Introduction

Fruits and vegetables are among the most widely consumed foods. They are important sources of calcium, vitamin C, carotene, and B-group vitamins. They provide few calories but are rich in fiber (cellulose), which helps facilitate intestinal transit, especially in sedentary individuals. Moreover, they help reduce the desire to eat without causing weight gain.

1.Fruits categories :

Fruits are the edible products of certain plants, generally sweet in taste with relatively high acidity. They are most often consumed raw. The different categories of fruits are :

Category	**Examples**
Berries (red fruits)	Strawberry, raspberry, blackcurrant
Stone fruits	Peach, apricot, cherry, plum
Pome fruits	Apple, pear, grape, kiwi
Nuts	Walnut, almond, hazelnut
Mediterranean or tropical fruits	Lemon, orange, avocado, banana, pineapple, mango Dattes, pomegranate

2.Vegetables Categories :

A vegetable is a cultivated plant of which, depending on the species, the leaves, stems, roots, tubers, fruits, or seeds are consumed. The different categories, shown in the following table, are defined according to the plant organ or part used as a vegetable.

Category	**Examples**
Leafy vegetables	**Whole leaves:** Swiss chard, cabbage, chives, watercress, spinach, lettuce, lamb's lettuce, sorrel, parsley, dandelion **Leaf bases:** Leek **Petioles:** Celery, fennel, rhubarb
Stem vegetables	Asparagus, kohlrabi
Root vegetables	Beetroot, carrot, celeriac, turnip, sweet potato, radish, rutabaga, salsify
Bulb vegetables	Garlic, shallot, onion

Category	Examples
Fruit vegetables	Eggplant, cucumber, gherkin, squash, zucchini, chili pepper, bell pepper, tomato, green bean Chestnut, walnut, hazelnut
Whole seedlings	Soybean sprouts, radish sprouts, alfalfa sprouts
Buds	Brussels sprou

Most of the processing carried out today by industry was once performed traditionally on farms.

However, many products are now deeply transformed through physical, chemical, or biological treatments, the most advanced of which is fermentation.

Some fruits and vegetables are processed in factories without undergoing real transformations, but simply to be packaged in ways that facilitate their marketing.

3.Industrial processing:

According to the Codex Alimentarius (2005), fruit juice is the unfermented, but fermentable, liquid obtained from the edible part of sound, ripe, fresh fruits, or from fruits that have been properly preserved under suitable conditions by appropriate means and/or by post-harvest surface treatments applied in accordance with regulations**.**

3.1.Fruit juice concentrate: An unfermented but fermentable product after reconstitution, obtained from the juice of sound and ripe fruits that has been dehydrated so that the soluble dry matter content is at least double that of the original juice intended for direct consumption; it must be preserved exclusively by physical means.

3.2. Fruit nectar: A non-pulpy, unfermented but fermentable product intended for direct consumption, obtained by mixing fruit juice and the whole edible part of sound and ripe fruit. It may be concentrated or not, and may have water and sugar added. The fruit juice content must not be less than 30%.

3. 3.Pre-treatments:

1.3.1. Harvesting: Fruits should be picked by hand and carefully placed in harvesting containers. Any further handling must be done carefully to avoid mechanical damage.

1.3.2.Reception: This step is mainly carried out to check sanitary conditions and the maturity and freshness of the fruit. Great attention must be paid to the quality of the fruits. The conformity of each batch must be verified.

1.3.3. Temporary storage before processing: This stage should be as short as possible to avoid loss of flavor, texture changes, weight loss, and other deterioration that may occur during this period.

1.3.4. Washing: This is a mandatory step aimed at removing any surface contamination of the fruit, such as dust, insects, mold spores, and dirt that could contaminate or affect the color, aroma, or flavor of the fruit.

1.3.5 .Sorting: For the production of high-quality fruit juices, this operation consists of removing partially or completely rotten fruits, damaged fruits, and any foreign bodies (which

may have remained after washing), as well as qualitative sorting based on organoleptic criteria and the level of ripeness.

1.3.6 .Trimming: This consists of removing parts of the fruit considered “not edible,” that do not keep well, and/or that do not meet the characteristics of the final product.

1.3.7 Pitting (de-stoning): The technologies used to remove stones or seeds are highly specific to the initial characteristics of the fruits being processed. The operations are either manual or carried out using suitable machines such as conveyor belts with rows of cavities in which the fruits are fitted.

2. Crushing (Grinding):

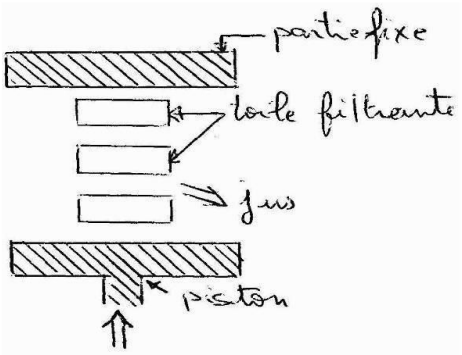
It consists of preparing the pulp before pressing or extraction through a number of operations: cutting for tomatoes; crushing (stomping) for grapes; grating for apples. It is carried out using knife mills, hammer mills, or other types of grinders.

3.Extraction or pressing:

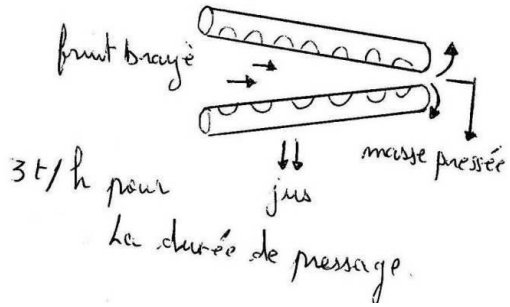
It consists of separating the product into two phases: solid and liquid. The liquid phase is almost always the desired one and should be as clear as possible. It is characterized by the following criteria:

- Juice yield relative to the fruit
- Extraction time
- Insoluble content of the juice (pectins, proteins)

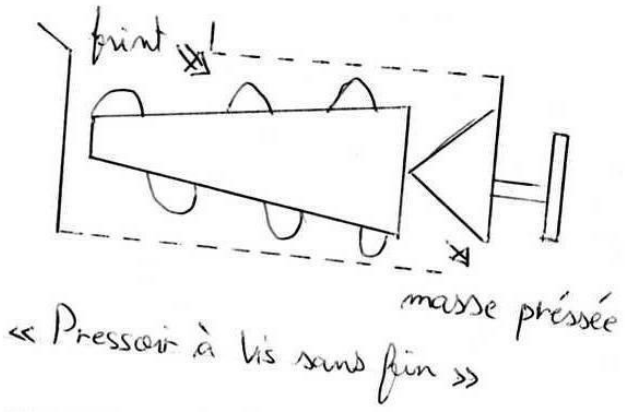
3.1.Piston pressing: The crushed pulp falls into a horizontal cylinder and is pressed using a piston. The yield is high, and the juice is almost clear, but the process is relatively long (60–90 minutes). In this case, pressing is not continuous.



3.2.Belt press: The pulp is placed on a nylon or stainless-steel belt and is mechanically pressed between rollers that are gradually brought closer together. The capacity can reach about 3 tons/hour for apples, and the extraction yield can reach up to 70%. The pressing time is only a few minutes. The press operates continuously.



3.3.Screw press (auger press): This process applies mechanical pressure using a conical screw with a vertical axis inside a cylindrical screen. The depth of the screw grooves decreases along its length, resulting in a reduction of volume in the compression zone and therefore a continuous extraction of juice. The screen perforations vary depending mainly on the nature of the product. The theoretical yield is about 80%. The juice contains a high level of insoluble solids due to pulp tearing during movement through the cylinder. It is mainly used for apples, pears, and grapes.



3.4.Citrus extractor: The operation takes place through several stages:

- 1st stage: The fruit is placed in a cup, then the upper part of the machine descends while the rigid end of the tube (second part of the device) cuts a hole at the base of the fruit.
- 2nd stage: The fruit is compressed between metal fingers; only the juice is extracted from the pulp, which passes through a perforated tube.
- 3rd stage: A central tube equipped with a stopper rises and compresses the contents of the tube, extracting the remaining juice.

- 4th stage: The essential oils from the peel, under the effect of compression, flow out of the fruit and are carried away along a conveyor belt. An annular space at the top of the cups allows the peel to be separated at the end of the cycle.

3.5.Centrifugal extractor: Mainly used for apple juice, this is a continuous extraction process by spinning. Its principle is as follows: the apple pulp is introduced at the top of the spinning bowl rotating at 3000 rpm, then it is pressed against a centrifugal screen. The process lasts only a few seconds, compared to about 60 minutes for a hydraulic press. The risk of oxidation is not zero. The extracted fruit has a different composition because its aroma, color, and flavor are much closer to those of the fresh product. However, it must be processed immediately (enzyme inactivation, especially browning enzymes) through deaeration, pasteurization, and possibly centrifugation, after which the juice becomes clear.

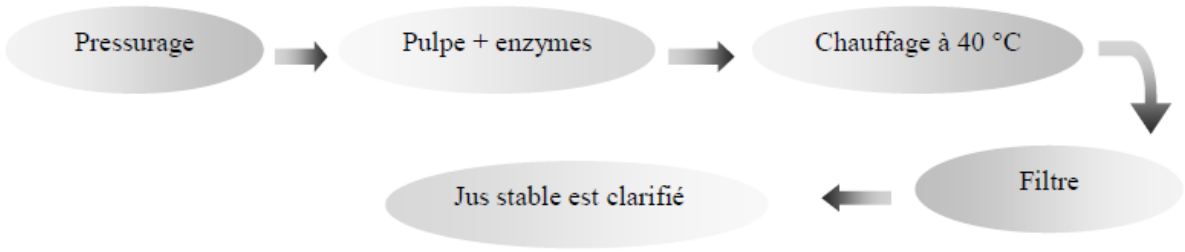
4. Juice clarification: It aims to separate, by centrifugation, the raw juice coming from presses from the coarse particles of fibrous pulp rich in bitter substances. The liquid to be treated is introduced into the center of the bowl through the feed tube, then it passes between discs where it is spread into thin layers under the effect of centrifugal force. The solid materials are removed from the flow and driven toward the outside.

5.Juice stabilization:

Juices are suspensions of insoluble matter maintained in solution by colloids. This suspension is more or less stable and can be marketed even in a cloudy form. However, in order to obtain clear and therefore more stable juices, it is necessary to remove these colloids. Different methods are used for this purpose:

5.1.Precipitation: It is carried out using tannins, which combine with proteins. This operation is called fining. However, decantation may sometimes be slowed down during this process.

5.2. Solubilization: It is carried out using enzymes. The insoluble substances responsible for turbidity are no longer kept in suspension and can precipitate. The process may be completed by juice deaeration, in which the juice flows in thin layers inside a vacuum chamber, leading to better stabilization of the juice and improved preservation of vitamin C.



6. Juice pasteurization:

1/ Heat pasteurization: This heat treatment is the most commonly used method for preserving fruit juice. It aims to destroy microorganisms and inactivate enzymes that could spoil the product or make it unfit for human consumption.

Pasteurization after packaging:

- Hot filling and self-pasteurization
- Flash pasteurization followed by aseptic filling

2/ By radiation: Pasteurization is achieved using UV or IR radiation from a source that passes through a fused quartz tube, through which the juice flows and is heated.

3/ Sterilizing filtration: Filters with a pore diameter smaller than that of microorganisms are used.

7. Juice concentration:

Concentration facilitates the transport and storage of juices. Fruit juice concentration is most often carried out by vacuum evaporation of part of the water from the juice. The equipment allows continuous operation in thin layers.

8. Juice storage:

Raw fruit juice can be stored in tanks, and the processes used to inhibit enzymes and microorganisms include:

- **Cold storage at around 0°C:** Above 0°C, fermentation would occur, requiring repeated pasteurization.
- **Storage under CO_2 pressure:** About 15 g/L of CO_2 is used. The juice is not completely protected against lactic fermentation. Complete removal of CO_2 is difficult, so juices preserved this way are always slightly sparkling.
- **Flash pasteurization followed by refrigeration (0–2°C):** The juice is stored at this temperature, preferably under nitrogen to prevent mold growth on the surface.
- **Preservation using sulfiting:** SO_2 protects even at low concentrations against enzymatic browning and other forms of oxidation.