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CONCENTRATION OF FEIJOA AND BOYSENBERRY FRUIT AROMA CONDENSATES USING PERVAPORATION

A thesis presented in partial fulfillment of the requirements
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at Massey University

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2000

ERRATA

- Page 64 The r^2 for the ethanol calibration curve was 0.64.
- Page 74 Table 4.4 , the ATV of ethanol should be changed from “NF” to “0.28-9%”. ATV of ethanol is 0.28-9 g/100g; it is different from other aroma compounds such as geraniol (ATV: 0.001-0.01 mg/kg), linalool (ATV: 0.001-0.01 mg/kg).
- Page 74 Table 4.4, the AV of ethanol should be changed from “NF” to “2.2 ”.
- Page 107 Table 4.22, the concentration of ethanol at the flow rate of $1.4 \times 10^{-5} \text{ m}^3 \text{ s}^{-1}$ should be changed from “10044” to “10044*”.
- Page 108 Table 4.23, the enrichment factor for ethanol at the flow rate of $1.4 \times 10^{-5} \text{ m}^3 \text{ s}^{-1}$ should be changed from “ 8.6 ± 0.5 ” to “ $8.6 \pm 0.5^*$ ”.

Abstract

This present work aimed to investigate pervaporation for aroma recovery and concentration from fruit aroma condensate collected during evaporation of fruit juices. A 5% ethanol solution, feijoa and boysenberry aroma condensates were concentrated in a pervaporation apparatus fitted with polydimethyl siloxane (PDMS: GFT1060, GFT1070) and poly-ether-block-amide (PEBA, GKSS) membranes, under the following operating conditions: feed temperature of 30°C, feed flow rate of $8.3 \times 10^{-6} \text{ m}^3 \text{ s}^{-1}$, $1.1 \times 10^{-5} \text{ m}^3 \text{ s}^{-1}$ or $1.4 \times 10^{-5} \text{ m}^3 \text{ s}^{-1}$, and permeate pressures of 100 Pa or 1000 Pa. Feijoa and boysenberry aroma condensates were also concentrated by vacuum distillation. Aroma compounds and their concentrations in the feed, retentate and permeate were identified and determined by gas chromatography (GC) and a mass spectrometer coupled to a GC.

The three membranes investigated for pervaporation gave different total fluxes, partial fluxes, mass transfer coefficients, enrichment factors and aroma compositions for feijoa and boysenberry condensate. PEBA membranes proved to have best performance for concentration of feijoa and boysenberry aroma due to high enrichment factors and mass transfer coefficients for the important aroma compounds of both feijoa and boysenberry.

Increasing the feed flow rate from $1.1 \times 10^{-5} \text{ m}^3 \text{ s}^{-1}$ to $1.4 \times 10^{-5} \text{ m}^3 \text{ s}^{-1}$ did not affect the total flux, but increased significantly the partial fluxes and enrichment factors of preferentially permeating compounds such as methyl benzoate, ethyl benzoate and linalool. Decreasing permeate pressure significantly increased the total flux, the partial fluxes and enrichment factors for higher boiling aliphatic alcohols. The mass transfer resistances of methyl benzoate, ethyl benzoate and linalool was dominated by the boundary layer effects. The mass transfer resistances of high boiling aliphatic alcohols, hexanol, Z-3-hexenol and E-2-hexenol were strongly influenced by permeate pressure.

Compared with vacuum distillation, pervaporation showed better performance for producing concentrated feijoa and boysenberry aromas which were highly enriched in the important flavour compounds for each fruit.

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List of nomenclature

Roman letters

| | | |
|------------|---------------------------------------|-----------------------|
| A_m | membrane area | m^2 |
| ATV | aroma threshold value | $kg\ m^{-3}$ |
| AV | aroma threshold | - |
| C_i | mass concentration of component i , | $kg\ kg^{-1}(wt/wt)$ |
| CF | concentration factor | - |
| D | diffusion coefficient | $m^2\ s^{-1}$ |
| J | flux | $kg\ m^2\ s^{-1}$ |
| k | mass transfer coefficient | $kg\ m^2\ s^{-1}$ |
| M | mass | kg |
| m | mass flow rate | $kg\ s^{-1}$ |
| n | number of samples for each mean | - |
| P | partial pressure | Pa |
| Q_m | total mass flow | $kg\ s^{-1}$ |
| R | universal gas constant | $J\ mol^{-1}\ K^{-1}$ |
| Re | Reynolds number | - |
| SD | standard deviation | - |
| SE | standard error | - |
| t | time | s |
| T | absolute temperature, | K |
| V | molar volume of component i | $m^3\ mol^{-1}$ |
| x | length coordinate | m |
| Δx | membrane thickness | m |
| Y | yield | % |

Greek symbols

| | | |
|-------------|--|---------------------|
| α | separation factor, selectivity | |
| β | enrichment factor | |
| φ_i | partition coefficient of component i . | kg kg ⁻¹ |

subscripts

| | |
|--------|---|
| bl | boundary layer |
| f | feed |
| fm | membrane at its feed side |
| i | preferentially permeating component i |
| j | non-preferentially permeating component j |
| m | membrane |
| $over$ | overall |
| p | permeate |
| pm | membrane at its permeate side |