The quality of orange juice produced by tangential microfiltration and osmotic evaporation

M. Cisse, F. Vaillant, A. Perez, M. Dornier, M. Reynes*
** Cirad, Cita, Universidad de Costa Rica*
2060 San José, Costa Rica
vaillant@cirad.fr

Orange juice microfiltered and then concentrated to 42° Brix and 62° Brix.

Orange juice concentrated to 62° Brix, whose quality is very similar to that of flash-pasteurised juice (F), was prepared by the combining in series, in a semi-industrial pilot installation of two athermal processes, tangential microfiltration (TMF) and osmotic evaporation (OE) (Figure 1).

The extraction process

The first technique was implemented using a tubular ceramic membrane with 0.2 micron pore diameter; this separated a pulpy juice (R) that contained more particularly the apolar aromatic and nutritional compounds (terpenic hydrocarbons and carotenoids) and sterile clarified orange juice (P) containing the greater part of the more heat-sensitive compounds (aliphatic alcohols, esters, aldehydes, terpenols and vitamin C) (Table 1). The proportion of retentate to clarified juice (permeate) was 70% and 30% with average filtration flows of some 60 l.h-1.m-2; this is compatible with industrial use. The permeate (P) was then concentrated in a pilot OE installation (Figure 2) consisting of a hydrophobic membrane that establishes a layer of air that cannot be penetrated by the liquid between the two compartments, one containing the clarified juice to be concentrated and the other highly saturated calcium chloride brine.

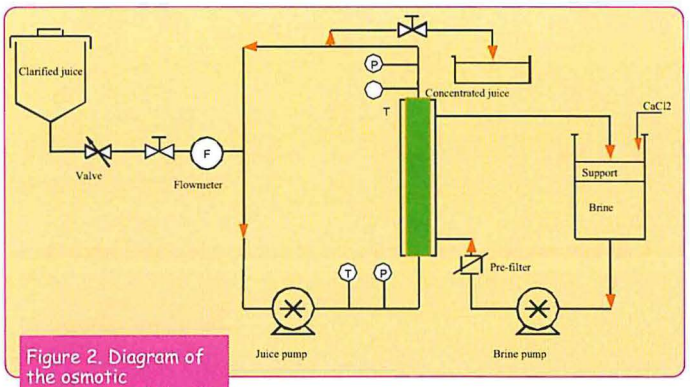

Figure 2. Diagram of the osmotic evaporation pilot unit.

This makes it possible, at room temperature, to extract the water that flows through the pores in vapour form and condenses on the brine side. Even though the characteristics of the membrane used for this application could be improved considerably, average flows of 0.6 kg.h-1.m-2 water are attained, making possible continuous extraction for several hours of an average flow of 150 ml.h-1.m-2 of concentrated juice at 62° Brix ($C_{62°Brix}$ OE), while feeding the pilot installation with a flow of 0.75 l.h-1.m-2 with clarified juice (P).

Juice quality

The aromatic and nutritional characteristics of the concentrated juice produced are very similar to those of the initial juice (F) and indeed a trained panel cannot perceive a significant difference at the same dilution. A pulpy orange juice (C62° Brix OE + R) reconstituted by mixing the concentrated clarified juice and the

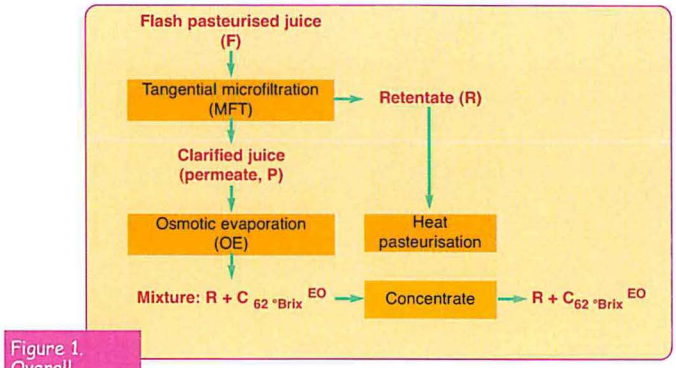

Figure 1. Overall process flow.

TMF retentate, previously pasteurised, is also considered to be equivalent to the initial juice (F) and distinctly better than the commercial orange juice produced by classic vacuum evaporation technology with recovery of the aroma (FCOJ). In contrast with classic concentrated juice, the colour is totally conserved, losses of aroma and nutritional compounds are very limited and the sugar:acid ratios are conserved (Table 1).

Table I. Main characteristics of the orange juices.

	F	PT	P	F R P C62°Brix	OE R+C62°Brix	OE FCOJ (65° Brix)
Viscosity (25°C, mPa.s)	1,1 (0,4)	1,7 (0,4)	1,2 (0,3)	28,2 (0,7)	1,6 (0,3)	37,3 (0,4)
Soluble solids (g SS.kg-1)	118 (2)	130 (2)	115 (2)	620 (2)	118 (2)	655 (2)
Solids in suspension (g.kg-1)	80 (3)	90 (4)	0	0	80 (2)	80[c] (2)
Titratable acidity (g citric acid.kg-1SS))	68 (1)	62 (2)	61 (1)	62 (1)	63 (1)	44 (1)
Glucose (g.kg-1 SS)	186 (1)	188 (2)	185 (2)	187 (2)	185 (2)	114 (1)
Fructose (g.kg-1 SS)	220 (2)	221 (2)	220 (2)	221 (2)	219 (2)	136 (1)
Sucrose (g.kg-1 SS)	491 (2)	494 (2)	489 (2)	491 (2)	48 (2)	291 (2)
Carotenoids (g.kg-1 SS)	0,38 (0,04)	0,34 (0,05)	> 0,02	> 0,02	0,35 (0,05)	0,24 (0,05)
Vitamin C (g.kg-1 SS)	3,7 (0,3)	3,3 (0,2)	3,6[a] 3,5[b] (0,3)	3,3 (0,3)	3,2 (0,3)	2,2 (0,2)
Colour L°	52	62	62	25 (61[d])	53	20 (28[c])
Hue angle (H°)	88	82,3	88,3	38,7 (88,3[d])	88	63,4 (86,4[d])
Saturation (C°)	30	37,3	17	25,6 (17[d])	29	31 (15[d])
Aromatic compounds (mg.kg-1 SS)						
Alcohol	2 405	397	2 141	1 808	1 946	1 649
Terpenic hydrocarbons	2 851	2 576	1 717	1 376	2 107	1 751
Aldehydes	112	43	102	81	93	46
Esters	1 810	291	1 795	1 216	1 363	544
Terpenols	166	152	135	119	137	102

Average of 6 analyses :
[a] After TMF; b Before OE; c After dilution to 118 g.kg-1 TSS; d After dilution to 115 g.kg-1 TSS.

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