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Combination of microfiltration and osmotic evaporation to prepare high quality passionfruit juice concentrates

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Context and objective

Osmotic evaporation (OE) is a membrane technique allowing concentration of aqueous solutions at ambient temperature and pressure. The water is extracted in gas phase by circulating the dilute solution on one side of a hydrophobic porous polymer and a hypertonic salt solution on the other side (Fig. 1). In this work, crossflow microfiltration (MF) and OE are combined to concentrate passionfruit juice and compared to conventional vacuum distillation (VD) on the basis of physical-chemical characteristics as well as flavour loss in the reconstituted juice.

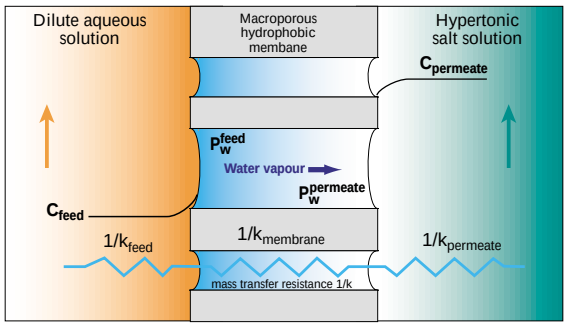

Figure 1: general principle of osmotic evaporation; solute concentration (C), vapour pressure (P_w)

Physical-chemical characteristics		IJ	OE	VD	MF	
					OE	MF-OE
TSS	(g/100g)	14.0	49.0	41.0	46.5	34.5
S + G + F [(1)]	(g/100g TSS)	0.95	0.77	0.84	0.81	0.83
Titratable acidity	(meq/100g TSS)	0.4	< 0.02	< 0.03	0.08	0.10
pH	-	2.94	2.92	2.93	2.78	-
Viscosity	(mPa.s)	24	898	325	13	-

[(1)] Sucrose + Glucose + Fructose

Table I : Comparison of the physical-chemical characteristics of the initial passionfruit juice (IJ) with the concentrates obtained by : osmotic evaporation (OE) or vacuum distillation (VD) of pulpy juice, OE of clarified juice (OE) mixed with microfiltration retentate (MF-OE).

Aroma compound	Aroma loss factor (Ci/Cf)			
	OE	MF-OE	VD	VD-AR
Ethyl acetate	3.0	1.6	11.4	10.8
Ethyl butanoate	4.8	2.1	23.4	nr[(1)]
Hexyl butanoate	nr	1.9	tr[(2)]	nr
Ethyl hexanoate	5.6	~ 1	tr	tr
β-myrcene	6.1	~ 1	25.2	22.3
Limonene	~ 1	~ 1	13.8	10.6
Trans-ocimene	nr	~ 1	17.3	19.1

[(1)] nr: non reproducible, [(2)] tr: trace, too small to quatify

Table II : Flavour loss measured as initial vs final concentration (C_i/C_f) in passionfruit juice reconstituted from the concentrates obtained by : osmotic evaporation of pulpy juice (OE), OE of clarified juice mixed with microfiltration retentate (MF-OE), vacuum distillation of pulpy juice (VD) with aroma recovery (VD-AR).

Materials and methods

Raw material, sterilised frozen juice from Passiflora Edulis

Clarification :

- enzymation with 400 $mg.kg^{-1}$ Rapidase Liq^+ (Gist Brocades)
- Imeca crossflow MF device, 1.3 m^2 0.2 µm Membralox® IP19-40 (SCT France)

Concentration methods :

- OE Model E06 (Cogia, France), 10.3 m^2 0.2 µm PP fibres, 41 w/w % $CaCl_2$ brine, 4.3 $kg.h^{-1}$ evaporation rate
- VD of juice, Corning unit 3 $kg.h^{-1}$ condensation rate under 3.10^3 Pa. Fractionation of condensate, Büchi unit 15 % rate of recovery for 25 $l.h^{-1}$ of fruit juice.

Results

The OE applied to pulpy or clarified juices allows to maintain the composition of the juice and to achieve concentration degrees of 45 to 50 % total soluble solid (TSS), comparable with a conventional VD process (Table I).

Among the 25 volatile compounds identified by GC-MS in the initial juice, 7 were selected on the basis of reproducibility (Fig.2) and used to compare the flavour loss of 4 concentration methods. VD leads to severe losses and reincorporating the fractionated distillate into the concentrate (VD-RA) hardly improves the flavour loss in this study. OE generates significantly lower losses but the best results are obtained for the cut-back method (MF-OE) (Table II).

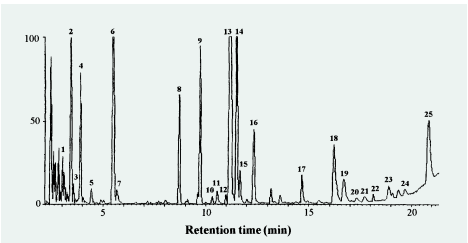

Figure 2 : Volatile compounds of the initial passionfruit juice analysed by GC/MS. 7 compounds were selected for quantification : (2) ethyl acetate, (6) ethyl butanoate, (8) β- myrcene, (9) limonene, (13) ethyl hexanoate, (14) trans-ocimene, (18) hexyl butanoate.

Conclusion

OE as well as VD allowed to achieve high concentration degrees of 40 to 50° Brix with total retention of the sugars and acids in the passiofruit juice concentrates. Although OE appears more gentle, the aroma loss remains non negligible and sensory analysis would help evaluating the perceived impact on final organoleptic quality. The high quality of the products obtained by cut-back shows the benefit of combining MF and OE: the performance of OE is improved because of lower viscosity of the clarified juice and the aroma retention is increased by mixing back the pulp to the concentrate.

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