remain filled with air. The difference in concentration between the two liquids causes a difference in the activity of water, creating a difference in partial pressure at the liquid-air interfaces on either side of the membrane. This results in water transfer in the form of vapour from the solution to be concentrated to the brine compartment. The evaporation flow is proportional to the difference in partial pressure at the interfaces and the aim is therefore to maintain the brine at saturation point by eliminating the water as it evaporates from the juice. The application is simple to operate as it consists simply of setting up two circuits in parallel with a module containing a membrane as an interface and with continuous re-circulation of the juice to be concentrated and of the brine, which is constantly regenerated so that the inflow is effectively saturated.

Practically constant evaporation fluxes can be obtained in industrial pilot trials, with the achieving of very high concentrations of over 60° Brix. The average evaporated flows at the pilot scale are still fairly low (0.6 kg/h. m^2), but these results are being improved since flows of the order of 10 kg/h.m^2 are easily achieved in small units in the laboratory. Excellent results are obtained with regard to organoleptic and nutritional quality. The fresh notes of the aroma and vitamin C are fully conserved.

This research has made it possible to develop new products and diversify the range of agroindustries producing tropical fruit juices in developing countries ■

Application of flash-release, a new extraction procedure (juice, pulp, essential oil)

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The procedure

The first part consists of a description of the process as a whole.

Stage 1: ***sterilisation*** of the plant material at 85-90°C. Heating is by means of a vapour injection inlet. This type of blanching is necessary for implementing the procedure and also inhibits endogenous enzymatic activity (e.g. polyphenoloxidase and pectinmethylesterase) and destroys bacterial flora.

Stage 2: ***release stage***, with the sudden intake under vacuum (approximately 30 mbar) of previously sterilised material (fruits, vegetables, plants, etc.). Under these vacuum conditions, the boiling point of water is between 27 and 30°C. This instantaneous vacuum treatment causes the sudden evaporation of part of the water contained in the sterilised plant material (approximately 10% of the initial moisture content) and a sudden fall in temperature of the material. This instantaneous moisture loss causes fine crushing by the creation of intercellular micro-channels. Disturbance and cell bursting give the products special physicochemical, rheological and organoleptic properties. The evaporation water is recovered separately by evaporation; it is particular rich in volatile aromatic compounds and referred to as **aromatic waters**. It can be re-incorporated in products after 'flash release'.

Products

'Flash release' is a produce with many uses and many effects. The products obtained are treated in two categories; juices and purées and then the recovery of essential oils.

Juices and purées

The process is thus upstream of the refining stage essential for obtaining homogeneous purées and downstream of the paring stages (leaves and stems removed) and fruit washing. Two purée type applications are presented.

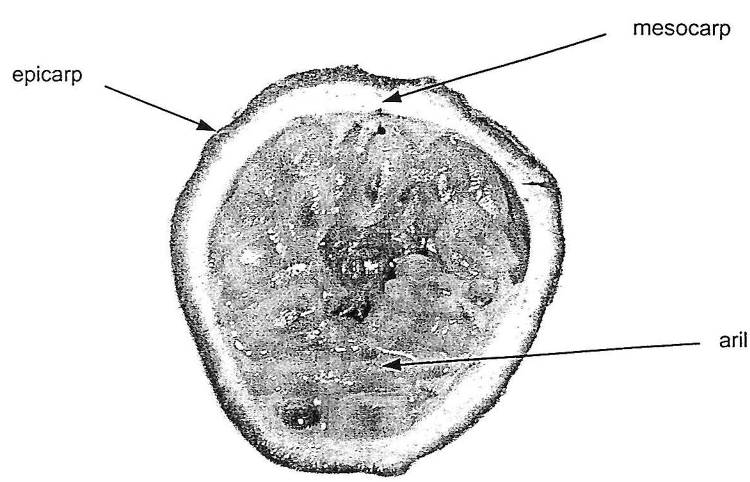

Photo 1 : Longitudinal section of a purple passion fruit (*Passiflora edulis* Sims)

Passion fruit purée

Three main zones can be shown in a morphological representation of a section of purple passion fruit:

- the **aril**: a yellow zone traditionally used for obtaining juice;
- the **mesocarp**: a whitish spongy zone containing high levels of cell walls and soluble pectins and displaying low acidity and a high volatile compounds content. However, the external face of the mesocarp is a reddish purple colour and rich in anthocyanins;
- the **epicarp**: a strongly lignified zone closely bonded to the mesocarp.

The degradation caused by the procedure (the formation of intercellular micro-channels) in the mesocarp make it possible to incorporate this zone in the aril. Indeed, the mesocarp, rich in cell walls, soluble pectins and anthocyanin compounds, disintegrates under the effect of the release and is then incorporated in the yellow (aril) passion fruit juice.

This treatment gives an intensely purple purée with a high anthocyanin content (Table 1) whose physicochemical, rheological and organoleptic characteristics differ greatly to those of a reference juice. Following the incorporation of part of the mesocarp and the loss of cell cohesion resulting from the flash release process, the purée is an intense reddish purple colour (chromameter index a), lower acidity and higher viscosity (Table 1), allowing greater dilution for the preparation of nectars. Finally, the bursting of part of the cell material releases the aromatic compounds mainly sited in the vacuole and hence enables the preparation of a product with greater aromatic strength.

Mango purée

Only the mesocarp, consisting mainly of parenchyma cells, undergoes the cell disturbance caused by the process. The particularly lignin-rich and very rigid epicarp is not broken down by the process. The classic physico-chemical parameters (pH, titratable acidity, etc.) of a purée prepared using the 'flash release' process are therefore similar to those of a traditional purée. However, the disorganisation of parenchyma cells and the bursting of a proportion of the cells cause rheological changes. The products prepared have a distinctly firmer consistency and higher viscosity (Table 2).

The vacuum treatment (the second stage of the process) makes it possible to reduce product oxygen content considerably (1/5 of the initial level) and thus limits oxidative browning phenomena to a minimum. Mango purée prepared using 'flash-release' is therefore paler and yellower; this is correlated by an increase in chromameter indices L and b (Table 2).

Extraction of citrus essential oils

The placing of sterilised citrus peel (grapefruit, orange, mandarin and lemon) in a vacuum chamber causes the explosion of the essential oil glandes in the flavedo (the outer coloured part of the fruit). The oils are vaporised simultaneously with part of the water in the peel. The oils are recovered as an aqueous emulsion after condensation and then purified by centrifugation. The extraction yields of lemon, orange and grapefruit peel are 44, 29, 33 and 27% respectively. After terpene removal, the essential oils extracted using the 'flash release' process are of better quality than freshly pressed oils and contain higher proportions of mono- and sesquiterpene aldehydes.

A multiple-use process

Fruits

It gives more consistent, viscous ***purées*** with greater colouring intensity that enable a higher dilution ratio for the preparation of nectars (purée after dilution). Depending on the case, these particular rheological characteristics are the result of purées with higher cell wall and soluble pectin contents and also of the cell disruption called by the release effect.

After dilution, ***nectars are more stable*** and display slower phase separation. The blanching stage ensures the almost complete inhibition of endogenous enzymatic activity (polyphenoloxidase and pectinmethylesterase) while higher product viscosity reduces cloud settling phenomena in the finished product.

A ***very low oxygen content*** is observed in the products after release, limiting oxidation phenomena and hence browning. The purées still display strong colour after pasteurisation, even after storage for several months.

Higher production yields. The fine disintegration of all the parts of the fruit, and in particular of the parenchyma zones, caused by the release phase gives higher final production yields (in the case of passion fruit).

Essential oils

The essential oils obtained from citrus peel subjected to 'flash release' are qualitatively similar to those obtained by cold pressing.

Table 1: the main characteristics of 'flash release' passion fruit purée in comparison with a reference juice

	Reference juice	Flash release purée
Extraction yield (%)	26	49
pH / titratable acidity (mg citric acid/100 ml)	3.2 / 44.3	3.8 / 31.5
Red colour index (a)	5.2	16.5
Anthocyanin content (mg/l)	3.9	45.7
Cell wall content (g/100 g)	0.6	3.9
Soluble pectin content at pH 4, 20°C (g/100 g)	0.1	0.9

Table 2: Colorimetric and rheological characteristics of reference and 'flash-release' mango purées

	Reference purée	'Flash release' purée
Colour indices L, a, b	50.2 / 2.1 / 29.6	52.2 / 2.0 / 35.0
Bostwick consistency (cm in 30 sec)	8.5	4.5
Apparent viscosity (Pa.s)	0.4	1.1

Yields are the same or higher as those of a classic FMC method. The process thus makes it possible to use citrus peels that are of only small economic interest today.

Subsidiary applications

Concentration process. Approximately 10% of the fruit mass placed in the heating chamber is recovered in the form of aromatic waters (condensed evaporation waters).

Deodorisation process. Some vegetables smell very unpleasant during cooking because of the volatilisation of sulphur compounds (e.g. cabbage). The prior treatment of these vegetables using the 'flash release' process would make it possible to trap all or part of the foul-smelling volatile compounds.

Facilitate the extraction of functional substances. Numerous fruits are rich in useful functional substances such as carotenes and lycopene. Fine disintegration and the bursting of part of the cells would increase the extraction yields of these substances ■

Quality criteria for new pineapple varieties

Abstract

Complete version
http://technofruits2001.cirad.fr

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Pineapple, the eighth fruit in terms of world production with nearly 13 million tonnes per year, is practically monovarietal with the Smooth Cayenne variety. With the aim of varietal diversification, CIRAD-FLHOR has been conducting a breeding programme for more than 20 years using in particular crosses between Smooth Cayenne on the one hand and the Colombian varieties Perolera and Manzana on the other. Of the 40,000 hybrids resulting from these crosses and displaying varied characteristics (agronomic performances, fruit morphology, suitability for cold storage and organoleptic characteristics) only about ten are currently in the final evaluation phase.

The CIRAD-FLHOR Chemistry-Technology laboratory analysed certain quality components (skin and flesh colour, flesh aromatic composition, flesh sugar content and titratable acidity) in seven selected genotypes resulting from the crossing of the parents mentioned above. The analyses were performed during maturation (from the green stage to the very ripe stage). The Smooth Cayenne parent served as reference.

The pigments responsible for skin colour (except for chlorophyll, that is to say after degreening)—carotenoids (yellow to orangey) and anthocyanins (pink to purple)—were extracted and either assayed as a whole by measurement of optical density or separated and identified by high performance chromatography. The flesh aroma components were extracted, separated and identified by gas phase chromatography combined with mass spectrometry.

Skin colour at maturity results from a balance of varying proportions of carotenoids and anthocyanins. Thus, the reference parent (Smooth Cayenne) and one of the selected hybrids with the same carotenoid content (3 mg/g fresh weight) displayed very different skin colours at maturity, with Smooth Cayenne being orangey yellow and the hybrid purple/scarlet. The difference is explained by a 50% higher skin anthocyanin content in the hybrid. Likewise, the flesh of one of the selected hybrids was a distinctly more intense golden yellow than that of Smooth Cayenne as a result of a total carotenoids content 2.5 times higher than in the latter, making this hybrid an interesting source of carotenoids.

At the ripe stage, the flesh aroma components of the hybrids and the Smooth Cayenne parent were observed at similar concentrations (30 mg/kg). Whatever the genotype and the state of maturity, esters (e.g. methyl acetoxy-3-hexanoate), thioesters (e.g. methyl 3-methylthiopropanoate) and furanones [e.g. dimethyl-2,5 hydroxy-4 furanone-3(2H)], typical components of the pineapple aroma, are dominant. Nevertheless, differences in relative proportions are observed, together with very distinct evolutions during the final phase of maturation [e.g. in one genotype the quantity of dimethyl-2,5 hydroxy-4 furanone-3(2H) decreases from 2 mg/kg to 0 from the ripe to the very ripe stage]. These variations that occur at the stage at which the fruit is eaten must be correlated with sensorial analysis ■