eat, drink, or spit in product handling and processing areas.

► Eliminate pens, pens, thermometers, bras, or other removable objects in upper clothing pockets in production and product handling areas.

► Jewelry or ornaments should not be worn: clips, earrings, rings, bracelets and watches, necklaces or others that may contaminate the product. Only small clips and barrettes are allowed to hold the hair when worn under a protection.

►Handle food as little as possible.

► All personnel operating in the production areas must be trained in good hygiene and sanitation practices, as well as know the tasks that they have to perform.

►All visitors, internal and external, must cover their hair, beard and mustache, in addition to wearing suitable or protective clothing before entering the process areas that require it.

► Signs should be posted instructing staff to wash their hands after using the toilets.

► Locate a signaling system and safety regulations in visible places for the knowledge of the plant personnel and external personnel.

EQUIPMENT AND FACILITIES

►All utensils, equipment and facilities that will be in contact with food must be clean, disinfected and well preserved.

► When lubricating equipment, use safe lubricants to avoid contamination.

► The equipment must be properly installed to allow the continuous and rational flow of material and personnel.

► All equipment and utensils that come into contact with food must be made of materials resistant to corrosion and cleaning and disinfection operations.

► The equipment must be installed leaving space between the wall, ceiling and floor, to be able to clean them properly.

► Impulse equipment such as pumps, compressors, fans must be placed on a base to facilitate maintenance and cleaning.

► The external parts of the equipment must be clean, without signs of spillage.

► After maintenance or repair, the equipment should be inspected for maintenance residue.

► All surfaces where raw materials will be placed must be waterproof and easy to clean.

► The sanitization of the equipment is very important to eliminate microorganisms, it is done by applying detergents.

► The water used for cleaning equipment that comes into direct contact with food must be made drinkable or treated according to national or international standards.

► The surfaces of the work tables must be smooth, with rounded edges, made of waterproof, unalterable and stainless material that allows easy cleaning.

FACILITIES

► The premises must comply with the hygienic design requirements required by health authorities for food processing.

► It must be large enough to house the following areas: reception of the raw material, process room, packaging section, warehouse, laboratory, office, sanitary services and dressing room.

► The construction must be plastered block with a sanitary finish at the floor and wall joints to facilitate cleaning.

► Floors must be concrete covered with tile or with a drop for drainage.

► Enamelled walls, easy to clean.

► The roofs of metallic structure, with zinc and simple ceiling. They do not allow the accumulation of rodents, birds and insects.

► Buildings must have protections to prevent the entry of pests.

► Use natural lighting if possible. If they have fluorescent lamps, cover them to prevent this material from falling into the processed product.

► The pipes, conduits, rails, beams, cables, etc., must not be free above tanks and work areas where the process is exposed, the risks of contamination to the products by condensation and accumulation of dust. They must always be kept clean.

► The facilities must have an area only for the temporary deposit of waste and garbage, outside the production area.

► Refrigeration or freezing chambers should allow easy cleaning, drainage and sanitary conditions.

► Trash and waste receptacles must be kept covered and identified.

► Waste and garbage generated in the process area must be collected from the plant daily.

► Containers for storing toxic materials must be properly identified and used exclusively for the handling of these substances, they must render them useless, destroy them or send them to authorized confinements.

►The facilities must be well ventilated.

► Have basic services permanently such as potable water and electricity.

► The steam used on surfaces that are in direct contact with the products must not contain hazardous substances that contaminate the product.

► Non-potable water pipes used for steam production, refrigeration, fire protection must be separated and identified by colors.

► The toilets in good condition and always clean. They must have the toilet, urinal and sink; in addition to cleaning utensils such as antibacterial soaps, towels, toilet paper, etc. likewise, they must have septic tanks and separate wastewater disposal from the processing plant. They should not have direct access to the place of processing. Be located in the yard and a little lower than the place where the food is processed to avoid flooding and contamination.

► A record must be kept of the chlorine content of the supply water. Microbiological analysis of total coliforms and fecal coliforms is recommended.

► Drains must be adequately covered to prevent entry of pests from the sewers or external areas. Drains must be provided with odor traps.

►The processing plant should be away from polluting areas like garbage dumps, vacant lots, overgrown lands, animal husbandry enclosures, near polluting industrial plants, etc.

► The doors must be made of metal or glass and glass windows; it is recommended to use a screen on doors and windows.

► Windows and vents must be provided with protections in good condition to reduce the entry of dust and rain.

► The air circulation openings must be protected with screens of non-corrosive material and must be easily removable for cleaning.

► Window glass that breaks should be replaced immediately. Collect all the fragments and make sure that none of the remains have contaminated ingredients or products.

► The use of unbreakable materials or plastic materials is recommended near exposed products.

► The glass windows must have a protective film that prevents the projection of particles in case of breakage.

► The direction of the air flow should never go from the dirty to the clean area.

► The area where the foods with the highest risk are exposed will not have direct access from the outside, they will place a double door system with protection systems for rodents and insects, thus avoiding contamination.

► Have a storage place separate from the processing plant.

► A place where the raw material is received, classified and even if it is necessary to cut it before entering the process.

► Have a warehouse for supplies and another for products, both can be located in a single area or room, separated by a mesh or board.

► Locate the kettles in the central part near the process line.

► Processing plants can be small. The important thing is that workers can carry out their work with a little space and safety.

► The workbench or process line should be about 80 cm away from the wall, so workers can carry out their work on both sides.

► All surfaces in direct contact with food should not be covered with paint or other removable material that represents a risk to food safety.

► Rodents must be trapped and eliminated.

► Handwashing facilities in processing areas.

► Do not allow the entry of domestic animals in the processing areas, raw material warehouses and finished product.

STANDARDS IN PROCESSING

► Raw materials must be inspected and classified before they are brought to the production line.

► Raw materials must be harvested with adequate maturity.

► Raw materials must be of good quality, kept in good condition, clean, without physical damage, maintain their organoleptic attributes.

► Raw materials should not be exposed directly to the sun.

► Raw materials and ingredients that contain parasites, pathogenic microorganisms and toxic substances will not be accepted.

► Raw materials that are obviously not suitable must be separated and disposed of in order to avoid misuse, contamination and adulteration.

► Fruits and vegetables are very sensitive to environmental conditions and for this reason they must be processed immediately after being harvested to avoid browning or other reactions.

► Only drinking water will be used as raw material according to national or international standards.

►The water used for cleaning and washing raw materials that come into direct contact with food must be purified or treated according to national or international standards;

► The materials' storage area should not be used for the storage of other products such as pesticides, paints, or cleaning utensils.

► All food processing operations should be done in the shortest time possible. Do not keep the products in the environment if it is not necessary.

Terminate one process and immediately enter the next.

► Follow all the given procedures step by step, such as: order of addition of components, mixing times, stirring and other processes, recording your procedure.

► Eliminate residues of the fruit remains that are left in the various preliminary operations.

► Peeling, stripping and other operations leave a lot of residues, these must be carried out in a place outside the process room.

► Do not mix products in the process of making with those that are not processed or fresh.

► Wood and other materials that cannot be adequately cleaned and disinfected should not be used in food and non-alcoholic beverages when in contact with raw materials and finished product.

► Care must be taken that the cleaning carried out during the manufacture or preparation of products does not generate dust or splashes of water that could contaminate them.

► All raw materials or products in process, which are in drums and containers must be properly covered and the bags kept closed to avoid contamination by the environment.

► If food in the process of preparation falls to the ground, it must be disposed of as required by law.

► Avoid contamination with foreign materials (dust, water, grease, etc.) that adhere to the packaging of the supplies that enter the production areas.

► Raw materials must be separated from those already processed or semi-processed, to avoid contamination.

► All inputs must be properly identified.

► The inputs used as food additives in the final product will not exceed the limits established in the Codex Alimentarius or equivalent international regulations.

► The packaging process must be done with great care to avoid contamination.

►Finished products must be stored and transported in appropriate, clean and contaminant-free places.

► All preservation methods must be appropriate to the type of product and raw material.

►The raw materials and supplies preserved by freezing that require thawing prior to use should be thawed under adequate controlled conditions to avoid the development of microorganisms.

► Containers and containers that come into contact with food must be made of materials that do not transfer harmful substances to food.

► If the containers are made of glass, and they break, make sure that the pieces of glass do not contaminate the adjacent containers.

► All glass containers or jars must be sterilized before filling the product.

► Packaging and containers of raw materials should not be used for purposes other than those for which they were originally intended.

► Tanks or deposits for the transport of food in bulk will be designed and built-in accordance with the respective technical standards, their surfaces will not be able to accumulate dirt and cause fermentation, decomposition or changes in the product.

► The products must be well labeled that includes all the details that the product contains, the batch number, date of manufacture, expiration date, identification of the manufacturer, sanitary registration, etc.

► In the application of chemical sanitizers are chlorinated ones, using sodium and calcium hypochlorite, and chloramines. They should be applied with a pH between 6 and 7 for 5 minutes, with temperatures not exceeding 30 ºC and with low light.

► Production wastes must be disposed of daily.

►After the processing has been carried out and once it is finished, the place will be cleaned with water at 40 °C, it will be cleaned with the detergent, and it will be rinsed.

► Equipment and facilities will be disinfected every 15 days. 2 % soda, 1.5 % nitric acid will be applied at 75 °C. Then it will be rinsed with plenty of water.

► The products used, both in the cleaning and disinfection process, must be from the lists of products authorized by the local health authorities. Without affecting the environment.

TRANSPORT

► Transport vehicles must be inspected by trained personnel making sure they are in good sanitary condition before loading the products.

► The area of the vehicle that stores and transports food must be made of easy-to-clean material and must avoid contamination or alteration of the food.

► Products that are transported outside their packaging must be transported protecting them against rain.

► If ice is used in contact with the product to be transported, it must be fit for human consumption to avoid any contamination.

► Do not transport food together with toxic, dangerous substances or that pose a risk of contamination or alteration of food.

► Vehicles that have a refrigeration system must be checked periodically to ensure proper operation for preserving food at the required temperatures. They must have temperature indicators.

► The person responsible for maintaining the conditions required by the food during its transport is the owner or legal representative of the transport unit.

STORAGE

► Keep all storage rooms cool, dry, and well ventilated.

► The storage and distribution of products that require refrigeration or freezing must be carried out in clean facilities to avoid the growth of psychrophilic microorganisms.

► A temperature and humidity control must be kept in the warehouse that allows the adequate conservation of the product.

► Place the products with enough space for the circulation of cold air.

► Dry food must be protected against moisture.

► Food or products are placed on shelves or pallets located at a height that avoids direct contact with the floor.

► Store dry food away from walls, six inches from the floor.

► Dry food should be out of direct sunlight.

► Store food in suitable containers that do not allow the entry of water or pests.

► Store food in such a way that allows the free entry of personnel for cleaning and maintenance of the premises.

► A temperature between 10 °C and 21 °C is recommended for dry food. Keep humidity between 60 % and 70 %.

► For frozen products, the freezer should be at -18 °C or lower if the food requires another temperature.

► Every freezer should have a thermometer near the front door of the freezer.

► Check the freezer temperature daily.

► Do not overload the freezer.

► Defrost the freezer periodically.

► Keep the freezer closed as much as possible.

BEFORE STARTING PRODUCTS PRODUCTION

To obtain a good quality product you must verify:

► That all documents and protocols related to manufacturing are ready.

► That the production line area is clean according to established procedures. Keep a record of inspections.

► That the environmental conditions such as temperature, humidity and ventilation are correctly fulfilled.

► That all equipment is in good working order.

► That all dangerous or toxic substances must be handled taking particular precautions defined in the manufacturing procedures.

► That all inputs and ingredients are properly identified throughout the manufacturing process.

► That the entire manufacturing process is written in a document, with the steps to follow, the sequence, the time and the controls that must be carried out in each process.

► That the time, temperature, humidity, water activity (Aw), pH, pressure and flow rate required by each food or process are controlled; also monitor manufacturing conditions such as freezing, dehydration, heat treatment, acidification, and refrigeration to ensure that waiting times, temperature fluctuations, and other factors do not contribute to food spoilage or contamination.

► That any abnormality that occurs during the manufacturing process must be recorded, as well as the corrective actions and measures taken.

► When air or gases intervene in the processes or nature of food, as a means of transport or preservation, take the necessary measures to avoid cross contamination.

► That, to avoid contamination or deterioration of the food or product, filling or packaging must be carried out quickly.

► That processed foods that do not meet technical production specifications must be destroyed. If their safety is guaranteed, they can be reprocessed or used in other processes.

► The production and distribution control records must be kept for a minimum period equivalent to the useful life of the product.

In all operations that include the manufacture, processing, packaging, storage and distribution of food, there must be quality controls to prevent and reduce defects that represent risks to human health. It is an obligation that all factories have a safety control and assurance system. The controls will be according to the nature of the food.

This quality assurance system must have the specifications on the raw materials and finished foods, that is, details of the raw materials, their preparation and why the foods have been accepted, rejected or retained.

It must have all the documents on the plant, equipment, processes, manuals and instructions, minutes, regulations, storage, distribution, laboratory methods and procedures.

Laboratory procedures, specifications, test methods, and sampling plans must be officially recognized to ensure that the results are reliable.

Factories or producers using the HACCP System must apply GMP as a prerequisite. They must have their own or external but accredited quality control testing and testing laboratory. Keep a written record of the maintenance and cleaning of the equipment. The cleaning mechanisms of the plant and equipment will be according to the nature of the food. The registry must include the agents and substances used for cleaning and disinfection and their periodicity, as well as the concentrations, forms of use, elimination and treatment action times to guarantee the effectiveness of the operation. Inspect after this operation.

The control of pests such as insects, rodents, birds, etc. it can be carried out by the same company or by third-party sanitation specialists. The company is responsible for establishing preventive measures in order not to put food safety at risk.

Chemicals for rodent control will be used outside of food production, packaging, transportation and distribution areas. Within the manufacturing areas, physical methods will be used.

Sources: Vértice, (2009); FAO, (1993); Official Mexican Standard, (1994); Regulation of Good Practices for Processed Foods- Ecuador, (2002).

SMALL-SCALE PROCESSING PLANT EQUIPMENT AND IMPLEMENTS

FAO, (1993) recommends the following tips to implement a Fruit and Vegetable Processing Plant (See figure 20):

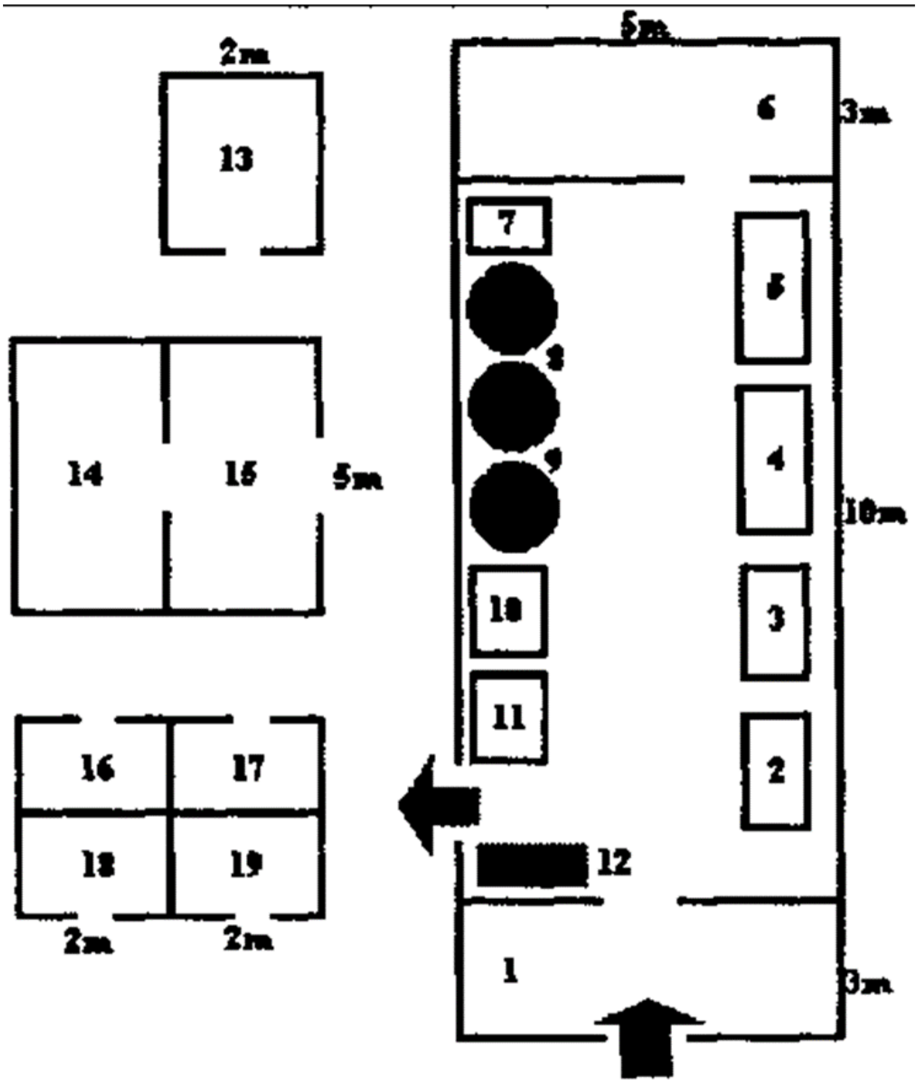


Figure 20: Scheme of Fruit and Vegetable process rooms.
Source: FAO (1993).

Installation of process rooms

PROCESS ROOM

- ► Reception and weighing (1).
- ► Selection and calibration (2).
- ► Washing and disinfection (3).
- ► Peeling and packaging counter (4).
- ► Pulp extraction (5).
- ► Quality control room (6).
- ► Juice extraction (7).
- ► Double bottom kettles (8).
- ► Autoclave (9).
- ► Sealer-bottle cap (10).
- ► Packaging and labeling (11).
- ► Double dishwasher (12).
- ► Boiler room (13).
- ► Warehouse of inputs (14).
- ► Warehouse of products (15).
- ► Men's dressing rooms (16).
- ► Men's bathrooms (17)
- ► Women's dressing rooms (18)
- ► Women's bathrooms (19).

LOCAL AREA

► An area for processing approx. 5 (10) x 10 m, a ceiling fan, a mosquito net and a room to store packaging material, additives and finished products (4 x 4 m.). Natural and artificial light.

► Hygienic services outside the processing area.

► Power supply and electrical outlets on each wall of the processing area.

► Double stainless steel or enamelled dishwasher, with running water.

► Double gas stove with their respective cylinders and regulators. You can also use electric, paraffin or wood heating.

► Drinking water in and around the processing area.

► Wooden table (approx. 180 x 120 x 80 cm.) Enameled or painted, with stainless steel cover.

MATERIALS

► Bottles with caps. As an alternative, disposable and / or returnable beer and beverage bottles (approx. 200-280 ml.) Can be used.

► Metal "crown" caps for bottles.

► Glass jars (approx. 450 gr) with screw caps.

► Glass jars (approx. 900 gr) with screw caps.

- ► Screw caps for bottles of different sizes.
- ► Stickers for bottles and jars.
- ► Citric acid or lemon juice.
- ► Pectin powder for food use, 2 Kg.
- ► Refined sugar.
- ► Flour sacks (approx. 1m X 0.5 m.).
- ► Sodium benzoate for food use, 1 Kg.
- ► Potassium sorbate for food use, 1 Kg.

TEAMS

- ► Scale (50 to 100 Kg.)
- ► Scale (3 to 5 Kg.)
- ► Balance (100 to 500 gr) Manual refractometer (0 - 90 °Brix).
- ► Refractometer (0 - 30 °Brix).
- ► Stainless steel thermometer (0 to 150 °C).
- ► Thick aluminum pot (with a capacity of approx. 50 liters).
- ► Thick aluminum pot (with a capacity of approx. 10 liters).
- ► Thick aluminum pot (with a capacity of approx. 5 liters).
- ► Wooden board (40 x 30 cm), to chop.

► Stainless steel knife with thick blade (15-20 cm. X 2 cm.).

► Stainless steel knife with thick blade (10 cm. X 1 cm.).

► Strainers (25-20 cm in diameter), with aluminum mesh.

► Plastic trays (40 x 60 x 5 cm.).

► Plastic bucket (20 l.).

► Plastic bucket (10 l.).

► Plastic or aluminum funnel, 20 cm. diameter.

► Plastic or aluminum funnel, 15 cm. diameter.

► Stainless steel spoons of different sizes.

► Large plastic spoon.

► Medium wooden spoon.

► Large wooden spoon.

► Manual pulp extractor / separator.

► Manual bottle cap for crown caps.

► Holed plastic boxes for fruit, for 18-20 Kg.

► Small boiler with a production of 250 kilos of steam.

► An autoclave.

► A powered or manual pulper.

► A manual presser.

► A pressurized bottle cap.

► Two double bottom kettles.

It is necessary to have a place or small room in which the minimum analyzes necessary to determine the quality of a given raw material or process can be carried out. The place should have a small sink, running water and a counter to perform the tests.

CHAPTER VI

JELLIES AND JAMS

Jelly is a semi-solid food composed of 45 % fruit juice, 55 % sugar and a 65 % concentration of soluble solids. We have to add some components such as pectin, acids, flavorings or colors to the jelly to cover the deficiencies that some fruits have.

For the preparation of fruit jellies, you will need:

• Pectin • Acid • Sugar • Water

Here is a brief explanation about pectin and acid to understand how necessary these components are in processing for jelly and jam preparations.

PECTIN

It is a non-crystallizable, colorless substance that, when dissolved or mixed with water, forms a gel, forming a dense and gelatinous texture when it is added in small amounts to the acids of fruits, sugar and water [Gianotti and Prandoni, 2012]. Pectin is found in the cell walls of fruits. Commercial pectin is sometimes used, because as we said before, some fruits do not have enough. Pectin is used to preserve jellies or jams.

To dissolve pectin in jellies or jams, heat the water or juice before mixing the pectin and sugar so that they dissolve easily. If dry pectin is added to cold water or juice, it will form lumps and affect the processing time. Pectin mixed with 10 times its weight in sugar will dissolve quickly. Jellies that are high in pectin keep best.

Pure pectin ranges from 0.5 % to 1.5 % by weight and household pectins contain up to 18 % sugar for each part of pectin. The stiffness of the gel depends on the concentration of sugar and acidity. The precise gel forms between 65 % and 68 % soluble solids and in a pH range of 3.1 to 3.3. Greater than 70 % and a pH lower than 3.0 we will obtain a hard gel [Smith, 2007].

Classification

Pectin is classified according to the gelling speed in two:

• Fast gelling, which are those that form gels at higher temperatures than slow gelling, are used for jams and preserves because they do not allow the fruit to rise to the surface before hardening.

• Slow gelling used to make jellies. The pectin grade value refers to the pounds of sugar that one pound of pectin gels. Commercial grade 150 pectin is the most widely used, one pound of pectin produces a perfect jelly with 150 pounds of sugar; Commercial grade 100 pectin is also used.

ACID

The acid does not allow crystallization, it gives shine, color and more flavor, it helps to lower the pH and obtain the optimal condition for gelling [Nunes, 2006]. The pH of the jelly determines the firmness of the gel. Pectin is identified by their degree of methylation (GM). The slow gelling is pectin with a range of 60 to 65 GM, they are used in the commercial production of jellies, a firm gel is obtained at a pH of 3.0 to 3.15; for good gelation the upper limit is a pH of 3.4. Rapid gelling is pectin with a range of 68 to 75 GM, they are used for jams and preserves because they harden at higher temperatures. They reach maximum firmness at a pH of 3.30 to 3.05; with a pH of 3.6 being the upper limit for good gelation.

The gelation temperature is determined by the pH. With fast gelling pectin the gelation temperature can be increased by approximately 25 °F as the pH is lowered from 3.3 to 3.1, it becomes more acidic. Slow gelling pectin gel between 50° and 60 °F at a pH of 3.0 to 3.25. Acidifying a jelly with slow-gelling pectin at a pH of 3.25 to 3.0 lowers the gelling temperature by approximately 50 °F [Smith, 2007].

PREPARING THE JELLY

Figure 21: Artisan fruit jelly.
Source: https://practicalselfreliance.com/

For the preparation of the jelly (See figure 21), apart from the equipment and materials, we need to know about the extraction methods that can be used, such as: juice extraction, cold pressing and hot - break.

EQUIPMENT AND MATERIALS

According to Smith (2007), stainless steel equipment is recommended because it is highly resistant to the action of fruit juices and enameled containers. Steel or iron and aluminum darken the juice. Galvanized containers (with zinc coating) are not recommended due to the toxic levels of zinc that can dissolve in the juice, nor are materials that have copper and tin because their salts affect the flavor and color of most juices, producing undesirable changes.

JUICE EXTRACTION

The fruits must be healthy, firm, have a good flavor and a good aroma, eliminating the defective ones and those infected by insects. The juice during processing and storage as jelly must maintain the same good aroma and flavor characteristics. Even if it has little fermentation or mold it will affect the flavor. The pectin level, flavor and sugar of the juice vary according to the ripeness of the fruit. Clean containers, free of dirt and mold, will be used for the collection and transport of the fruit. Some fruits accumulate dust during harvesting or transport, for this reason they should be rinsed with jets of water before being crushed. Fruits are traditionally blanched before juicing.

PRESSING

According to the structure of the fruit, the extraction method is used. Previously, the pulp and juice were heated, placed in a cloth jelly bag and drained to obtain a clarified juice. Currently, rack and cloth filter presses are used to extract the juice from the hot fruit. To facilitate the filtering of the juice, the sugar is added afterwards.

HOT-BREAK

To facilitate the extraction of the juice and inactivate the enzymes and maintain the color of the fruits, temperatures below the boiling point are used, although its juice has a cooked flavor, it is very good for the production of jellies.

JELLY PROCESSING

Raw material

• Pulp of some fruit (45 %) except for several fruits such as bananas (25 %) or soursop (30 %).

• Sugar from 55 % to 70 %.

• Pectin 0.3 – 1 %.

• Citric acid 0.2 - 0.8 %.

► The chosen fruit is received and selected (Fig. 22).

Figure 22: Selection of apples.

Source: https://www.recetasdesbieta.com/

►It is washed with plenty of water and disinfected with immersion or spraying of 1 % Sodium Hypochlorite solution for 1 to 2 minutes and rinsed with plenty of water (Fig. 23).

Figure 23: Apple washing.
Source: ximenallosachef.blogspot.com

► The apples are peeled and cut (Fig. 24).

Figure 24: Peeling apples.
Source: https://www.hiddenspringshomestead.com/

► It is scalding depending on the type of fruit from seconds to minutes between 75 °C to 90 °C (Fig. 25).

Figure 25: Blanching the apples.
Source: https://www.hiddenspringshomestead.com/

► The fruit is pulped.

► The filtered juice is heated.

► Evaporation takes place. Citric acid is added until reaching a pH of the fruit pulp of 3.5-3.8. The acid addition depends on the original acidity of the juice. The sugar must be applied divided into three equal parts, during the solid’s concentration process (Fig. 26).

Figure 26: Adding a part of sugar.
Source: https://www.recetasdesbieta.com/

► A portion of sugar is mixed with the pectin before adding to the juice to aid in the dissolution of the pectin (Fig. 27).

Figure 27: Mixture of pectin with sugar.
Source: https://pickyourown.org/

► Slowly dissolved pectin is added to hot fruit juice at 170° to 180 °F.

► With the application of the last part of sugar, the dissolved pectin is applied until reaching a solid concentration of 65 to 68 °Brix.

► Boiling increases the concentration of sugar to a point where it gels and forms a jelly of the proper consistency when cooled. Not long to avoid losing flavor and color (Fig. 28).

Figure 28: Boiling of the jelly.
Source: https://pickyourown.org/

► Take a little jelly with a spoon, if it partially coagulates and falls, leaving the spoon clean, check that the boiling is complete. The refractometer that determines the sugar content is also used, a drop of the liquid is placed on the refractometer and the percentage of sugar or °Brix is read directly from the scale.

► It is packaged at 85 °C in previously sterilized glass jars. They are filled to 90 % of their capacity, that is, we leave half an inch of space at the top of the bottle (Fig. 29). The boiling lids are placed on the containers immediately after filling and squeezed at an interval of two or three minutes to evacuate the air from the headspace. When the containers are filled with heat it is not necessary to sterilize them after placing the lid on them.

Figure 29: Packaged jelly.
Source: www.recetasdesbieta.com

► In the exhausting tunnel, the semi-covered jelly jars are placed at a temperature of 90 °C for 20 minutes, then the lid is opened to allow the compressed air to escape, then they are tightly covered and placed again in the tunnel at a temperature of 90 -100 °C for 30 to 40 minutes.

► They are labeled following INEN standards and stored at room temperature.

PREPARATION OF JAM

Jam is the concentrated pulp with sugar, pectin and acid that, having reached sufficient Brix degrees, produces gelation during cooling. The characteristics of a quality jam are: having a good consistency (pasty but not hard body), a good fruity flavor, having a bright color, well gelled and not too rigid so that we can spread it easily.

RAW MATERIAL

- Fruit 50 %.
- Sugar 50 %.
- Citric Acid from 0.15 % to 0.20 %.
- Pectin from 1 % to 1.5 %.
- Preservatives: 0.05 % sodium benzoate and/or potassium sorbate.

The percentages mentioned above may be different depending on the type of fruit and its acidity.

FRUIT

Fruits are the most important ingredient as they provide flavor, smell, product color, pectin, acids and sugars that are necessary elements for a final product. The most common fruits used in the production of jams are: strawberry, raspberry, blackberry, apricot, peach, orange, pineapple, among others.

Among the characteristics that the fruit must have been:

• Optimal state of maturity.

• Flavor, color and aroma of fruits that have reached physiological maturity.

• Good sugar-acid balance.

• Adequate pectin content.

• Without presenting physical damage.

It is used to make jams:

• Fresh fruit.

• Fruit rejected for size.

• Preserved fruit.

SUGAR

It is preferable to use white sugar because it maintains the characteristics of the color and flavor of the fruit; We use brown sugar for dark-colored fruits like blackberries. The concentration of sugar in the jam should prevent both fermentation (too little sugar) and crystallization (too much sugar). The amount of sugar must be more than 60 % of the weight of the finished product [Jones, 2001].

When the sugar is cooked in an acid medium, the inversion of sucrose occurs, splitting into two sugars (fructose and glucose) that delay or prevent the crystallization of sucrose in the jam. Sucrose and invert sugar must be balanced for the good conservation of the product. A low investment causes the crystallization of cane sugar, and a high or total investment, the granulation of dextrose. The optimal percentage of invert sugar is between 35 and 40 % of the total sugar in the jam. Sweeteners are used in the manufacture of jams from the following sugars: sucrose, invert sugar, glucose and honey.

ACIDS

Many fruits are acid deficient and must be added to produce a good gel. Fruits contain different organic acids, of which one generally predominates. Ecuadorian standards allow the addition of the following acids: citric, tartaric, malic [INEN 0419, 1988]; the most widely used is citrus due to its pleasant flavor, it prevents sugar crystallization, brightens the color of the jam and prolongs its shelf life [Coronado and Hilario, 2001]. Citric acid (the amount is between 0.15 and 0.2 % of the total weight of the jam) is added before cooking the fruit as it helps to extract the pectin; although lemon juice is used as a source of citric acid.

PECTINS

Pectin is located in the cell walls of fruits. It is extracted when the fruit is a little green. The proportions of pectin, citric acid and sugar must be exact for the final product to be of good quality. The quality of the pectin is expressed in degrees. The grade of the pectin indicates the amount of sugar that a kilo of this pectin can gel, that is, at a sugar concentration of 65 % and at a pH between 3 - 3.5. Eg A 150-grade pectin means that 1 kilo of pectin will gel 150 kilos of sugar [Chacón, 2006].

Currently, carrageenan and modified starch are used as a substitute for pectin; although "the product must be free of starches, starches and other gelling agents other than pectin" [INEN, 1988]. Commercial pectin is available in solid and liquid form. It is recommended to use powdered pectin, because its activity remains unchanged during storage at room temperature, whereas liquid pectin undergoes degradation, losing activity with storage and requires a preservative to prevent fermentation (See Table 3).

Table 3: Fruits that have pectin and acid.

Fruits rich in pectin and acid	**Grapes, green apple (Granny Smith), guavas, cherries, plums, blackberries, citrus in general.**
Fruits moderately rich in pectin and acid	Ripe grapes, ripe apples, ripe fruits in general.
Fruits rich in pectin and poor in acid	Ripe melon, green figs, strawberries.
Fruits poor in pectin and acid	Peaches, pears.

Source: Coronado e Hilario, 2001.

Pectin test

According to Jones (2001) states that, if the amount of pectin in the fruit to be preserved is sufficient to obtain a stabilized product or not, we check it as follows: we put 30 ml. of the fruit already cooked in a jar, and it is cooled, then the equivalent amount of methyl alcohol is added, shaking the mixture gently and allowing it to stabilize. If a single mass of gelatin forms, it means that the mixture contains a lot of pectin. If 2 or 3 smaller masses are formed, it means that it contains a moderate amount of pectin and a moderately stabilized preserve will result; If there are several masses, it will indicate that there is little pectin and more must be added.

PRESERVATIVES

Preservatives are substances that are added to food to prevent its deterioration, avoiding the development of microorganisms such as fungi and yeasts [Chacón, 2006]. The most used chemical preservatives are potassium sorbate and sodium benzoate. Potassium sorbate has a greater action on microorganisms. Sodium benzoate acts on fungi and yeasts and is inexpensive, but at certain concentrations it produces changes in the taste of the product and has a higher degree of toxicity on people.

EQUIPMENT AND MATERIALS

Teams

• Pulper or blender

• Kitchen

• Balance

• Refractometer

• pH meter or acidity indicator tape

• Thermometer

Materials

• Pots

• Plastic tubs

• Jugs

• Strainers

• Chopping boards

• Knives

• Measuring spoons

• Skimmer

• Palettes

• Work table

• Glass or plastic jars

PROCESS

When fresh fruit is used, the following steps are carried out:

1. Reception of the harvest.

2. Selection, spoiled fruits are eliminated.

3. Weighing, in addition to weighing in this process, yields are determined and the amount of the other ingredients is calculated.

4. Washing that can be by immersion, agitation or spraying.

5. Disinfection, washing the fruit removes dirt and foreign particles.

6. Peeling, it is done manually using a knife or with machines.

7. Cut, according to our taste.

8. Pulping, the pulp is obtained.

9. Desulfation (when sulfated fruit is used, boil it with 20 % water and heat it for 5-10 minutes, eliminating 90 % of the sulfur dioxide present).

When the pulp is obtained, the concentration of soluble solids and the pH are verified. The proportion of the various components of the product is then calculated; this formulation depends on the product to be obtained: final Brix degrees and percentage of fruit.

10. Cooking, to determine the end point of cooking the following methods are used:

• **Drop test in glass of water,** consists of placing drops of jam in a glass of water. These drops should fall to the bottom of the glass without disintegrating.

• **Thermometer test,** a caramel-type alcohol thermometer is used, graduated up to 110 °C. The bulb is inserted until it is covered with the jam. Wait for the alcohol column to stabilize and then take a reading. The bulb should not touch the bottom of the pot so that it does not reach the temperature of the pot.

In the cooking process, the pulp and half the sugar are added to the kettle (to transform the sugar into invert sugar), when the boiling begins, the other half of the sugar is added so that it dissolves completely (no more than 60 °Brix), thus a special shine is achieved by glucose. Brix degrees must be controlled to avoid crystallization and do not cook in open containers of more than 400 kg in order not to degrade the pectin.

11. To avoid too much sugar inversion, the addition of acid or salt for pH adjustment is done before the end of the process. The pectin is added at the end of it and in a mixture of 5 to 10 times its weight in sugar due to its tendency to form lumps. The jam must reach a pH of 3.5 for the preservation of the product (See table 6).

Table 6: Table of addition of citric acid.

Pulp pH	Amount of Citric Acid to add
3.5 a 3.6 * **	1 to 2 gr / kg pulp
3.6 a 4.0	3 to 4 gr / kg pulp
4.0 a 4.5	5 gr. / kg pulp
More of 4.5	More of 5 gr / kg pulp

Source: Coronado and Hilario, 2001.

*** Blackberries and strawberries; that have a pH of 3.5, 2 grams of citric acid is added for each kilo of pulp.

Boiling (8 to 10 min.) If the boiling time is exceeded can invert sucrose too much, degrade pectin, deteriorate the flavor and aroma of the product. The boiling evaporates the water achieving the desired concentration, also the pasteurization of the mixture dissolving the sugar, the other soluble ingredients and the partial inversion of the sucrose.

The mixture thickens at the end of the boil and the best way to check if it is ready is to use a ladle with a little of the mixture and when pouring it falls in thick drops. The degree of concentration (65 °Brix) is checked with the refractometer, the sample must be cooled and from there the preservatives are added: Sodium Benzoate 0.05 % with respect to weight/Potassium Sorbate 0.05 %. If we make jam with pieces of fruit, they are prepared in a 70 % syrup until they cook, then they are removed, drained and preservatives are added.

When the mixture cools down (not -85 ºC), it is poured into the conservation containers. When the jam contains pieces of fruit, cooling makes the product thick so that the fruit does not rise to the surface and prevents the degradation of the pectin. The filled containers are closed under a jet of steam to sterilize the lid, container walls and free space. Then the containers are cooled in the air or underwater showers and let them rest until they are completely cooled, thus avoiding the degradation of the pectin and we will have a good gelation that takes place between 50 - 60 ºC.

12. Labeling is the final stage. The label must include all the information about the product, according to INEN (1988) the following information must be noted.

► Product designation.

► Trademark.

► Lot number or code.

► Business name of the company.

► Net content in S.I.

► Date of maximum consumption time.

► Health Registration Number.

► List of ingredients.

► Retail price.

► Country of origin.

► INEN technical standard of reference.

► Form of conservation.

► And other specifications required by law such as the traffic light.

13. The storage must be in a cool, clean and dry place; with sufficient ventilation in order to guarantee the conservation of the product until the moment of its commercialization.

TIPS FOR A GOOD PREPARATION OF JAM

According to Coronado and Hilario (2001), they state that these requirements are essential to achieve an optimum quality jam.

► Soluble solids per reading (°Brix) at 20 °C: min. 64 %, max. 68 %.

► pH: 3.25 - 3.75.

► Ethyl alcohol content in % (V/V) at 15 °C/15 ° C: max. 0.5.h

►Conservative: Sodium Benzoate and/or Potassium Sorbate (alone or together) in g/100 ml: max. 0.05.

►Must be free of pathogenic bacteria. A maximum mold content of five positive fields per 100 is allowed.

► Should not contain antiseptics.

Next, we can see in table 4 the defects that usually occur in the production of jams.

Table 4: Defects in the production of jams.

DEFECTS	CHANGES OF COLOUR	SYNERESIS OR BLEEDING **	GROWTH OF FUNGI AND YEAST ON THE SURFACE	CRYSTALLIZATION	LOOSE OR LITTLE FIRM JAM ***
CAUSES*	•Prolonged cooking, caramelizes the sugar.	•Pectin deficiency.	• Leaky containers of the 63 %.	• High amount of sugar.	•Prolonged cooking that causes hydrolysis of the pectin.
	• Poor cooling after packaging.	• Too high acidity	• Filling of the containers at too high a temperature, higher than 90 °C.	• High acidity causing the high investment of sugars, leading to the granulation of the jam.	• High acidity in the formation structure system.
	•Metal contamination: tin, iron, and their salts cause a dark color. Magnesium and potassium phosphates, oxalates, and other salts of these metals cause cloudiness.	• Too much invert sugar.	• Filling of the containers at too low a temperature, less than 85 °C.	• Too low acidity causing crystallization of sucrose.	• Too low acidity that impairs gelling.
		• Poor concentration, excess water (too low in solids).	• Syneresis of the jam.	**• Overcooking that results in an excessive investment.**	• High amount of mineral salts or buffers present in the fruit, which delay or prevent complete gelling.
			• Contamination due to poor sterilization of containers and used caps.	• The jam that remains in the cooking pans or pots, after boiling leads to an excessive investment.	**• Lack of pectin in the fruit.**
			• Contamination prior to closing the containers.		• High amount of sugar in relation to the amount of pectin.
			• Excessive humidity in storage.		• Excessive cooling that causes the gel to break down during packaging.

Source: Coronado and Hilario, 2001.

* To determine the causes of defects, the following factors should be checked: soluble solids content (°Brix), pH, color and flavor.

** To determine this failure, the following must be checked: °Brix and pH. It occurs when the solidified mass releases liquid, the trapped water is exuded and a compression of the gel occurs.

*** For the determination of this failure, it is necessary to check °Brix, pH and the gelling capacity of the pectin.

MANGO MARMALADE

Raw material

• Mangoes 50 %

• Sugar 50 %

• Citric Acid from 0.15 % to 0.20 %.

• Pectin from 1 % to 1.5 %.

• Preservatives: 0.05 % sodium benzoate and/or potassium sorbate.

Process

► Selection of the mangoes, they are in good condition and good state of maturity (Fig. 30).

Figure 30: Selection of handles.
Source: El Salous, 2016.

► Peel the mangoes, remove the central bone and cut them into small cubes (Fig. 31).

Figure 31: Mangoes cut into squares.
Source: El Salous, 2016.

► Weigh the fruit; and add the same weight of sugar.

► In a saucepan, add the mango pulp along with half the sugar, when the boiling begins the other half of the sugar is added so that it dissolves completely, we add the acid to adjust the pH. The pectin is added at the end of it and in a mixture of 5 to 10 times its weight in sugar due to its tendency to form lumps and from there the preservatives are added at 0.05 % with respect to the weight.

► Stir well and cook until set well, moving it with a spoon so that it does not stick to the bottom of the pan, removing the foam every time it is required (Fig. 32), then let it cool.

Figure 32: Cooking over low heat.
Source: El Salous, 2016.

► Sterilize the containers that we will use at home in boiling water for about 10 minutes.

► Take out and put upside down to dry completely.

► Pour the jam into the containers when it has reached a thick consistency.

► In a vacuum, put the jam containers tightly closed in a pot with a cloth and cover them with two fingers of water, put it to boil and when it starts to boil, we leave it for about 20 minutes.

► Cool them completely.

► Label the containers and store according to the specifications indicated by the INEN.

NONI JAM

Currently, noni is a fruit that is widely used for its nutritional properties, its flavor is a bit strong and unpleasant, you can add some substance that when combined can reduce its unpleasant taste.

Raw material

• Noni 50 %

• Sugar 50 %

• Vanilla essence 4 %

• Pectin 1 % to 1.5 %.

• Citric Acid from 0.15 % to 0.20 %.

• Preservatives: Potassium Sorbate and/or Sodium Benzoate at 0.05 %.

Process

► Select and peel the noni and marinate it in a glass jar with a lid, with a little lemon juice, vanilla essence and sugar (50 % syrup). Leave a couple of days until it is ripe (Fig. 33).

Figure 33: Selection of the noni fruit.
Source: El Salous, 2016.

► Once ripe we place it in a saucepan with a thick bottom and add sugar, citric acid, pectin and preservatives as in the previous process (Fig. 34).

Figure 34: We add sugar to the noni.
Source: El Salous, 2016.

► Boil over low heat until it has the consistency of a sweet. Add a little water if necessary. When it reaches the exact boiling point, turn it off, let it rest and add a few drops of vanilla essence to flavor it (Fig. 35).

Figure 35: We boil the noni.
Source: El Salous, 2016.

► Pack in glass jars previously sterilized; Label noting the name of the product, the date of manufacture and ingredients as indicated by the

INEN (Fig. 36). Store in a dry place and away from light.

Figure 36: Noni jam.
Source: El Salous, 2016.

APRICOT JAM

Raw material

• Fresh apricots 50 %

• Sugar 50 %

• Citric Acid from 0.15 % to 0.20 %.

• Pectin from 1 % to 1.5 %.

• Preservatives: 0.05 % sodium benzoate and / or potassium sorbate.

Process

► Collect not very ripe apricots and separate the fruit with defects or damaged.

► Wash with plenty of water and drain the excess water.

► Separate the stem, resin residues and those pieces of apricots with small spots. Open each fruit in half, using our fingers and remove the pit.

► Weigh and put the halves in a pot or kettle over low heat and stir frequently with a wooden ladle so that it does not stick to the bottom of the pot and burn, boil for approximately 15 minutes.

► Separate the residues of dark skin that have remained on the fruit, raise the heat for another 15 minutes, constantly stirring with the ladle.

► Add the sugar and dissolve, let it cook as in the previous process.

► Add the remaining sugar, citric acid, pectin and preservatives, dissolve and boil for 15 - 20 minutes, turn off the fire when the product is at its point, that is, thick.

►Fill the glass jars (washed and dried) with the hot jam up to 1.5 cm from the top, clean the top of the jar and close with the screw cap. We put the covered jars upside down, to sterilize the lid until the content is cool.

► Remove the jam residue from the outside of the jar and the lid, label the containers with the name of the product, ingredients and production date, following all the aforementioned specifications and in accordance with the INEN.

► And finally store it in a dry place, without dust and away from light.

TROPICAL FRUIT JAM

For the production of tropical fruits (pineapple, papaya, passion fruit, guava) the same procedure is followed. Passion fruit and guava are made with pulp already extracted, the seeds are removed and pectin is added.

Raw material

- Pineapples 50 %
- Sugar 50 %
- Citric Acid from 0.15 % to 0.20 %.

• Pectin from 1 % to 1.5 %.

• Preservatives: 0.05 % sodium benzoate and/or potassium sorbate.

Materials and Equipment

• Aluminum pot with lid.

• Screw-on jars with metallic screw-on lid of different sizes already sterilized or jars with "twist off" lids.

• Heat source.

• Kitchen utensils: wooden spoon, wooden board, knives, spoons and funnel, cleaning cloths.

• Plastic or metal buckets.

Process

► Separate the unripe, defective or damaged fruit and wash them with plenty of water, draining the excess.

► Cut the fruit into halves or quarters, depending on the size, placing it in a pot, put over medium heat and stir frequently with a wooden spoon so that it does not stick to the bottom of the pot and burn. Boil over low heat for 15 minutes and increase the heat for another 15 minutes stirring with the spoon.

► Add a first part of the sugar, dissolve quickly and boil for 30 minutes, add the remaining sugar, citric acid, pectin and preservatives as in the previous processes, dissolve and boil for approximately 15 - 20 minutes.

► Turn off the heat when the product has thickened and fill the glass jars (washed and dried) with the hot jam up to 1.5 cm from the top.

► Clean the upper part of the jar, close with the screw cap and put the covered jars upside down, to sterilize the lid until the content is cool, remove all jam residues from the outside of the jar and from the top.

► Label the containers as indicated by the Ecuadorian norm for preserves.

► Store in a dry place, without dust and away from light.

STRAWBERRY JAM

We can also make strawberry jam, sarsaparilla (dog grape), raspberry, cherry or a mixed jam with these fruits.

Raw material

• Ripe strawberries 50 %

• Refined white sugar 50 %

• Citric Acid from 0.15 % to 0.20 %.

• Pectin from 1 % to 1.5 %.

• Preservatives: 0.05 % sodium benzoate and/or potassium sorbate.

Process

► Collect the fruits and separate the ones that are ripe, eliminate those that are defective and damaged.

► Wash with clean water and drain the excess water, disinfect with sodium hypochlorite followed by washing until the disinfectant is removed.

► Separate the stems and cut the fruit into halves or quarters, depending on the size, and place them in a pot, add half the sugar in layers, a layer of the fruit covered with a layer of sugar, and leave it to rest overnight.

►Add the citric acid or green lemon juice, cook.

►Add a second part of the sugar and stir everything with a ladle, add the pectin and preservatives; continue cooking over low heat constantly stirring to prevent the product from burning (Fig. 37).

Figure 37: Adding sugar.
Source: El Salous, 2016.

►Boil over high heat, stirring and removing the foam. We turn off the heat and let the jam cool slightly to 90 - 95 °C before filling the jars. (Fig. 38).

Figure 38: Strawberry concentrate.
Source: El Salous, 2016.

►Label and store following the procedures mentioned above.

CARROT AND LEMON JAM

Raw material

• Carrot 1 kg

• Lemons 200 g

• Sugar 1 kg

• Lemon juice

• Water

• Pectin from 1 % to 1.5 %.

• Preservatives: 0.05 % sodium benzoate and/or potassium sorbate.

Materials and Equipment

• Those listed above and a wide-mouth funnel, wooden board, and cheese grater.

Process

► Select carrots by size and maturity, separate the leaves from the stem.

► Wash the carrots with plenty of water, brushing to remove all residues of soil from the roots. Let the excess water drain.

► Cut into strips 3 - 6 mm thick, cutting the strips in half, or can grate the carrots with a grater.

► Weigh and put the pieces in a pot.

► Wash the lemons and cut into thin slices, eliminating the seeds. Cut the peels into thin strips, without removing the white skin, and add the peel strips, the inner part and the juice to the carrots.

► Add water to cover the carrots and simmer for an hour or an hour and a half, depending on the maturity of the carrots, constantly stir with a wooden ladle avoiding burning.

► When the carrots begin to fall apart and become transparent and the lemon peel strips are soft, add 1/3 of the total sugar and dissolve, continue cooking for 10 minutes over medium heat.

► Add the remaining 2/3 parts of sugar, about 5 ml of lemon juice, pectin, preservatives and dissolve. Boil over normal heat until it is accentuated, always stirring with the ladle and turn off the heat.

► Fill the glass jars (washed and dried) with the hot jam up to 1 - 1.5 cm from the top, clean the top of the jar and close with the screw cap, and put the covered jars upside down to sterilize the lid, until the content is cool.

► Remove the jam residue from the outside of the jar and the lid, label and store following the procedures mentioned above.

ORANGE JAM

Raw material

• Oranges with a low degree of bitterness 50 %

• Sugar 50 %

• Pectin 0.05 %.

• Preservatives: 0.05 % sodium benzoate and/or potassium sorbate.

Materials and Equipment

• Manual orange juice extractor.

• Plastic tanks to store the juice.

• Filter cloths, one thin and one thick.

• Medium and large pot.

• Various utensils: knives, wooden spoon, cloths, trays, strainers.

• Balance.

• Refractometer.

• Heat production system.

• Washing system.

Process

►Select healthy oranges, wash the oranges with drinking water and detergent, rinse well and drain.

►Split the oranges, extract the juice from the halves and store the peels in clean tanks.

► Filter the juice twice, in a thick cloth and in a fine cloth, weigh the juice, measure the soluble solids and heat to a slow boil with the pot covered.

► Remove the albedo (white part) to some shells and add them, and macerate the peels in the juice for 15 minutes and remove them.

► Add sugar to complete 65 - 68 ºBrix, and leave a little sugar to mix with the pectin.

► Weigh the pectin at 0.05 % of the total weight of the juice and sugar mixture. We add the pectin mixed with the sugar to the juice and dissolve it.

► Separately cut the shells into thin strips of 3 - 4 mm thick and 3 cm long, we remove the albedo and add these shells to the boiling mixture with the preservatives and cook for 5 minutes in a covered pot.

► fill the jars, cool, label and store following the steps mentioned above.

BLACKBERRY JAM

Raw material

• Fruit pulp 50 %

• Sugar 50 %

• Citric Acid from 0.15 % to 0.20 %.

• Pectin from 1 % to 1.5 %.

• Preservatives: 0.05 % sodium benzoate and/or potassium sorbate.

Materials and equipment

• Aluminum pot with lid.

• Screw-on jars with screw-on metal lids of different sizes already sterilized or jars with twist off lids.

• Heat source.

• Kitchen utensils: wooden spoon, wooden board, knives, spoons and funnel, cleaning cloths.

• Plastic or metal buckets.

Process

► Reception and selection of blackberries. We separate the blackberries that are not in a state of adequate maturity and the damaged ones.

► Weigh the blackberries. We blanch them at 85 °C for 2 or 3 minutes.

► Put the pulp in the pot with 1/2 of the sugar, citric acid, and we put it to cook over moderate heat, stirring it continuously. When it reaches the boiling point, we add the second part of sugar with the pectin and preservatives at the end of the process.

►End point determination is 65° - 68 °Brix.

►Pack them at 85 °C in the previously sterilized jars. When jams are made at an industrial level, "Exhausting" is used, this is a process in which the semi-covered jam jars are placed in an exhausting tunnel at a temperature of 90 °C for 20 minutes. Then they open the covers to let the air out and close them well and enter the tunnel again at a temp. 90 - 100 °C for 30 - 40 minutes.

► Afterwards, either by hand or industrially, we label and store following the steps mentioned above according to the INEN standard (Fig. 39).

Figure 39: Artisan blackberry jam.
Source: El Salous, 2016.

BANANA AND APPLE JAM

Raw material

- Bananas 35 %
- Apples 30 %
- Sugar 45 %

• Pectin 1 % to 1.5 %.

• Citric acid 0.15 % to 0.20 %.

• Preservatives: Sodium Benzoate and/or Potassium Sorbate 0.05 %.

Process

► Collection and selection of the fruit, separating the defective or damaged ones.

► Remove the skin from the bananas and cut them into thin slices.

► Wash the selected apples, peel them, remove the stalk and the core.

► Cook both fruits in a casserole or pot with 5% water, half the sugar, drops of lemon juice or citric acid over low heat, stirring continuously, we add the other half of the sugar, the pectin and preservatives at the end of the process. Stirring the mixture to form a paste. When it reaches its point, we turn it off. Let it cold down.

► Fill the previously sterilized containers and close.

► Label and store following the steps mentioned above according to the INEN standard.

APPLE JAM

Raw material

• Apples 50 %

• Sugar 50 %

• Water 10 %

• Pectin 0.05 %

• Citric acid 0.15 % to 0.20 %.

• Preservatives: Sodium Benzoate and/or Potassium Sorbate 0.15 % to 0.20 %.

Process

► Collection and selection of apples.

► Disinfect the apples and wash them until the disinfectant is removed with plenty of water.

► Peel and weigh and cook them in a pot with approximately 15 % of the weight of water that covers them (Fig. 40).

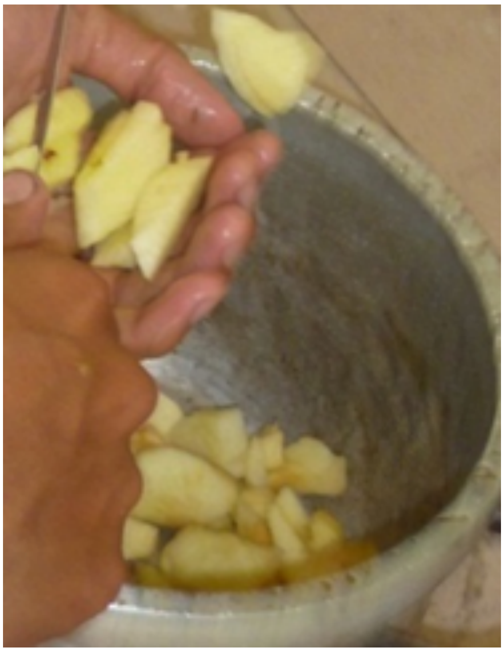


Figure 40: Apple peeling.
Source: El Salous, 2016.

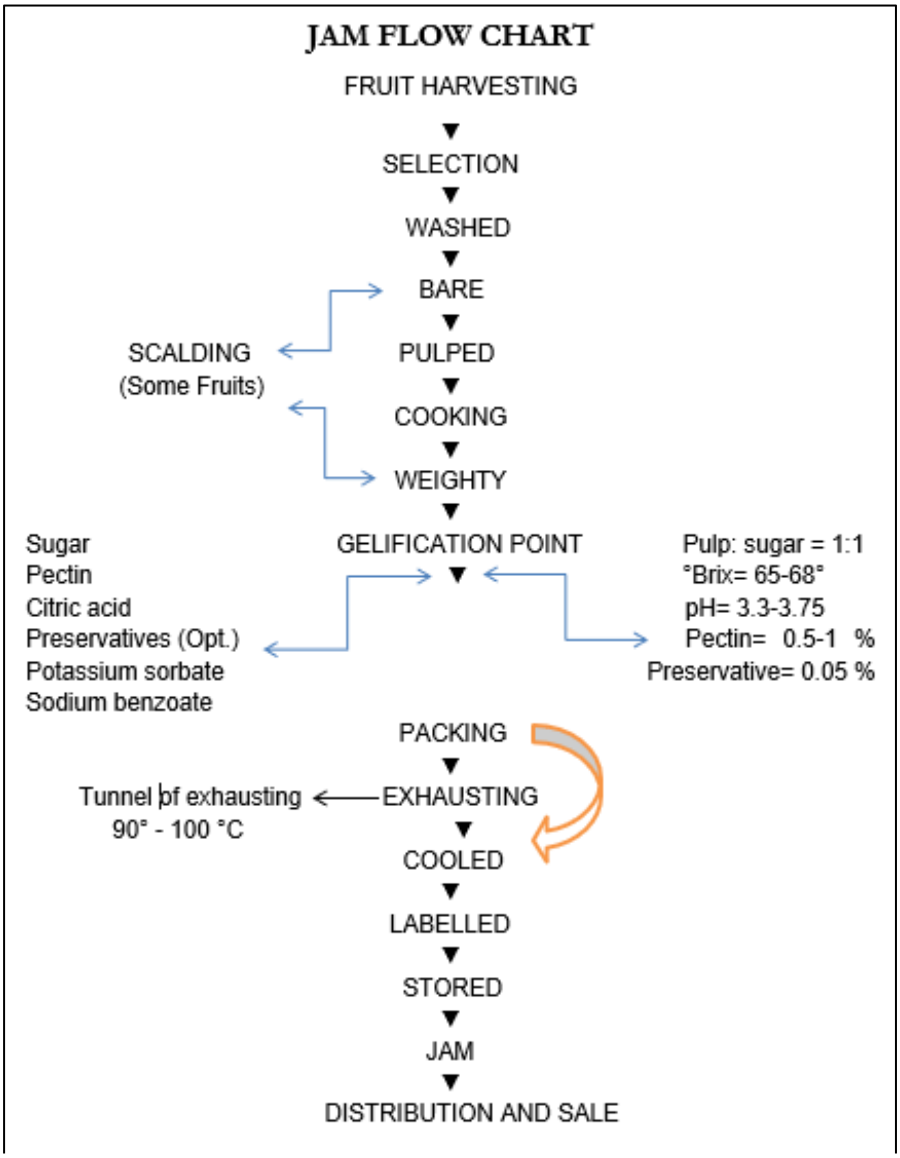
► When the apples cook and are very soft, take them out and reserve.

► With the water from the apples, prepare a gelatinous liquid by adding the peels of the apples themselves.

► Strain the water and add half the sugar with citric acid and the apples and cook it over low heat without stopping moving, and add the other half of the sugar with a minimum amount of pectin of 0.05 % of the preparation.

► When the liquid becomes thick, the jam is ready, pack it and let it cool.

► Label following the procedures mentioned above according to the INEN standard.



Source: El Salous, 2016.

CHAPTER VII

VEGETABLE PROCESSING

Figure 41: Vegetables and pickled vegetables.
Source: El Salous, 2016.

Vegetables and vegetables are used in pickles and sauces, salt is one of the most important ingredients for preserving them. Among the conservation techniques are: Salting and brining, Pickles, Sour vegetables or sauerkraut, pickled vegetables and pickles (Fig. 41).

SALTED AND BRINE

The brine is a highly concentrated solution of salt, they can reach 100,000 mg. of salt per liter of water. For the preservation of food, the use of salt adds flavor, is a preservative effect and influences the texture of pickles. The salt must be white, free of halophilic bacteria and foreign matter, of good quality, with a low content of calcium, magnesium and iron. Salting and brining are the main applications of salt in the preparation of pickles and sauces. So that there is no proliferation of germs, the temperature must be between 15 and 20 °C.

TIPS FOR A CORRECT PREPARATION

● The salt concentration at the beginning of the brine must be kept at 8 – 10 % (40° from the salimeter) due to the water content of the vegetable and does not produce harmful effects, allowing a balance between the brine and the vegetables.

● Highly concentrated saline solutions (more than 17 % salt), inhibit the multiplication of fermentation bacteria. According to the Codex Alimentarius (2004) the percentage of salt in the covered liquid should not be less than 10 % by weight, when salt is used as the main preservative.

● Vegetables must be in perfect condition and will be classified according to size.

● Vegetables and brine destined for each container should be weighed.

● Brine tanks or drums are used.

● First, the brine is put into the container and then the vegetables.

● Must be mixed periodically to avoid stratification.

● Control the brine, adding, diluting or concentrating when necessary.

● A final brine drain is made and replaced by another fresh brine to remove milky, dirt, enzymatic activity and superficial yeasts. The new brine will have a high salt (can reach up to 15 %) and lactic acid (up to 1 %) to avoid subsequent microbial activity.

● For the vegetables to remain in good condition for months, the minimum salt content of the brine should be approximately 10 % and that of lactic acid 0.3 %.

For fermented products, the main microorganisms that cause desirable changes in fermentation are: *Lactobacteriaceae, Acetobacter* and Yeasts [Rodríguez and Simon, 2008].

• *Lactobacteriaceae,* which produce lactic acid from the natural sugars present in vegetables.

• *Acetobacter*, which produces CO_2 and H_2. Carbon dioxide bubbles to the surface and causes a stirring effect.

• Yeasts, which produce CO_2 and alcohol.

According to Rodríguez and Simon (2008) as a result of the production of lactic acid the pH drops, the flora is reduced to some acid-tolerant species and the product acquires its characteristic acid texture and flavor.

PICKLES

Figure 42: Vegetable pickles.
Source: El Salous, 2016.

Pickles are vegetables that are preserved by acidification by adding common salt (See figure 42). Pickling preserves vegetables with their nutritional and organoleptic characteristics for a long time. The pickle can be: salty, which contains 3 % salt and 5 % vinegar; (% with respect to water); sweet that contains 3 % salt, 5 % vinegar and 2 to 10 % sugar; acid containing 5 % vinegar. Unfermented pickles are directly added acetic acid or vinegar to the vegetable. Fermented pickles cause spontaneous lactic fermentation of the vegetable's sugar.

For the preparation of pickles, products with a pH greater than 4.5 are not used. The activity of the water, the heat treatments, the addition of preservatives and antioxidants, the salt content, the soluble solids content, these factors help in the preservation and balance of the products. The risk of food poisoning is minimal in pickles.

The acids used are: acetic acid (from vinegar), citric acid (from fruits), lactic acid (derived from fermentation), and malic acid (from apples). Acetic acid widely used in the food industry, in the form of “vinegar essence” which is 80% acetic acid, is sold in special bottles and is diluted before use [Mayer, 1987]. It is the only one that has the preservative capacity, influences its effect on pH and is combined with other preservation methods. To which preservatives are added such as unpasteurized products, acetic acid is the cause of their self-preservation and in pasteurized products, acetic acid binds with heat treatment.

The action of acetic acid in preserves does not kill bacteria, it only prevents them from reproducing and as they age, they do not leave offspring, and the undissociated molecules cause their inhibitory effect, it is bacteriostatic. The pH value influences the degree of dissociation of the acetic acid molecules. According to Bello (2000) at diluted concentrations of 0.1 % it inhibits the growth of most of pathogenic bacteria, but to inhibit the growth of mycotoxic fungi requires concentrations higher than 0.3 %.

The process consists of preserving the vegetables with a previous cooking, in salt water and vinegar (acetic acid) that act as preservatives and added to a product to prevent or delay its deterioration. The mixture of vegetables with the prepared medium is 60 % of the weight of the vegetables and 40 % of the medium, the mixture is heated to boiling and the mixture is heated and is filled [Hernández, 2003].

RAW MATERIAL

• Vegetables: carrot, onion, sweet chili, cucumber, cauliflower, green beans, etc.

Solution:

• Vinegar or acetic acid

• Sugar

• Salt

• Spices

The concentration of salt, acetic acid, sugar and spices depends on the type of brine solution that we are going to use as I mentioned before.

FACILITIES AND EQUIPMENT

• The place must be very spacious for the fruit reception, processing, packaging, warehouse, laboratory, office, sanitary services and dressing areas.

• The construction must be plastered in block.

• Floors must be concrete covered with tiles or plastic resin, with a drop for drainage.

• The roofs of metallic structure, with zinc and ceiling.

• Metal or glass doors and glass windows. The use of screen on doors and windows is recommended.

• Operators must protect their hair with nets or caps and wear aprons, rubber boots, antiallergic polyvinyl gloves, and mouth and nose masks.

Equipment

• Heat source

• Knives

- Buckets
- Pots
- Chopping boards
- Sealer
- Thermometer
- Salimeter (hydrometer)
- Glass jars and/or plastic bags

PICKLES FLOW CHART

VEGETABLES
▼
SELECTION
▼
WASHED
▼
CHLORINATED WATER ► VEGETABLES PREPARATION ► WASH WATER
▼
COOKING
▼
FILL
▼
BRINE PREPARATION ► ADDING THE BRINE
▼
DESAIRED
▼
CLOSED
▼
PASTEURIZED
▼
LABELLED
▼
STORED
▼
PICKLED OF VEGETABLES
▼
DISTRIBUTION AND SALE

Source: El Salous, 2016.

Process

► Reception of the vegetables, we select those that are in good condition based on the color and texture.

► Weigh and wash with chlorinated water.

► When preparing vegetables, we remove the peel and cut them into smaller sizes, into strips (chili peppers) or slices (onion, carrots), allowing greater absorption of the brine.

► Peel them either by abrasion or manually (Fig. 43).

Figure 43: Manual peeling of vegetables.
Source: El Salous, 2016.

► Each group of vegetables is cooked individually if the pickle is mixed (various kinds of vegetables).

► We continue with the filling of jars; the vegetables are placed. We fill with only one variety of vegetables or a mixture of them (Fig. 44).

Figure 44: Vegetable filling (vegetables).
Source: El Salous, 2016.

► The brine that we have previously prepared is heated to 82 to 86 °C, and we add it to the jars containing the vegetables. We can add seasonings such as pepper, garlic and others to the brine (Fig. 45).

Figure 45: Filling the brine.
Source: El Salous, 2016.

► The exhausting or deaeration, we do it to avoid that air remains in the bottle at the time of sealing, preventing the development of microorganisms. We do it manually, shaking the jars after being filled with the hot brine or in a water bath.

► Then we continue with the closing that we can do manually or mechanically.

► We label them following all the requirements of the law of the Codex General Standard for the Labeling of Prepackaged Foods [CODEX STAN 1-1985].

► We store it according to the type of container; we will place boxes on boxes (stacked). The place must be ventilated, cool and without humidity.

We must carry out quality control throughout the process, since if we carry out all the controls properly, we will obtain a final product of good quality. In the raw material, which is the most important thing, we must control that it is fresh, that it does not present any defect. During the process we must control the cooking time of the vegetables to prevent them from being destroyed and this varies according to the type of vegetable (See table 5). In the final product we verify that the content of the vegetables and the brine are in accordance with the established formulation and if the drained weight is correct. We check that the weight is the same in all the jars and that they are well sealed. And finally, the quality control of the product in the warehouse, we leave several samples stored for months to verify the useful life of the product. When we review the stored samples and find that the cans or lids are bulging, this indicates that the product has decomposed, and we should not consume it.

Table 5: Cooking time of some vegetables.

VEGETABLE	COOKING TIME IN BOILING WATER (MINUTES)
Carrot	7
Onion	1
Vanite	6
Cucumber	2
Cauliflower	7

Source: Bello, 2000.

SOUR VEGETABLES OR CHUCRUT

The fermentation of vegetables such as white cabbage is kept for several months at a cool temperature (See figure 46), salt is added to the cut cabbage, controlling the fermentation so that putrefactive organisms do not develop. The organisms present in vegetables cause fermentation, they are different consecutive fermentation that produce acetic acid, lactic acid and other fermentation products.

Figure 46: Cabbage in sauerkraut.
Source: El Salous, 2016.

The fermentation does not need oxygen, the temperature is 17 °C, it should not be higher at the beginning of the process because the second fermentation will start too soon, causing poor development of the flavor and characteristic smell of Sauerkraut. Cabbage is fermented in tanks, wooden barrels, or large concrete or plastic containers.

Process

► Take the cabbages and remove the outer leaves.

► Wash and dishearten them.

► Cut the vegetables into 3 mm pieces, and wide approximately.

► Fill the barrels distributing the pieces evenly on the surface, we place layers of vegetables and layers of salt without leaving air pockets, 2.5 % of the weight of the vegetables is used.

► Cover the barrel with a flexible and waterproof cover. We put a 15 cm layer on it. 3 % brine, so the vegetables are submerged in their juice and the air does not enter.

PICKLED VEGETABLES

They are blanched vegetables packed with flavored vinegar. The difference between this and pickling is that it uses fresh raw material, preserved by means of salt and not fermented. The fried vegetables are packed with the boiling pickle. The vinegar used is 2 % acetic acid (See figure 47).

Figure 47: Peppers, carrots, pickled onion.
Source: El Salous, 2016.

Raw material

• Mixed vegetables: onion, cauliflower, cucumbers, carrots, etc.

Materials

• Plastic containers

• Glass bottles

• Plastic or wooden kitchen utensils

• Balance

• Heat source

Process

► Select the vegetables, and separate he damaged ones.

► Wash the vegetables and prepare the 2 % vinegar and add spices (flavoring).

► Cut the vegetables either into slices, strips, etc., and place them in a container, distributing the salt between the layers. We cover the layers with the brine alternately.

► Cover the container and let it rest for a day. The next day we rinse the vegetables well to remove the excess salt.

► Fry the vegetables with oil, garlic and bay leaves.

► Fill the jars with the hot flavored vinegar, up to the top, covering the vegetables completely.

► With a spatula, remove any air bubbles that have remained between the vegetables and hermetically close the jars with the lids that have already been previously sterilized.

► Label with all the information following the standards established by INEN.

► And finally we store in a dry and ventilated place.

PREPARATION OF PICKLES

Among the vegetables most used in the preparation of Pickles we have the gherkin, peppers, artichokes, cauliflower, chives, carrots, etc.

Raw material

• Pickles or other vegetables already named in good condition.

Process

► Reception of the gherkin or another kind of vegetable, after the harvest the maximum time to start the elaboration is 6 to 8 hours.

► Select the pickles that are firm, small, without bruises (See figure 48).

Figure 48: Selection of cucumbers by size and appearance.

Source: https://gardenerspath.com/

► Put the gherkins in a 10 % brine to cover them so that they ferment before placing them in vinegar. In wooden containers of 2.5 m. in diameter and 1.8 m. deep.

There are two procedures that we can use to remove excess salt by soaking it in water.

• The first is to add 30 liters of water for every 25 kg. of cucumbers and heating it to 43.3 °C by means of steam jets. They are kept for one hour, and then it is allowed to fall to room temperature, it is slowly reheated to 49 °C, it is left to cool and it is kept for 24 hours, removing the water. The same amount of water with alum (0.45 %) and turmeric (0.0 5 %) is added to harden and give color. After 24 hours, the water is eliminated and another clean one is placed that is left for 1 hour to eliminate the excess of alum and turmeric, the cucumbers being ready to acidify.

• Another procedure is to soak in cold water for 1 - 2 days, changing the water 2 or 3 times a day and then treat the cucumbers for 10 or 12 hours in hot water at 43 to 54 °C, if the cucumbers are very hard, it rises the temperature up to 60 and 65 °C for a short time (See figure 49).

Figure 49: Treatment of cucumbers in hot water.
Source: https://www.juvasa.com/

► Cucumbers undergo acid treatment using distillation vinegar for its uniform composition, neutral flavor, light color and inexpensive. At the beginning they are in 3 – 5 % vinegar and at the end they have an acidity of 2.5 % or more. During the first 24 hours, the percentage of acid penetration in the pickles is higher. During the first six hours the small gherkins have 75 to 80 % of the total acid, the balance is achieved after 48 hours and for the medium ones it takes longer.

► We put a wooden lid on top (something heavy on top) and keep the cucumbers submerged during fermentation.

► Control fermentation by keeping it at 10 % by adding salt to prevent putrid fermentation from occurring. We can stimulate lactic acid fermentation by adding 1 % glucose, it lasts 4 - 6 weeks, adding a small amount of acetic acid that makes it easier to regulate the fermentation.

► Once finished, the concentration of brines is increased, keeping them around 15 %. During this process the cucumbers change from green to olive green or yellowish green.

► During fermentation there is a gaseous release by the gasifying microorganisms, this ends and the lactic microbes act that increase the acidity up to 0.6 to 0.8 % of lactic acid or more, producing small amounts of alcohol due to yeast activity and some acetic acid and propionic by other bacteria.

► Add sugar to obtain a good degree of acidity, it is added when the natural sugar of the vegetable has disappeared.

► Once the fermentation is finished, we keep the cucumbers in the brine indefinitely, 60° to 66° from the salimeter. The superficial veils must be foamed to eliminate microbes, these veils are caused by false salt-resistant yeasts that destroy lactic acid by oxidation and make conservation difficult. To prevent the development of aerobic microorganisms, we place a 3 mm layer of neutral mineral oil on the surface. of thickness.

► Remove the oil by filling the water tanks until it overflows, we do it before removing the cucumbers. We can also add 0.4 % acetic acid or placing the tanks covered in the sun so that the sunlight prevents its development.

► Pack in cans (varnished, avoid acid on metal) previously pre-sterilized for 10 minutes at 95 °C, closed. When we pack them in glass jars, we do it by hand and fill with boiling vinegar, condiments or spices and close it hermetically.

CHAPTER VIII

DRYING PROCESS OF FRUITS AND VEGETABLES

Dehydration or drying is the process of extracting water from food by circulating hot air, dehydration stops the growth of enzymes and destroys microorganisms. This drying technique is used for the preservation of food, benefiting the producer economically, reducing storage and transportation costs by reducing weight, volume and packaging of the product. In addition, another very important benefit is that it is kept at room temperature for a long time without being damaged.

DEHYDRATION PROCESS FLOW CHART

RECEPTION
▼
SELECTION AND CLASSIFICATION
▼
WASHING AND DISINFECTION
▼
CUT
▼
CONDITIONING
▼
HEAT TREATMENT – SCALDING
▼
CHEMICAL TREATMENT
▼
DRAINED
▼
DEHYDRATION
▼
CUT
▼
PACKING
▼
STORAGE
▼
DISTRIBUTION AND SALE

Source: El Salous, 2016.

Process

►The fruit is received and selected, sometimes you can select fruit that is not in good condition, but those that are too damaged that can affect its flavor will not be accepted.

►The product is washed with plenty of water and disinfected with a low concentration of hypochlorite (15ppm[1]).

►After washing you have to cut the fruits into slices or pieces, it depends on the fruit. Ex: mango and pineapple are cut into slices, papaya into pieces.

► Hard skin fruits should be blanched for 3 minutes and cooled with ice water, immediately.

►If natural solar drying is used, the fruit should be cut into slices with a thickness of 3 mm. If you use osmodehydration, cut the fruit into 2 cm cubes.

►Place the slices next to each other and so on.

► Check the product every 4 or 5 hours. If necessary, flip it.

To avoid contamination by pathogens and increase the content of soluble solids during solar drying, the fruit is immersed in syrup with 80 °B, for 6 to 12 hours.

To avoid browning during storage, 4 grams of ascorbic acid is applied to one liter of water or 0.25

% sodium bisulfite. The fruit is immersed for 5 to 10 minutes to perform this treatment.

DEHYDRATION METHODS

There are several methods of dehydrating fruits. One of them is the **osmotic dehydration** process, which consists of immersing the fruit in a concentrated solution of 75 to 90 % sugar, creating two flows: First, a flow of water that comes out of the product. It loses about 60 % of water, in a temp. 30 to 50 °C, in the absence of oxygen, without phase changes (liquid to gaseous) between 1 and 3 hours. Second, entry of solutes from the solution into the product. Here you can incorporate preservative, flavors, etc. [Landwehr, 2001].

Dehydration by hot air, this process consists of the transfer of heat and direct contact of the substance with the hot air in which evaporation occurs. For this process to be successful, they must control the temperature, relative humidity of the drying air, air flow, size and shape of the product.

The temperature of the drying air is very important, because if the temperature is too high it causes deterioration of the product such as crusting on its surface, browning, gelatinization of products that have high starch content and loss of aromas.

Drying time, another important factor, since you have to determine the amount of product you want to dry per unit of time and the air flow that is required for drying. Drying time depends on the amount of air that flows through the product. The size and shape, the smaller and thinner the faster the drying.

PRESERVATION OF FOOD BY REDUCING WATER CONTENT

Microorganisms contain more than 80 % water, obtained from the food in which they proliferate. By removing water from food, it is removed from the bacterial cell and proliferation is stopped. Partial dehydration stops bacterial growth and multiplication in some microorganisms, but total dehydration is more effective. Bacteria and yeasts require more moisture than molds (they grow on semi-dehydrated foods).

The removal of water from food takes place in the form of steam that escapes into the atmosphere in which the food is found. Two mechanisms are produced: A heat transfer, which produces the energy necessary for the water molecules to pass from the liquid to the gaseous state; and, a mass transfer in which the vapor passes by diffusion through the food and reaches the surface and evaporates into the environment [Bello, 2000].

Bello (2000) states that these mechanisms have factors that vary in each case, such as the temperature of the food product, the surface of the food that serves as an exchange with its environment, the water content of the food, the properties of the calorific environment: relative humidity, temperature, vapor pressure, etc.; and fluid movements. The control of these factors allows regulating. The speed of drying, the cost of operations, performance and the quality of the product.

Two methods are used to remove part of the water content of food. Mechanically, only 60 % of the water content is removed, it removes molecules from pure water and solutes. By thermal means that heat and mass transfer processes are carried out, two systems are used: By boiling in which the product is heated until its water vapor reaches the same from the environment. The boil reaches 100 °C. Due to drag in which the energy is provided by the flow of hot air, the air pressure is lower than that of the product [Bello, 2000].

Next, table 6 shows the conditions for the dehydration of vegetables.

Table 6: Conditions in the dehydration of vegetables.

CONDITIONS IN THE DEHYDRATION OF VEGETABLES **						
CONDITION	**UNIT**	**GARLIC**	**CELERY**	**ONION**	**PEPPER**	**CARROT**
Temp. wet area.	°C	75 - 80	70	75 - 80	75	75
Temp. drying area.	°C	55 - 60	60	55 - 60	56 - 60	75
Cont. Initial moisture.	%	62 - 65	94	86	87	88
Cont. Final moisture.	%	8	12	8 - 10	8	8
Load/m².	Kg.	12	15	13	15	15
Drying moisture.	%	6.5	8	5		

** Illustrates the isothermal water absorption for a given food at a given temperature. It shows what final moisture content the food will have when it reaches moisture equilibrium with atmospheres of different relative humidity.
Source: Valdés, 2008.

TIPS FOR A GOOD DEHYDRATE

• Dry air to extract moisture from the food.

• Enough heat to extract moisture from food quickly without cooking it so as not to affect its flavor, texture and color.

• Sufficient air circulation to carry moisture out of the drying tunnel.

• The temperature is 50 to 60 °C (See table 7).

Table 7: Recommended maximum temperatures.

PRODUCT	RECOMMENDED TEMPERATURE
Herbs	greater than 35 °C
Vegetables	greater than 52 °C
Fruits	greater than 57 °C
Fruit leather	greater than 60 °C
Charqui	greater than 62 °C

Source: Valdés, 2008.

• The time to dehydrate the product depends on some factors such as the product and its thickness, relative humidity, heat, ambient temperature, etc. See below Table 8 in which the conditions of the finished product are observed and Table 8a, in which the dehydration time of vegetables and fruits is observed.

Table 8: Conditions of the finished product.

PRODUCT	RH %	PERFORMANCE %
Chickpeas	4 - 6	9 - 14
Onion	4 - 6	8 - 11
Herbs	5 - 7	5 - 7
Vegetables w/leaves	6 - 8	5 - 7
Potatoes	8 - 10	12 - 16
Leek	4 - 6	7 - 10
Cabbage	4 - 7	4 - 6
Carrot	4 - 6	7
Squash	6 - 8	6

Source: Valdés, 2008.

Table 8a: Dehydration time of vegetables and fruits.

VEGETABLES	TIME (50 °C and 60 °C), HOURS	FRUITS	TIME (50 °C and 60 °C), HOURS
Celery	18	Blueberry	8 - 12
Chickpeas	17	Cherry	18 - 30
Eggplant	24	Plum	18 - 24
Broccoli	10	Damascus	16 - 36
Bruselites	24	peach	24 - 36
pumpkin	18	Strawberry	20
Onion	20	FIG	10 - 12
Cauliflower	16	Apple	6 - 12
Asparagus	10	Banana	8 - 16
Spinach	15	Pear	24 - 36
Mushrooms	16	Pineapple	24 - 26
Corn	12	Grape	24 - 48
Potatoes	12	Blueberry	
Peppers	12		
Cabbage	10		
Tomato	26		
Pods	14		
Carrot	18		

Source: Valdés, 2008.

• Control of dehydration every two hours. Rotate the trays to obtain a uniform dehydration. Upstream food dehydrates faster than downstream. The product should be turned over with a spatula.

• Dehydration ends when the weight of the product tends to reach equilibrium conditions over time, that is, when the variation in the weight of the solid is almost zero.

In the following table 9 we have some fruits and vegetables that we can dehydrate.

Table 9: Fruits and Vegetables recommended for dehydration.

Fruits	Vegetables
Citrus peels	Chili pepper
Banana	Garlic
Cherry	Onion
Plum	Corn
Coconut	Beans
Damascus	Mushrooms
Date	Potatoes
peach	Parsley
Currant	Pepper
FIG	Tomatoes
Apple	Chili pepper
Mango	
Cantaloupe	
Papaya	
Pear	
Pineapple	
Grape	

Source: Valdés, 2008.

POST DEHYDRATED

DRYING TESTS

According to Valdés (2008) the following points must be taken into account for post-dehydration.

• On fruits when there are no fingerprints left when pressing on the fruit leather in the center of the tray. The leather dries from the edges towards the center.

• We let the product cool down because when it is hot it is softer, humid and rubbery.

• Fruits are dehydrated when they are flexible and leathery without moisture.

• Some pieces are selected by cutting them in half. Take a bunch of fruits by squeezing it firmly in your hand and when you release them, they should fall separately and your hand should not remain wet (See table 10).

• For example, the banana must be leathery and soft to be able to eat it and not dehydrate it until it is brittle. Its moisture content should be around 20 %. When the fruit is very sticky, it is sprinkled with powdered or powdered sugar.

• If the fruit leather is sticky it should be further dehydrated. The leather is removed from the tray when it is hot, it must be detached, cut (squares or slices), left to cool, package and store.

• Vegetables are dehydrated when they are brittle and hard like green beans, corn, peas, onions; or leathery and strong like tomatoes and vegetables in general. If they are leathery, they will be flexible and can return to their initial shape if bent (See table 11).

• The pasteurization of the fruit is done at 70 °C for 30 minutes. Insect eggs, their larvae and microbes that survived dehydration are destroyed.

• The lower the moisture content, the higher the quality.

• Over-dehydrated products are of lower quality.

• After dehydration, the product is selected on the tray or on a table, and we remove the remains of foreign matter, the products of poor quality and flavor.

• Then the dehydrated product is packed in polyethylene bags that must be sealed, we put them in cardboard boxes or jute bags before being stored and transported.

• When the trays have been unoccupied, they must be moistened, washed with clean, cold water, dried and spread a thin layer of glycerin or vegetable margarine on the frame and the rack. The frame is protected and it is easier to remove the already dehydrated product from the rack.

Table 10: Dryness index of fruits.

FRUIT	DRY INDEX
Blueberry	Chewy, chewy.
Cherry	Chewy, chewy.
Plum	Something tough, rubbery.
Damascus	Soft, flexible.
Peach	Soft, flexible.
Strawberry	Chewy, chewy.
FIG	Flexible, somewhat sticky.
Apple	Soft, flexible.

Banana	Leathery but soft, light brown.
Pear	Soft, flexible.
Pineapple	Chewy, dry.
Grape	Flexible, wrinkled.

Source: Valdés, 2008.

Table 11: Vegetable dryness index.

VEGETABLE	DRY INDEX
Celery	Fragile, brittle.
Chickpeas	Wrinkled, hard, green.
Eggplant	Leathery, brittle.
Broccoli	Fragile, brittle.
Bruselites	Hard to brittle.
pumpkin	Brittle.
Onion	Brittle, like paper.
Cauliflower	Hard to break.
Asparagus	Brittle to leathery.
Spinach	Fragile, brittle.
Mushrooms	Dry, strong, leathery.
Corn	Crisp, crisp.
Potato	Brittle.
Peppers	Flexible, dry, brittle.
Cabbage	Fragile, brittle.
Tomato	Strong, leathery.
Vanite	Brittle.
Carrot	Hard to brittle.

Source: Valdés, 2008.

SOLAR DRYING

There are many reasons for drying food, one of them is to preserve food for a long time, ensure food quality, generate work and take advantage of free solar energy [Martin, et al, 2005]

The oldest method is the one that places the products directly on a flat black surface, where the sun and the wind will dry them (See Figure 50).

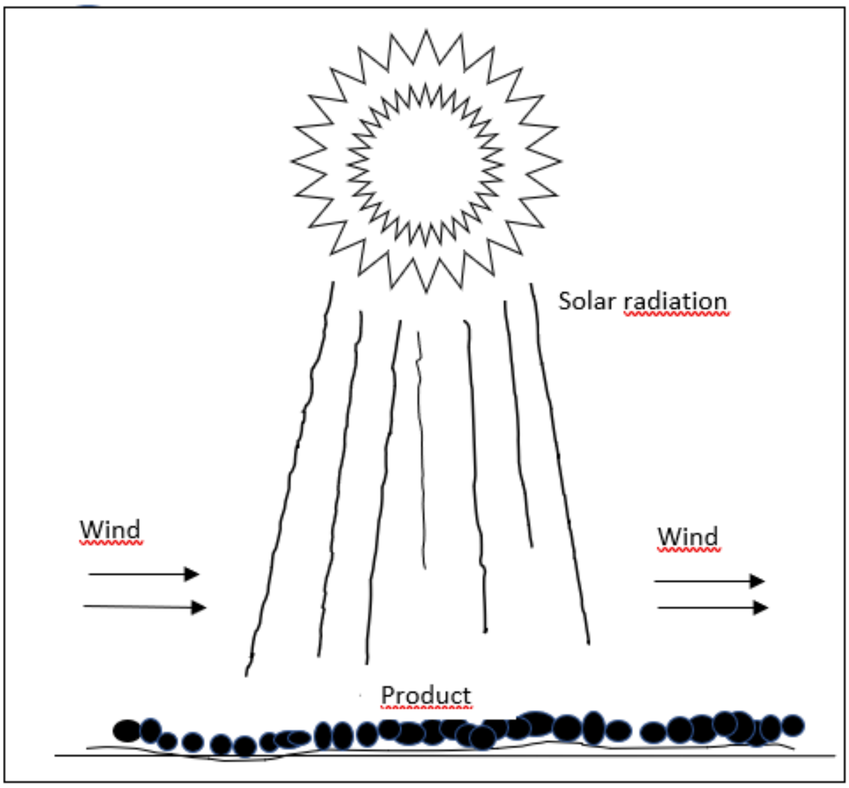


Figure 50: Drying on the floor directly. **Source:** FAO, 1996.

Solar drying meets all market conditions such as energy saving, environmental protection, easy handling and cost reduction.

Direct dryers are built with frame-shaped screens that are placed on wooden or concrete blocks allowing air circulation underneath the products. An almost transparent, light and soft fabric; it is placed on top of products, protecting them against insects and birds (See figure 51) [FAO, 1996].

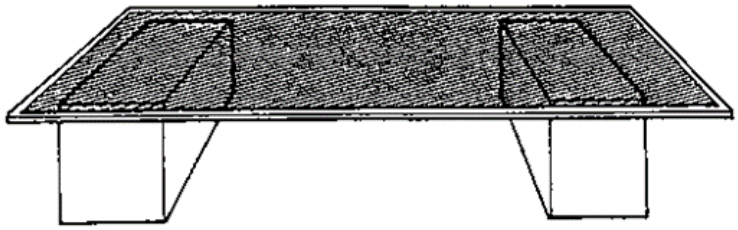


Figure 51: Frame-shaped screens on wooden or concrete blocks. **Source:** FAO, 1996.

Another type of solar dryer is to be built on a wooden deck covered with a loose-woven, wide-mesh frame or straw mats. The air passes above and below the product accelerating drying and reducing losses due to overheating (See figure 52) [Kitinoja, 1992].

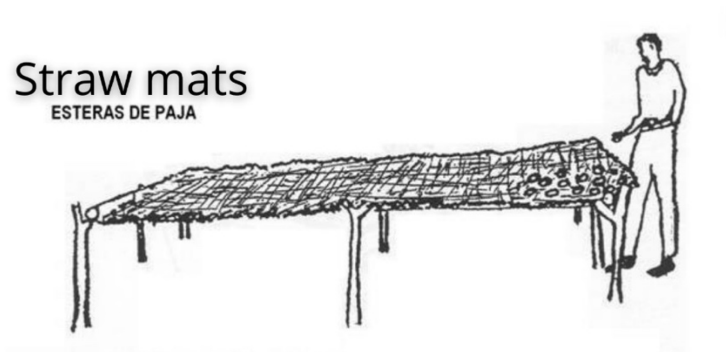


Figure 52: Represents direct solar drying on a straw mat. **Source:** Kitinoja, L 1992. Consultancy for Africare / USAID on food processing in the Ouadhai, Chad, Central Africa. Extension Systems International, 73 Antelope Street, Woodland, California 95695.

Aluminum foil can be used to reflect the sun on the drying trays, it is covered with a plastic so that the heat does not escape and thus accelerates the drying time as represented in figure 53 [Kitinoja and Kader, 2002].

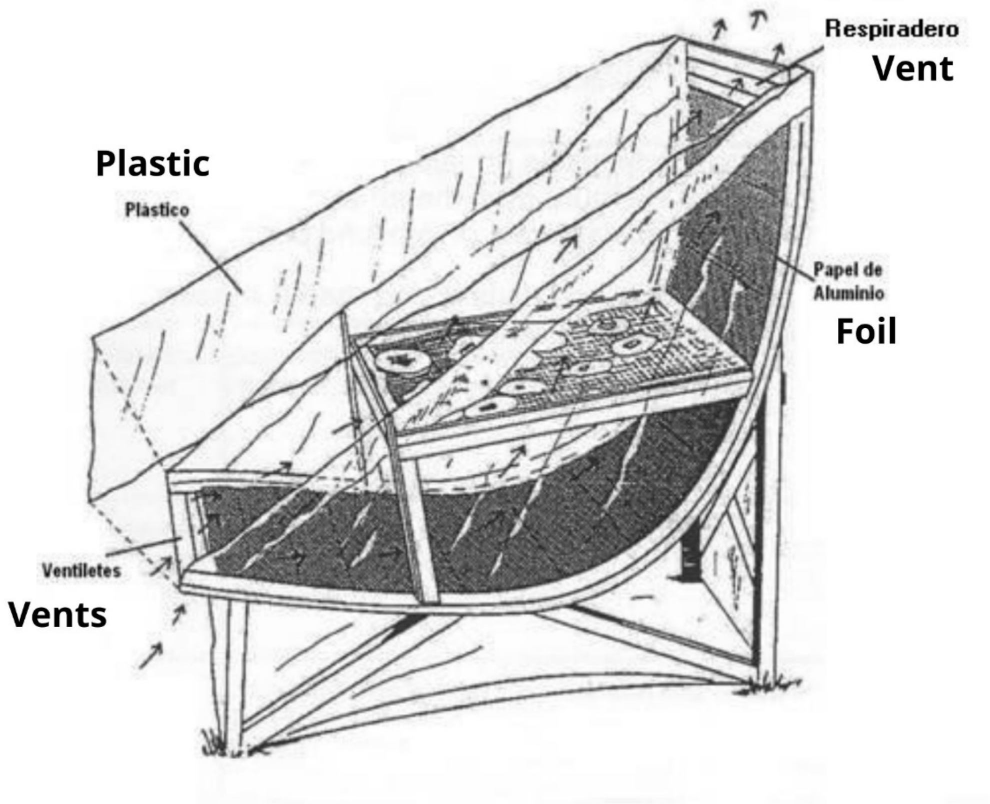


Figure 53: Cover with plastic so there is no heat leak. **Sources:** Intermediate Technology Publications, 1987. Post-harvest Crop Processing: Some tools for agriculture. Intermediate Technology Publications. London, England. 29 pp .; Kitinoja and Kader, 2002.

TIPS FOR CLEANING DRYERS

• All trays, racks and mats used for drying must be kept clean. Use a good detergent and brush to scrub them. Dry before use.

• Stainless steel, plastic or nylon trays can be kept clean more easily than wooden trays. Fruit juices adhere to the surface accumulating dirt and mold growth that affects and contaminates the dried product.

• Calcium chloride when spread on the ground absorbs moisture from the air and keeps the soil moist. It is perfect for the settlement of dust on floors, roads. Rake the calcium chloride on the surface to be treated at a ratio of ½ pound (227 g) per square yard (0.836 m2) [Kitinoja and Kader, 2002].

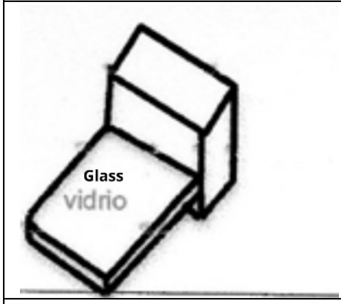
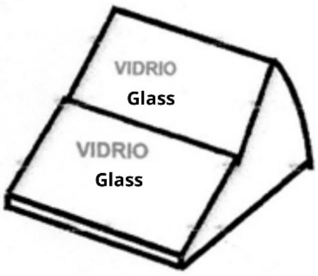
• To reduce mold growth on trays, partitions, and mats when it is not in season, wash, dry, and store in a well-ventilated area.

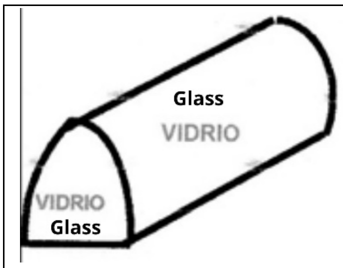
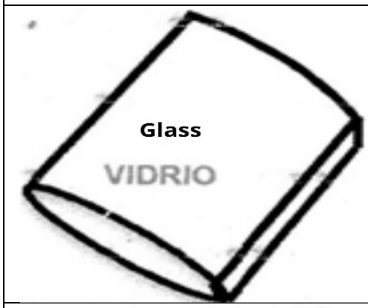
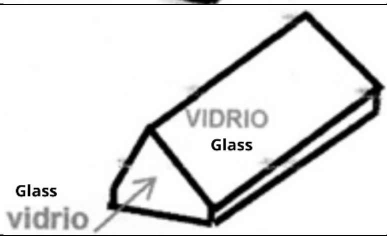
TYPES OF DRYERS

Various types of solar dryers have been developed to increase drying efficiency.

In Table 12 we present the various types of basic dryers that can be built.

Table 12: Basic dryers that can be built.

	BASIC SOLAR DRYERS	
BASIC MODEL SCHEME	**TYPE OF DRYER**	**DESCRIPTION**
	CABIN (CABINET) DIRECT.	THE DRYING CHAMBER IS MADE OF GLASS AND DOES NOT USE A SEPARATE SOLAR COLLECTOR.
	INDIRECT (CABINET) CABIN.	THE SOLAR COLLECTOR IS SEPARATED FROM THE DRYING CHAMBER AND DOES NOT HAVE TRANSPARENT SURFACES.
	COMBINED MODEL.	THE DRYING CHAMBER IS MADE OF GLASS PARTLY OR COMPLETELY AND USES A SEPARATE SOLAR COLLECTOR.

	TUNNEL.	A METALLIC FRAME IS USED WITH ONE OR TWO LAYERS OF GLASSED PLASTIC. THIS DRYER IS DIRECT. IT MAY BE INDIRECT IF THE PLASTIC OF THE INNER LAYER IS BLACK.
	LOW TUNNEL.	IT IS THE SAME AS THE PREVIOUS, THE DIFFERENCE IS THAT IT IS BUILT CLOSER TO THE GROUND AND WITH ONLY ONE LAYER OF PRODUCT.
	STORE.	SOLAR DRYER WITH A STRAIGHT FRAME INSTEAD OF CURVED.
	CHEST (BIN).	INDIRECT DRYER WITH CONVENTIONAL FORCED AIR FLOW THAT CAN DRY DEEP LAYERS (300MM OR MORE) OF PRODUCT.

Sources: Fuller, R.J. 1993. Solar Drying of Horticultural Produce: Present Practice and Future Prospects. Postharvest News and Information; Kader and Kitinoja, 2002.

There are solar dryers that have glass or transparent plastic windows that cover the product to protect them against insects, capturing more solar heat at the same time, they are a little more complex (See figure 54) [Kader and Kitinoja, 2002].

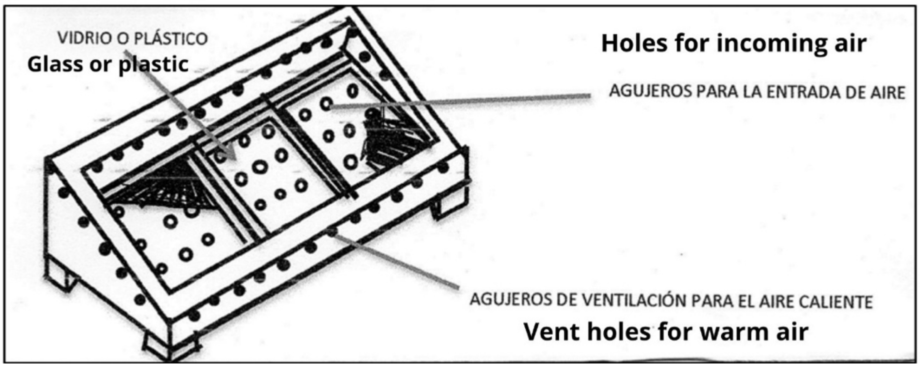


Figure 54: Direct solar dryer. **Sources:** Kader and Kitinoja, 2002; Yaciuk, G. 1982. Food Drying: Proceedings of a Workshop held at Edmonton.

In contrast, indirect dryers allow solar radiation to be collected by a solar collector, the heated air moves up through a chimney that contains stacked 4 to 6 trays in which the products to be dried are placed. As we see below in figure 55, a shallow box with black painted interiors and a glass panel on top is shown [Yaciuk, 1982].

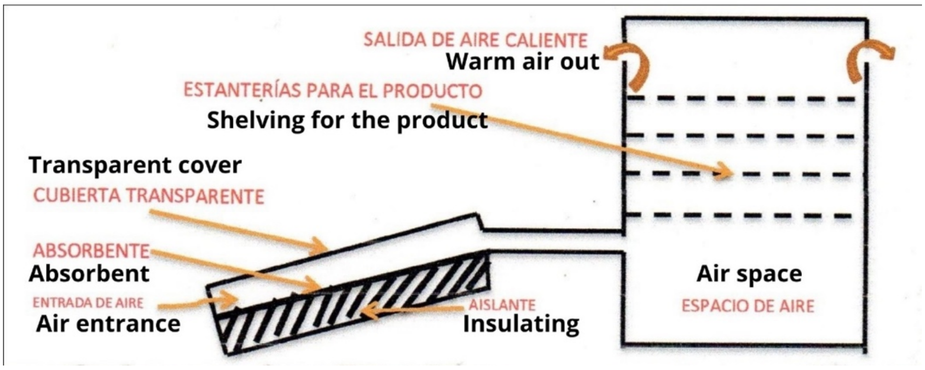


Figure 55: Shallow box with black painted interiors and a glass panel on top. **Sources:** Yaciuk, G. 1982. Food Drying: Proceedings of a Workshop held at Edmonton, Alberta, 6-9 July 1981. Ottawa, Ontario: IDRC 104 pp .; Kader and Kitinoja, 2002.

FORCED AIR DEHYDRATORS

The plenum chamber (enclosed space) below the products is covered or covered with a perforated metal sheet or wooden slats or slats. A fan located between the oven and the plenum chamber blows the hot air through the drying products [FAO, 1985]. This dryer is perfect for bulk nuts (See figure 56).

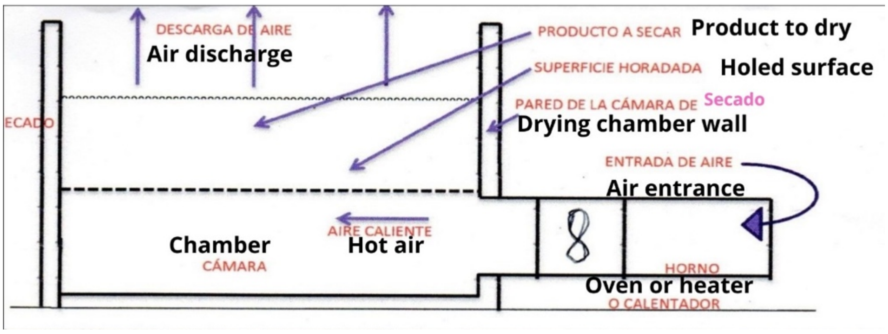


Figure 56: Dehydrator that combines a constant flow of air with an external heat source**. Sources:** FAO. 1985. Prevention of Post-Harvest Food Losses: A Training Manual. Rome: UNFAO. 120 pp .; FAO, 1996. Section 10: Processing of horticultural crops.

COMBUSTION DEHYDRATORS

The batch dehydrator is constructed of wood, (See figure 57) it has an axial type fan and works with kerosene oil or diesel [Kitinoja and Gormy, 1999].

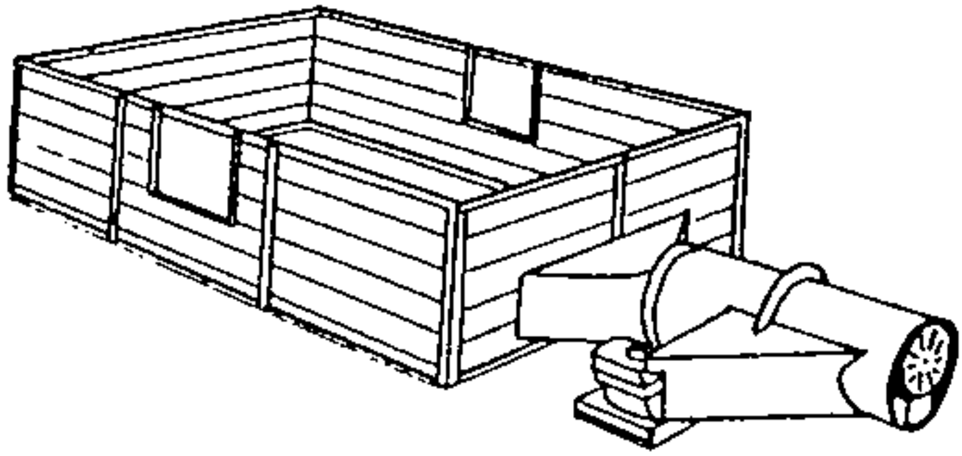


Figure 57: Wooden drawer. **Sources:** Clarke, B. 1987. Post-Harvest Crop Processing: Some Tools for Agriculture. London, UK: Intermediate Technology Publications; Kader and Kitinoja, 2002; FAO, 1996.

Two types of dehydrators are used for drying small volumes of walnuts. The first is a car (truck or wagon) with a perforated floor that can be transported from the field and is connected to a portable burner for batch drying (See figure 58). The second is stationary, known as a multi-chest dehydrator, it is designed to move hot air along a plenum chamber located under a fixed platform (See figure 59). The individual walnut chests are placed on the platform and dried by the hot air that rises through the perforated floor [Kader and Thompson, 2002].

WAGON TYPE DEHYDRATOR

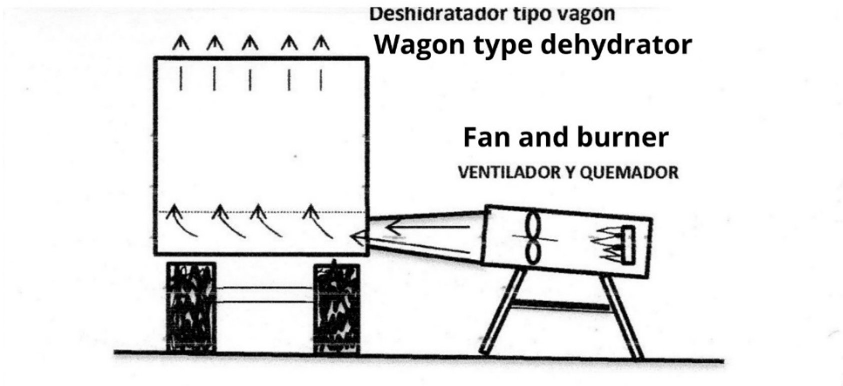


Figure 58: Wagon type dehydrator. **Source:** FAO, 1996.

MULTIPLE CHEST DEHYDRATOR

DRYING CHEST PLATFORM

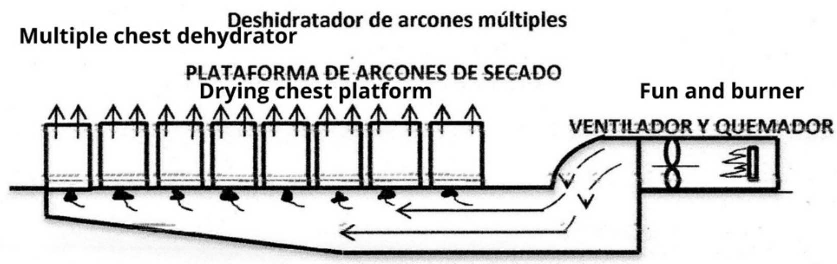


Figure 59: Multiple chest dehydrator. **Sources:** Kader, Adel. A. and Thompson, J.F. 2002. Postharvest handling Systems: Tree nuts. Pp. 399-406. In: Kader, AA. (Ed). Postharvest Technology of Horticultural Crops. University of California, Division of Agriculture and Natural Sources, Publication 3311; FAO, 1996.

Electric dehydrators

The electric dehydrator is constructed of plywood, a metal sheet, a small fan, five spotlights with porcelain inlets in a fixed installation, and some screen or sieve material (Fig. 60).

◄This dryer is 32 inches (80 cm) long by 21 wide (53 cm) and 30 high (76 cm) and contains shelves for five trays. The fan and the metallic foil that lines the lower compartment help in the conduction of the upward heat through the chamber [Kader and Kitinoja, 2002].

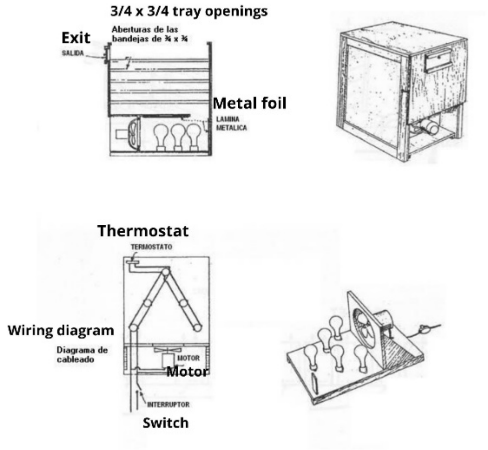


Figure 60: Electric dryers.
Source: Chioffi, N. and Mead, G. 1991. Keeping the Harvest. Pownal, Vermont: Storey Publishing; Kader and Kitinoja, 2002.

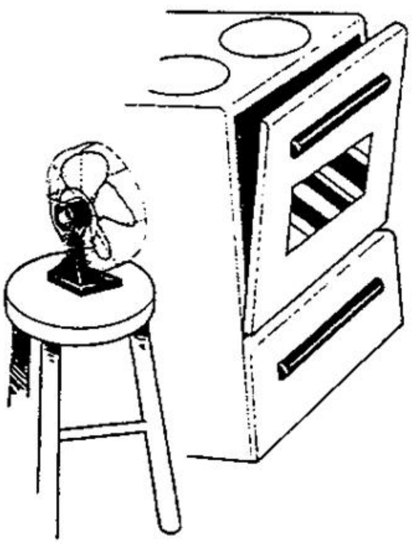


Figure 61: Oven dryer. **Source:** Georgia Cooperative Extension Service. 1984. So Easy to Preserve. University of Georgia; Kader and Kitinoja, 2002.

Oven dried

◄Fruits and vegetables can be dried in a domestic oven, if it operates at low temperatures. The product is placed on baking sheets or wire mesh trays. The oven temperature is set at 140 °F (60 °C) leaving the door ajar (2 to 4 inches; 5 to 10 cm). To reduce the drying time, we increase the ventilation by placing a fan outside the oven (Fig. 61).

Next, tables 13 and 14, in which the relationship of respiration and useful life of the products is observed; the recommendations of temperature, relative humidity, approximate life of transport, storage for fruits and vegetables.

Table 13: Relationship of respiration and shelf life of products.

PRODUCT	BREATHING ($mg\ CO_2\ Kg$ / h) 5 °C	25 °C	USEFUL LIFE (weeks to 5 °C)
Peas	50	475	1
Asparagus	45	260	2- 3
Avocados	10	400	2 - 4
Radishes	6	17	16 - 20

Table 14: Recommendations of temperature, relative humidity and approximate life of transport and storage for fruits and vegetables.

Product	Temperature °C	°F	RH (Percent)	Approximate Storage Life
Amarnanto (Amaranth)	0-2	32 - 36	95 - 100	10 a 14 days
Anise (Anis)	0-2	32 - 36	90 - 95	2 - 3 weeks
Apples (Apples)	-1-4	30 - 40	90 - 95	1 - 12 months
Apricots (Apricots)	-0.5-0	31 - 32	90 - 95	1 - 3 weeks
Artichokes, globe (Alacachofa, globe)	0	32	95 - 100	2 - 3 weeks
Asian pear	1	34	90 - 95	5 - 6 months
Asparagus (Asparagus)	0- 2	32 - 36	95 - 100	2 - 3 weeks
Atemoya (Atemoya)	1 - 3	55	85 - 90	4 - 6 weeks
Avocados, Strong, Hass (Avocado, Strong, Hass)	7	45	85 - 90	2 weeks
Avocados, Lula, Booth-1 (Avocado, Lula, Booth-1)	4	40	90 - 95	4 - 8 weeks
Avocados, Fuchs, Pollock (Avocado, Fuchs, Pollock)	13	55	85 - 90	2 weeks
Babaco (Babaco)	7	45	85 - 90	1 - 3 weeks
Bananas, green (Bananas, green)	13-14	56 - 58	90 - 95	1 - 4 weeks
Barbados cherry (Barbados cherry)	0	32	85 - 90	7 - 8 weeks
Bean sprouts	0	32	95 - 100	5 - 9 days
Beans, dry	4 - 10	40 - 50	40 - 50	6 - 10 months
Beans, green or snap (Green beans)	4 - 7	40 - 45	95	7 - 10 days
Beans, lima, in pods (Beans, lime, pods)	5 - 6	41 - 43	95	5 days
Beets, bunched (Beets, bunches)	0	32	98 - 100	10 - 14 days
Beets, topped (Beetroot, leafless)	0	32	98 - 100	4 - 6 months
Belgian endive (Belgian endive)	2 - 3	36 - 38	95 - 98	2 - 4 weeks
Bitter melon (Bitter melon)	12 -13	53 - 55	85 - 90	2 -3 weeks
Black sapote (black sapote)	13 -15	55 - 60	85 - 90	2 - 3 weeks
Blackberries (Mora)	-0.5-0	31 - 32	90 - 95	2 - 3 weeks
Blood orange	4 - 7	40 - 44	90 - 95	3 - 8 weeks

Blueberries	-0.5-0	31 - 32	90 - 95	2 weeks
Bread fruit	13 -15	55 - 60	85 - 90	2 - 6 weeks
Broccoli (Broccoli)	0	32	95 - 100	10 - 14 days
Brussels sprouts (Brussels sprouts)	0	32	95 - 100	3 - 5 weeks
Cabbage, early	0	32	98 - 100	3 - 6 weeks
Cabbage, late (Cabbage, late)	0	32	98 - 100	5 - 6 months
Cactus leaves	2 - 4	36 - 40	90 - 95	3 weeks
Cactus Pear (Tuna)	2 - 4	36 - 40	90 - 95	3 weeks
Caimito (Caimito)	3	38	90	3 weeks
Pumpkin (Pumpkin)	10-13	50 - 55	50 - 70	2 - 3 months
Carrots, bunched (Carrot, bunch)	0	32	95 - 100	2 weeks
Carrots, mature (Carrots, mature)	0	32	95 - 100	7 - 9 months
Carrots, immature (Carrot, tender)	0	32	98 - 100	4 - 6 weeks
Cauliflower (Cauliflower)	0	32	95 - 98	3 - 4 weeks
Celery (Celery)	0	32	98 - 100	2 - 3 months
Chard (Chard)	0	32	95 - 100	10 - 14 days
Cherimoya (Cherimoya)	13	55	90 - 95	2 - 4 weeks
Cherries, sour (Cherries, bitter)	0	32	90 - 95	3 - 7 days
Cherries, sweet (Cherries, sweets)	-1-0.5	30 - 31	90 - 95	2 - 3 weeks
Chinese broccoli (Chinese broccoli)	0	32	95 - 100	10 – 14 days
Chinese cabbage	0	32	95 - 100	2 - 3 months
Chinese long bean	4 -7	40 - 45	90 - 95	7 - 10 days
Coconuts (Coco)	0 -15	32 - 35	80 - 85	1 - 2 months
Collards (Kale)	0	32	95 -100	10 - 14 days
Corn, sweet	0	32	95 - 98	5 - 8 days
Cranberries	2 - 4	36 - 40	90 - 95	2 - 4 months
Cucumbers (Cucumber)	10 -13	50 - 55	95	10 - 14 days
Currants (Pass)	-0.5-0	31 - 32	90 - 95	1 - 4 weeks
Custard apples (Anona)	5 -7	41 - 45	85 - 90	4 - 6 weeks
Dates	-18-0	0 - 32	75	6 - 12 months
Dewberries (Blackberry)	-0.5-0	31 - 32	90 - 95	2 - 3 days
Eggplants (Benjerena)	12	54	90 - 95	1 week
Figs, fresh (Figs, fresh)	-0.5-0	31 - 32	85 - 90	7 - 10 days
Garlic (Garlic)	0	32	65 - 70	6 - 7 months
Ginger root (Ginger)	13	55	65	6 months

Granadilla (Granadilla)	10	50	85 - 90	3 - 4 weeks
Grapefruit, Calif. & Ariz. (Grapefruit Calif. And Ariz.)	14 -15	58 -60	85 - 90	6 - 8 weeks
Grapes, Vinifera (Grapes, vinifera)	-1 a - 0.5	30 -31	90 -95	1 - 6 months
Grapes, American (Grapes, American)	-0.5-0	31 - 32	85	2 - 8 weeks
Greens, leafy	0	32	95 - 100	10 - 14 days
Guavas (Guava)	5 -10	41 - 50	90	2 - 3 weeks
Horseradish (Horseradish)	-1-0	30 - 32	98 - 100	10 - 12 months
Kiwifruit (Kiwi)	0	32	90 - 95	3 - 5 months
Leeks (Leek)	0	32	95 - 100	2 -3 months
Lemons	10-13	50 - 55	85 - 90	1- 6 months
Lettuce (Lettuce)	0	32	98 - 100	2 -3 weeks
Limes (Lemongrass)	9 -10	48 - 50	85 - 90	6 - 8 weeks
Loganberries (Raspberry)	-0.5-0	31 - 32	90 - 95	2 - 3 days
Mamey (Mamey)	13 -15	55 - 60	90 - 95	2 - 6 weeks
Mangoes (Mango)	13	55	85 - 90	2 - 3 weeks
Melons (Melons)				
Married	10	50	90 - 95	3 weeks
Crenshaw	7	45	90 - 95	2 weeks
Persian (Persia)	7	45	90 - 95	2 weeks
Honeydew	7	45	90 - 95	3 weeks
Mushrooms	0	32	95	3 - 4 days
Nectarines (Peach)	-0.5-0	31 - 32	90 - 95	2 - 4 weeks
Olives, fresh (Olives, fresh)	5 - 10	41 - 50	85 - 90	4 - 6 weeks
Onions, green (Onions, greens)	0	32	95 - 100	3 - 4 weeks
Onions, dry	0	32	65 - 70	1 - 8 months
Onion sets (Onion, seedling)	0	32	65 - 70	6 - 8 months
Oranges, Calif. & Ariz. (Naranjas, Calif. And Ariz.)	3-9	38 - 48	85 - 90	3 - 8 weeks
Papaya (Papaya)	7 - 13	45 - 55	85 - 90	1 - 3 weeks
Passionfruit (Passion fruit)	7 - 10	45 - 50	85 - 90	3 - 5 weeks
Parsley (Parsley)	0	32	95 - 100	2- 2.5 months
Peaches	-0.5-0	31 - 32	90 - 95	2 - 4 weeks
Pears	-1.5 a- 0.5	29 - 31	90 - 95	2 – 7 months
Peas, green (Peas)	0	32	95 - 98	1 - 2 weeks
Cucumber (Cucumber [tree melon])	4	40	85 - 90	1 month

Peppers, Chili [dry] (Hot Chiles [dry])	0 -10	32 - 50	60 - 70	6 months
Peppers sweet (Pepper)	7 -13	45 - 55	90 - 95	2 -3 weeks
Pineapples (Pineapple)	7 - 13	45 - 55	85 - 90	2 - 4 weeks
Plantain (Banana)	13-14	56 - 58	90 - 95	1 - 5 weeks
Plums and prunes (Plums and prunes)	-0.5-0	31 - 32	90 - 95	2 - 5 weeks
Pomgranates (Granada)	5	41	90 - 95	2 - 3 months
Potatoes, early crop	10-16	50 - 60	90 - 95	10 - 14 days
Potatoes, late crop (Potatoes, late)	4.5-13	40 - 55	90 - 95	5 - 10 months
Pummelo (Grapefruit)	7 -9	45 - 48	85 - 90	12 weeks
Pumpkins	10-13	50 - 55	50 - 70	2 - 3 months
Quinces (Quince)	-0.5-0	31 - 32	90	2 - 3 months
Radishes, winter	0	32	95 - 100	2 - 4 months
Raspberries (Raspberry)	-0.5-0	31	90 - 95	2 - 3 days
Rhubarb (Rhubarb)	0	32	95 - 100	2 - 4 weeks
Snow peas (Chinese pea)	0-1	32 - 34	90 - 95	1 - 2 weeks
Soursop (Soursop)	13	55	85 - 90	1 - 2 weeks
Spinach (Spinach)	0	32	95 - 100	10 - 14 days
Strawberries	0	32	90 - 95	5 - 7 days
Sugar apples (Anona)	7	45	85 - 90	4 weeks
Sweetpotatoes	13-15	55 - 60	85 - 90	4 - 7 months
Tamarinds (Tamarind)	7	45	90 - 95	3 - 4 weeks
Tangerines, mandarins, and related citrus fruits (Tangerines, mandarins and related citrus fruits)	4	40	90 - 95	2 - 4 weeks
Tomatillos (Tomatillo)	13-15	55 - 60	85 - 90	3 weeks
Tomatoes, firm-ripe (Tomatoes, firm ripe)	13-15	55- 60	90 - 95	4 - 7 days
Turnips (Turnip)	0	32	95	4 - 5 months
Turnip greens (Turnip greens)	0	32	95 - 100	10 - 14 days
Watercress (Watercress)	0	32	95 - 100	2 - 3 s weeks
Watermelon (Sandia)	10 -15	50 - 60	90	2 - 3 weeks
White asparagus (White asparagus)	0-2	32 - 36	95 - 100	2 -3 weeks
Yucca root (Yuca)	0 - 5	32 - 41	85 - 90	1 -2 months

Sources: McGregor, B.M. 1989 Tropical Products Transport Handbook. USDA, Office of Transportation, Agricultural Handbook Number 668; FAO, 1996.

DRYING AROMATIC PLANTS TO MAKE TEA

The time for drying aromatic plants to make tea depends on the type of herb and the technique used, it can last a few hours or up to 8 days. Among the drying techniques there are industrial drying and home drying. Home drying is subdivided into other techniques.

INDUSTRIAL DRYING

Adequate machinery is used to control the drying conditions, obtaining higher quality in the final product. In this drying, a heat source is applied to evaporate the water from the herbs and accelerate their drying.

HOME DRYING

This home drying is much cheaper and easier, we can do it in three ways:

◀ Dried on a raised base above the ground, this drying technique allows air circulation between the herbs, it is used for plants that have young stems and leaves: basil, dandelion, parsley, chamomile, nettle.

Steps for drying on an elevated base:

• In plants with broad leaves, separate the leaves from the stems and discard the stems.

• In plants with narrow leaves, form bouquets with the plants, and tie them loosely so that air circulates inside them.

• In a wooden frame a mesh with large holes is placed, the frame is placed on 4 legs 10 cm high, you can use a barbecue or kitchen rack.

• Put a fine cotton or linen cloth on top of the grid or mesh.

• On this cloth, put the separated large leaves and the bouquets, so that the air can circulate.

• When everything is located, leave it in a dry and dark place at 24 °C, letting it dry for 7 to 20 days, turning it every one or two days. Once dry, store them in containers or in a suitable place.

◄ Drying with the hanging technique consists of hanging the herbs tied with bouquets. On the ceiling, hang some nails to tie strings; you can put canes with ropes to hang the bunches, whatever method we use we must leave 10 cm of distance between the bouquets for air circulation. The plants that we can use are: rosemary, sage, thyme, and olive, among others. The temperature between 20 °C and 27 °C [González, 2012].

◄ Oven dried, the home oven is heated and we place the bouquets on the rack, leaving the oven door ajar about 5 cm. Plants dry in a few hours. The temperature must not exceed 33 °C.

Recommendations

You must take into account the following recommendations to achieve a quality product.

• Herbs should be dried immediately after being picked.

• Do not dry them between sheets of books to avoid absorbing ink.

• Do not dry them on the floor, no matter what material it is.

• A ventilated place to avoid the appearance of fungi.

• The temperature of the place is over 24 °C, not too cold or too hot.

• The place should not be illuminated, because the light alters the components.

• The drying area should not be windy. The wind dries the plants too much and the aroma of the oils disappears.

CHAPTER IX

CACAO BEANS PROCESSING

APPLICATION OF THE WASHING TECHNIQUE FOR CACAO PROCESSING: *"Theobroma Cacao L"*

Ecuadorian cocoa has an excellent quality due to its floral aroma and its exceptional flavor. These two reasons are very important why large multinationals want to acquire it. In addition, Ecuadorian cocoa meets all the requirements to produce the highest quality products used in fine chocolates, coverage, coatings and preparation of exquisite dishes.

Some Ecuadorian producers in many cocoa crops do not ferment the cocoa properly. According to Quiroz (2012), he states that each type of cocoa is always fermented separately. For López (1987) expresses that the almonds extracted from the ears on different days should not be mixed. Wilbaux (1963) states that fermentation should last from 6 and a half to 7 days in a cool, dry place, stirring 2 or 3 times.

Post fermentation is another very important step. This technique was carried out approximately 50 years ago in Africa, the result was an improvement in the quality of Creole cocoa. It is very simple and fast; it consists of washing the cocoa beans with plenty of water after finishing the fermentation to remove the pulp remains. Jean Braudeau (1970) indicates that washing the cocoa when it comes out of fermentation improves the aromatic taste qualities of Creole cocoa grown in Africa.

Specialized in this product, they recommend storing the cocoa husk to start fermentation in 2 or 3 days, so that the ears lose water and favor fermentation and a rise in temperature [Woods and Lass, 1985]. With this practice, a good fermentation and a decrease in the acidity of the almonds is achieved [Said and Musa, 1988].

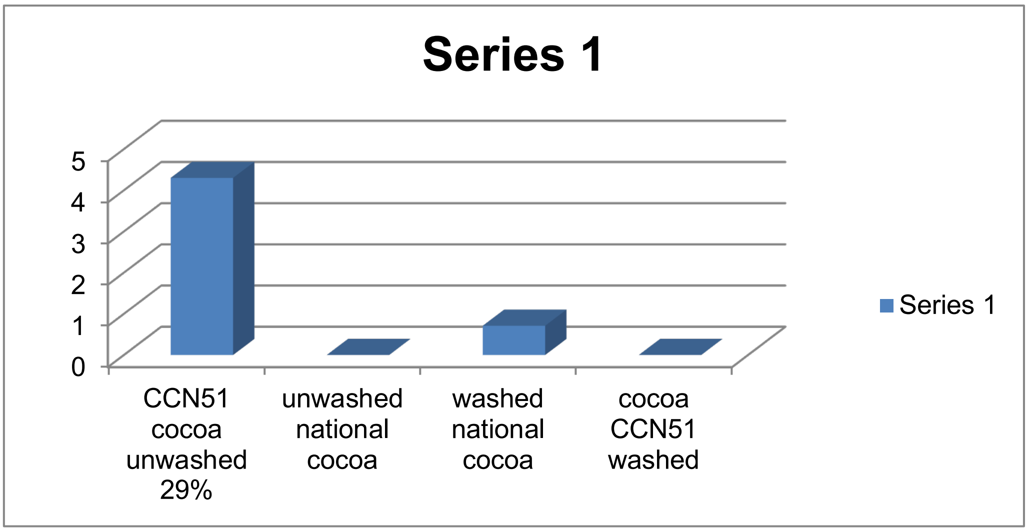
Here in Ecuador, the author of this book carried out research on the application of the same washing technique after fermentation of the Nacional cacao Arriba and the CCN51 cacao to identify the improvement of the organoleptic properties, especially on the astringent flavor of the cacao. In his research, he made 50 % chocolate bars and cocoa paste, in both types of cocoa, with tasting tests. See figure 76, the National Arriba cocoa and the CCN51 cocoa are already washed.

Figure 76: Cacao Nacional Arriba and CCN51 washed, respectively.
Source: El Salous, 2013.

The result of this research and its application in the Nacional Arriba cocoa and the CCN51 cocoa showed the improvement of the flavor of the Nacional Arriba cocoa, and in the CCN51 cocoa, on the other hand, by washing it lost a percentage of the astringent flavor and a little color and aroma and that was reflected in the final product as 50 % chocolate. See graphs 1 and 2, present the results of the cocoa mass tasting and the 50 % chocolate tasting.

This research is a guide for small and large Ecuadorian cocoa producers to use this technique and further improve the quality of cocoa. In addition, for artisan producers, who do not have conchers in their processing plants, they can improve their products; and large industries save energy costs and reduce manufacturing time.

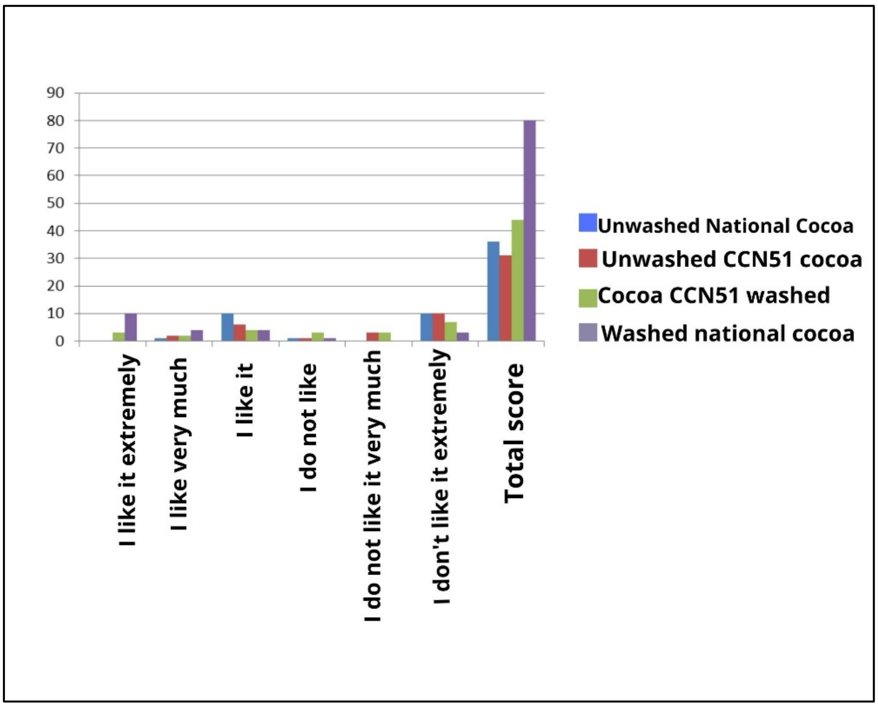
Graph 1: Results of the tasting presented of the cocoa mass.



Source: El Salous, 2013.

The test was small-scale, and the results can be approximate.

Graph 2: Graphic acceptance of the 50 % chocolate tasting.



Source: El Salous, 2013.

EQUIPMENT AND SUPPLIES USED

• Food dryer.

• Cocoa hulling machine.

• Cocoa mill.

• HACH brand pH meter.

• Cocoa beans.

• Icing sugar

ELABORATION STEPS

► Selection and cleaning of the CCN51, and national Cacao beans for fermentation.

► Fermenting the cocoa beans, the national cocoa was fermented for 3 days, while the CCN51 cocoa was fermented for 5 days.

► Divide each type of cocoa into 2 parts, the first were washed, while the other 2 were for control.

► Dry the 4 groups of cocoa beans to an approximate humidity of 6 %.

► Roasting the cocoa beans: The cocoa beans have to be roasted to facilitate the removal of the husk and so that the flavor precursors

(sugars, amino acids and others that are formed during fermentation) combine and transform to form the typical smells and sensations of chocolate flavor and other sensory notes such as floral, fruity and nutty, the temperature of toasting almonds is approximately 125 °C to 130 °C for 20 to 25 minutes in an industrial toaster. See figure 77, in which the cocoa roaster is shown, figure 78 the degree of roasting is verified and figure 79, in which the roasted cocoa is observed.

Figure 77: Cocoa roasting.
Source: El Salous, 2013.

Figure 78: Verification of the degree of toasting.
Source: El Salous, 2013.

Figure 79: Cocoa already roasted.
Source: El Salous, 2013.

► **Shelling:** The shell that is firmly attached to the bean in raw cocoa, separates from it, facilitating the shelling operation. In Figures 80 and 81, the cacao beans cocoa is observed in the dehuller.

Figure 80: Shelling the cocoa.
Source: El Salous, 2013.

Figure 81: Cocoa already shelled.
Source: El Salous, 2013.

►**Milling:** Due to the fat content of cacao beans (higher than 51 %) and due to the heat generated by friction during several grinds with the industrial mill at the plant, the cocoa is transformed into a fluid paste called Cocoa Liquor. Figures 82, 83, 84 and 85 show the cocoa grinding operation.

Figure 82: Entry of cocoa into the mill.
Source: El Salous, 2013.

Figure 83: Grinding the cocoa.
Source: El Salous, 2013.

Figure 84: Exit of ground cocoa.
Source: El Salous, 2013.

Figure 85: Cacao beans already ground.
Source: El Salous, 2013.

► In the last stage, the cocoa paste was separated into 2 parts, the first was left as cocoa paste and the other was used for the manufacture of 50 % chocolate, with 50 % cocoa paste and 50 % powdered sugar and the operation was repeated in the mill. See figure 86, in which the chocolate is made.

Figure 86: Making chocolate for tasting.
Source: El Salous, 2013.

► Preparation for tasting was carried out.

COCOA PROCESSING

Figure 87: Processed products of cocoa beans.
Source: El Salous, 2016.

CHOCOLATE

For the elaboration of chocolate, it depends on the mixture and flavors that are added to it. Chocolate is made with liquor, sugar, flavors and fat. You can add nuts, almonds, condensed milk, peanuts, delicacy, etc. These are usually added at the end of the processing (Figure 87). The smoothness of the chocolate depends on the quality of the fat or cocoa butter.

Process

► The ears are collected. The kernels are extracted from the cob. See figure 88.

Figure 88: Beans and the cocoa pod.
Source: El Salous, 2016.

► The beans are fermented for 3 to 7 days. Carry out washing after fermentation to improve the quality of the chocolate.

► Dry the grains, the longer the drying process lasts, the better the aroma of the grain. The dried beans are called almonds.

► During the roasting process, the grain color is accentuated (Fig. 89).

Figure 89: Artisanal roasting of cocoa.
Source: El Salous, 2016.

► Shelling, the shells are removed and the seed is left (Fig. 90).

Figure 90: Artisan husking of cocoa.
Source: El Salous, 2016.

► Grind the seeds until you get a fatty paste (cocoa liquor). See figure 91.

Figure 91: Ground cocoa.
Source: http://cyberspaceandtime.com/13_pochYMgA.video+related

► Pressing the cocoa paste, is obtained by pressing the cocoa butter and cocoa and a finer paste that is chocolate.

► After grinding, conching is carried out. Mix the ingredients like sugar, more cocoa butter, powdered milk (milk chocolate), vanilla, etc.

► Blend the cocoa liquor at a temperature of 82 °C, if you want a good quality chocolate. The friction of the sugar crystals and cocoa makes the chocolate shiny and smooth (Fig. 92).

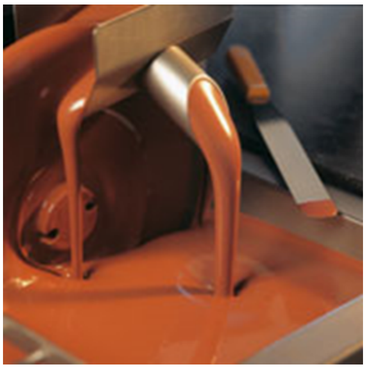


Figure 92: Mechanically beating the cocoa liquor.
Source: www.callebaut.com

► Liquid chocolate is stored in warm containers until the next step.

► Once tempered, it is poured into molds. Move the molds a little so that some air bubbles come out (Fig. 93).

Figure 93: Chocolate molds.
Source: El Salous, 2016.

►The molds are cooled, then extract the chocolate from the molds. See figures 94 and 95.

Figure 94: Chocolate extracted from the molds.
Source: El Salous, 2016.

Figure 95: Chocolates of different models ready to be tasted.
Source: El Salous, 2016.

Note: The difference between the different varieties of chocolate is the proportion of solid cocoa in the tablet. Solid cocoa is everything in a ground cocoa bean, including cocoa butter. For example: In the chocolate tablet it indicates 70 % solid cocoa, that is to say that 70 % of the tablet comes from cocoa beans. Or else 70 % solid cocoa can mean 50 % ground beans plus 20 % cocoa butter; or, 68 % ground beans plus 2 % cocoa butter. The rest are sugar, vanilla, milk, etc.

Chocolate should be stored at 10 °C, shelf life of one year. Store it in an airtight or plastic container, because it is a product that easily absorbs other odors.

TO MELT THE CHOCOLATE

► Break the chocolate into small pieces and place them in a clean, dry bowl or pyrex (Fig. 96).

Figure 96: Chocolates in a bowl.
Source: El Salous, 2016.

► Put a saucepan with a little water over a low heat, place the bowl holding it with your hand in the saucepan without the bowl or pyrex not touching the water. Do not let any drop of water fall into the chocolate, otherwise it will form lumps or harden and stick.

► When the chocolate is melted, turn off the heat and remove the bowl from the saucepan.

► Stir the melted chocolate with a wooden spoon or plastic spatula until it is completely creamy (Fig. 97).

Figure 97: Stirring the chocolate.
Source: El Salous, 2016.

To melt in the microwave, cut the chocolate into pieces and place them in a dry pyrex. Use on medium or low heat for small amounts. High temperature for a lot of quantity. If it is done in a pyrex cup at high temperature, it is left for 30 to 40 seconds. Take it out and stir quickly until it is creamy, smooth and shiny.

COCOA MASK

Figure 98: Cocoa mask.

Source: El Salous, 2016.

The cocoa mask is a product that gives many benefits to the skin, the Ph. D. Albert Leung, natural products' pharmacist recommends it especially for wrinkles around the eyes, mouth and neck, since this product rehydrates dry skin [Duke, 1998]. Figure 98 shows a handmade cocoa mask.

Ingredients:

• 250 dark chocolate

• 200 ml of milk

• 5 g of sea salt

• 30 brown sugar

Steps

► Heat the dark chocolate in a container over a water bath for 3 minutes (Fig. 99).

Figure 99: Melting the chocolate in a water bath**.**

Source: https://www.stockfood.no/

► Mix sea salt, brown sugar, and milk in a bowl.

► Remove the melted chocolate from the heat. Mix the melted chocolate with the salt and milk mixture.

Or it can also be prepared as follows:

• 70 g of cocoa liquor

• 30 g of jojoba oil

The paste is melted and mixed with the oil.

COCOA DRESSING

Figure 101: Artisan cocoa dressing.
Source: El Salous, 2016.

For the preparation of the cocoa dressing (Fig. 101) the following raw materials are needed:

Figure 102: Cocoa almonds.
Source: El Salous, 2016.

• 600 g. of roasted and ground cacao almonds (Figure 102).

• 400 g. of red onion.

• 200 g. of garlic.

• 50 g. ground cumin.

• 50 g. of salt.

• 30 g. of herbs. 1 bay leaf.

• 5 g. cardamom, other spices.

Process

► A syrup solution is prepared using 1 liter of water and 1 kilogram of panela.

► The syrup is liquefied with the toasted and ground cocoa beans (or cocoa paste), the red onion, the garlic, the ground cumin, the salt, little herbs, the bay leaf, the cardamom and other spices (optional). See figure 103.

Figure 103: Blending the ingredients.
Source: El Salous, 2016.

► The ingredients already blended (dressing) are placed in a saucepan over low heat until the dressing thickens (Fig. 104).

Figure 104: Heat the dressing until it thickens.
Source: El Salous, 2016.

► The dressing is packaged at a temperature of 85 °C in sterilized jars (Figures 105 and 106).

Figure 105: Packaged dressing.
Source: El Salous, 2016.

Figure 106: Artisan dressing.
Source: El Salous, 2016.

QUICK CHOCOLATE CONDENSED MILK

For the production of quickly prepared chocolate condensed milk (Fig. 107), only the next step will be followed.

Figure 107: Quick chocolate condensed milk.
Source: El Salous, 2016.

Raw material

• 250 ml of mineral water.

• 400 g of icing sugar.

• 400 g of powdered milk.

• 70 g of cocoa powder.

Process

► The mineral water is liquefied with the powdered sugar, the milk powder and the cocoa powder.

► The liquefied is poured into a previously sterilized container.

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