The scientific and technical objectives are organised as research and development projects concerning products covered by the department: fruits, vegetables, aromatic plants and other horticultural produce.

They concern the following themes:

- knowledge of fresh produce and characterisation of horticultural products,
- quality in close relation with pre-harvest physiology and phytotechny,
- storage in relation with pre-harvest physiology and phytotechny,
- fresh and processed technology in close relation with yield and quality constitution components ■

The international market for citrus and tropical fruit juices: review and prospects

Abstract

Complete version
http://technofruits2001.cirad.fr

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Although it is difficult to find accurate, reliable statistics, we can nevertheless affirm that the market for practically all citrus juices and all tropical fruit juices is growing slowly but steadily at both the global scale and that of the European Union. The analysis and interpretation of official data and above all permanent contacts with economic operators in the fruit juice sector led us to reaching this conclusion.

The European market situation is analysed product by product (orange, grapefruit, lemon, pineapple, mango, passion fruit and banana), and the fruit juice market at the beginning of the twenty-first century is characterised by two new, important trends:

1. business concentration at all levels in the production and distribution chain;
2. the emergence and very rapid development of demand for NFC (Not From Concentrate) and organic products ■

Processing exotic fruits for juice: description of processes and optimisation of qualities

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A number of French market statistics from the *Union Nationale des Producteurs de Jus de Fruits Français* reveal a fairly substantial increase in exotic juices and blended juices containing mango, pineapple, passion fruit, etc. since the beginning of the 1990s. They consist of juice prepared from concentrate, nectar and pure juice and of beverages. Vitamins are often added to restore the initial levels in the raw materials; this is performed within a specific framework of regulations.

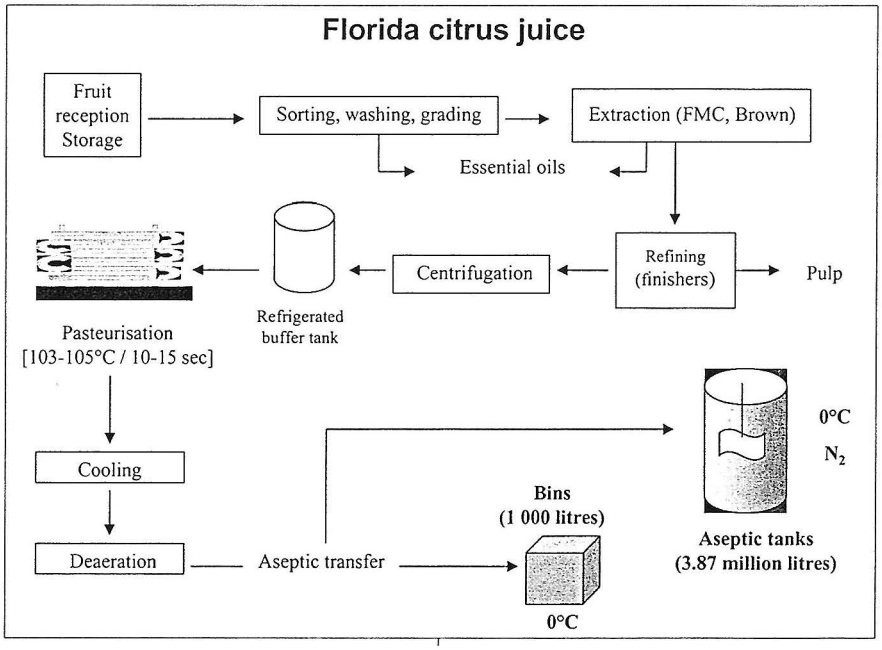
Florida citrus juices

The crop estimate for 2001/2002 varies from 223 to 241 million boxes depending on the source. One box of oranges (approximately 41 kilograms) gives about 21 to 24 litres of pure orange juice. This means 5 thousand million litres of juice to be stored and distributed. The main orange juice producers in Florida have chosen bulk aseptic packaging and storage in two forms: 1,000-litre wooden bins with aseptic liners and giant aseptic tanks containing a million gallons (3.78 million litres). Some six factories in Florida store juice in this way. It reduces storage and handling costs in comparison with the traditional frozen tank method, increases productivity and enables better stock management and conserves juice quality.

The process

Citrus juice manufacturing processes are fairly well known: fruit reception, storage and selection. Inspections are performed by USDA and the FDA in Florida on reception and at several stages. They make it possible to check whether regulation ripeness has been attained. Washing is often followed by abrasive scrubbing of the fruits to recover essential oils. Two types of extraction are performed in Florida and Brazil: FMC and Brown. In the FMC method, oranges are pressed vertically with metal cups and the Brown method is similar to a traditional citrus fruit squeeze with the oranges cut in two and pressed horizontally by cones.

Extraction gives a high-pulp juice that must then be refined. This is performed in several stages: finishers (filters) separate out the coarse pulp. The addition of pulp to



juices gives consistency appreciated by consumers. The citrus pulp market has developed, together with all the related technology.

Refining reduces the coarse pulp content. Centrifugation is then performed to adjust the fine pulp content of juice, which varies from 8 to 12% in orange juice. The aseptic process itself then starts with a buffer tank that is refrigerated or not according to the flow. Pasteurisation is performed at a fairly high temperature and for very short periods of time. The juice is cooled very rapidly, deaerated and transferred under aseptic conditions to the bins or aseptic tanks.

These tanks are kept under nitrogen and housed in gigantic warehouses at a very stable 0°C. Each warehouse may hold about 30 tanks storing the production of an entire season (October to July). They are agitated horizontally and vertically at least once a day and sometimes every 15 minutes because the settling of fine pulp hinders the sampling performed regularly for quality control and also causes off-aromas. Five or six factories of this type are to be found in Florida. Some produce more than 1 million litres of pure juice per day when the season is in full swing. The factories can handle up to 200 trucks of citrus fruits per day with FMC machines with five extraction cups each pressing 100 oranges per minute (at the highest pressing frequency). Juice is shipped to Europe from these tanks. Different methods are used. Bins are exported in the conventional manner in refrigerated containers. However, one of the most recent innovations consists of exporting a little more than 20 tonnes of pure juice in bulk in a tanker type container. The tanker is disinfected under 'ultra-clean' conditions and filled at 0°C directly from the storage tanks without re-pasteurisation. This method conserves the qualities of the juice, as is shown by the results of analyses: it is well deaerated, well stored and cold conditions are good. Very little vitamin C is lost. Producers consider that vitamin C loss from fruit reception to tanker filling is about 10%. The fall is rarely more than 15% on arrival of the containers in Europe. Traceability from producer to packager is perfect. The latter takes delivery of a container with no breaking of the cold chain, opens the antiseptic cocks and fills the bottles. About 150 containers of this type are shipped to Germany and France each year. Temperature variations are very well mastered and are always less than one degree.

Mango purée from Mexico

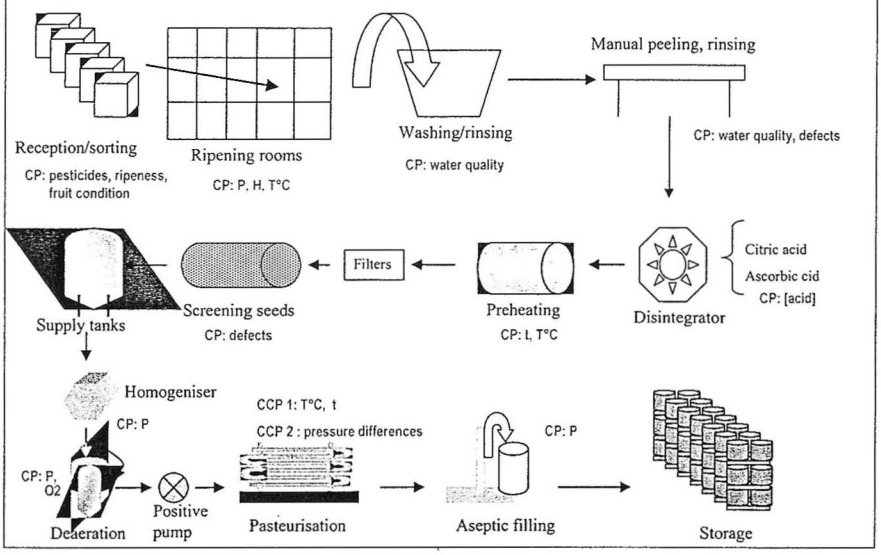
Nearly 23 million tonnes of fruits are grown annually. India is the world's leading producer with 15 million tonnes in 2000. It exports more processed fruits than fresh fruits. Mexico is the second largest producer in the world and the leading fruit exporter. The main varieties used for the preparation of mango purée are Alphonso, Totapuri, Kesar and Kent. Alphonso is the most sought-after variety for its colour and aromatic qualities but it is also the most expensive. Thus, Totapuri is mixed with Tommy Atkins from Central America.

The process

The fruits are picked during the mature phase, sorted and washed very carefully because of the latex that collects at the base of the fruit and contains toxic compounds. Preliminary sorting is performed according to the defects in fruits, which are mainly sorting rejects from the fresh fruit market. A second sorting operation is performed for ripeness according to colour, juice content and the soluble dry matter content (Brix, acidity). These mangoes are then stored in large ripening sheds. Optimum ripening is achieved with no additives (for economic reasons) to give a purée with the aromatic flavour of the original fruit.

The first heat treatment is then performed on the whole mangoes to reduce the microbial load at their surface and also to inactive enzymes (pectinase and polyphenol oxidases) and facilitate peeling. The fruits are peeled hot by cutting and pressing against screens. The stones and the peel, forming about 40% of the mango are removed at this stage. The hotbreak is then performed, consisting of heating to fairly high temperatures to optimise the extraction yield and complete the inactivation of enzymes. The fibrous network in the fruit holds juice like a sponge and heat treatment gives a good texture that is refined in the finishers and settlers that adjust the pulp content. There are then two possibilities—the preparation of unconcentrated single purée using deaeration, pasteurisation and aseptic filling and the preparation of concentrated purée using an evaporator.

Manufacture of banana purée, Ecuador



Banana purée

Ecuador is a large banana purée producer, as are Costa Rica and Colombia, with a policy of renewal of plantations and the selection of varieties for banana purée.

The process

The fruits are harvested green. Final ripening is achieved with vapour pressure, temperature and sometimes additives (ethylene or other ripening agents). Peeling is still performed by hand in many factories under the strictest conditions of hygiene. The critical points of the HACCP procedure are pesticides, ripeness, fruit condition, pressure and temperature conditions in the ripening rooms and water quality. The fruits are then pulped. Technological additives may be incorporated during this stage or during screening: citric acid (as pH regulator) and ascorbic acid (antioxidant) so that a whitish and not grey colour is conserved. After pre-heating at a fairly low temperature to conserve this colour, coarse filtering is performed and then finer filtering to remove seeds. The purée is examined carefully so that a number of defects can be eliminated.

This is followed by homogenisation, a very important phase because even purée of ripe bananas contains about 1% insoluble material. This consists in particular of starch that must be disintegrated and broken down or it may clump and form grains in the purée that are visible with the naked eye. The homogenisation phase is performed at high pressure of up to 250 bar. The deaeration that follows is performed in all processes and with aroma recovery. The process is completed by positive pumping, pasteurisation and aseptic filling.

Pure and concentrated pineapple juice from Côte d'Ivoire: the example of the SAFCO factory

Optimisation of the extraction and packing process has been in progress at this factory for a year or two. SAFCO has installed a fruit traceability and integrated agricultural system. This is in perfect working order and is now attractive for customers. The company also produces organic fruits and it is hoped that it will soon be able to reserve a proportion of these fruits for the preparation of organic pineapple juice. The factory is supplied by 'private' planters or by its own production.

The process

Fruit reception and selection are an essential part of the process. Washing with chlorinated water and spray rinsing follow. This is very important for pineapple, which grows close to the ground and may be contaminated by heat-resistant moulds. Grading is then performed for better peeling and peel residue removal to prevent off-flavours. The fruits are then cut in two and peeled lengthways.

The flesh first passes through rotary presses resembling finishers. A first juice is obtained at this stage. The coarse pulp leaving this extractor on a rotary screen undergoes a second pressing stage at two levels. This gives increased yield while maintaining juice quality. This consists of fairly gentle belt pressing. Two grades of juice are obtained depending on the stage and the pressure applied. One or other of these juices are chosen according to the specification desired.

The combining of these two pure juices is a novelty at the packaging stage. Part is centrifuged to adjust the pulp content according to juice quality and factory requirements and another proportion is concentrated to 60° Brix with a conventional evaporator. However, SAFCO specialises in pure juice and has optimised this production line with pre-heating and deaeration to prevent any oxidation and to remove up to 97% of the dissolved oxygen. It is noted that there is 10 mg oxygen per litre of fruit juice and that 1 mg oxygen can potentially destroy 10 mg vitamin C at ambient temperature. The next steps are pasteurisation and aseptic filling, in which the aseptic transfer procedure is somewhat original. It consists of passage in an aseptic chamber in which an operator injects the juice that has just been pasteurised directly in an aseptic bag and closes it with an aseptic stopper. This ensures system asepsis and above all will make it possible to develop reliable aseptic transfer of the juice for packaging (bottles and cartons) without re-pasteurisation. This is the future and many people are currently considering avoiding the re-pasteurisation of this raw material which does suffer from process aggression, as has been seen. Filling juice containers for the final consumer without re-pasteurisation would be the best way of conserving micronutrients ■