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# Impact of processing on carotenoid bioaccessibility in citrus concentrates obtained by microfiltration

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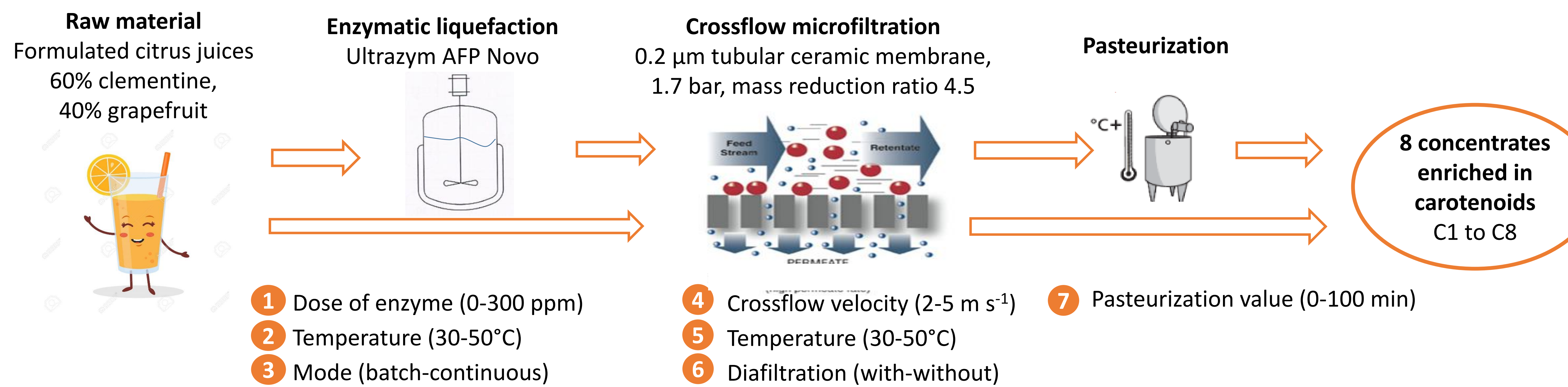
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## Introduction

Citrus juices are interesting sources of carotenoids especially  $\beta$ -carotene (BC) and  $\beta$ -cryptoxanthin (BCX) as pro-vitamin A which contribute with lycopene (LYC) to their health benefits. Thanks to an innovative eco-friendly process that includes a crossflow microfiltration step<sup>1</sup>, carotenoids can be concentrated at low temperature. This process also modifies physical properties of concentrates and so could affect carotenoid bioaccessibility. The aim of this study was to evaluate the effect of the main processing parameters on both carotenoid bioaccessibility and process performance.

## Methodology

### Three processing steps with modulation of 7 operating parameters (Plackett-Burman experimental design)

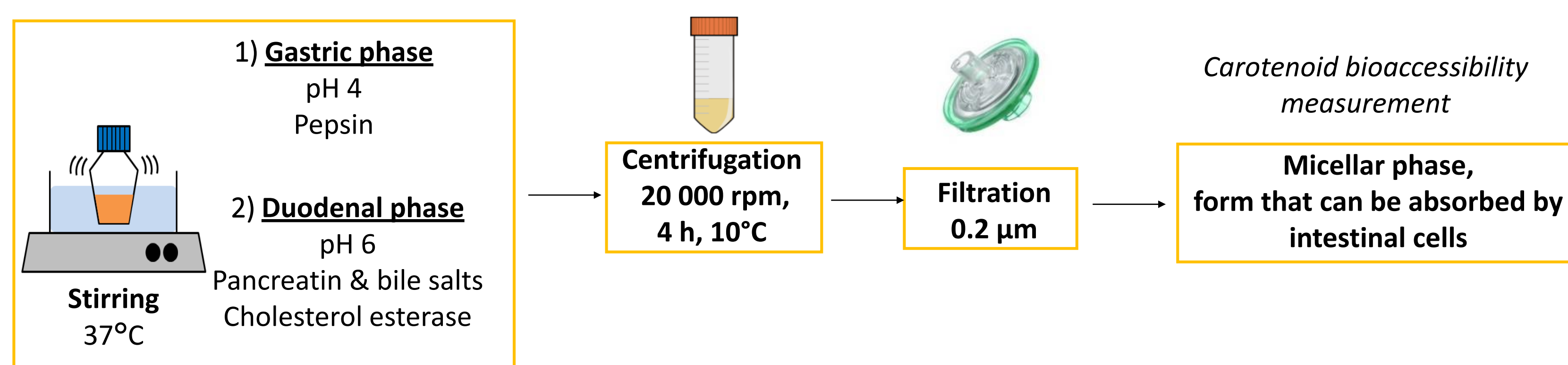


### Evaluation of the nutritional quality, process performance and physical properties of concentrates

#### Nutritional quality

**Carotenoid content:** HPLC-DAD C18,  $\lambda = 450$  &  $470$  nm

**Carotenoid bioaccessibility:** *In vitro* digestion by gastro-duodenal simulation<sup>2</sup>



#### Process performance

Permeate flux  $J_p$  ( $\text{kg h}^{-1} \text{m}^{-2}$ )

#### Physical characteristics

- Particle size distribution (LASER diffraction) statistical diameter  $D(90)$
- Rheological properties (Couette rheometer) limit viscosity  $\eta_{\text{limit}}$   $\gamma = 1000 \text{ s}^{-1}$ ,  $25^\circ\text{C}$

## Results

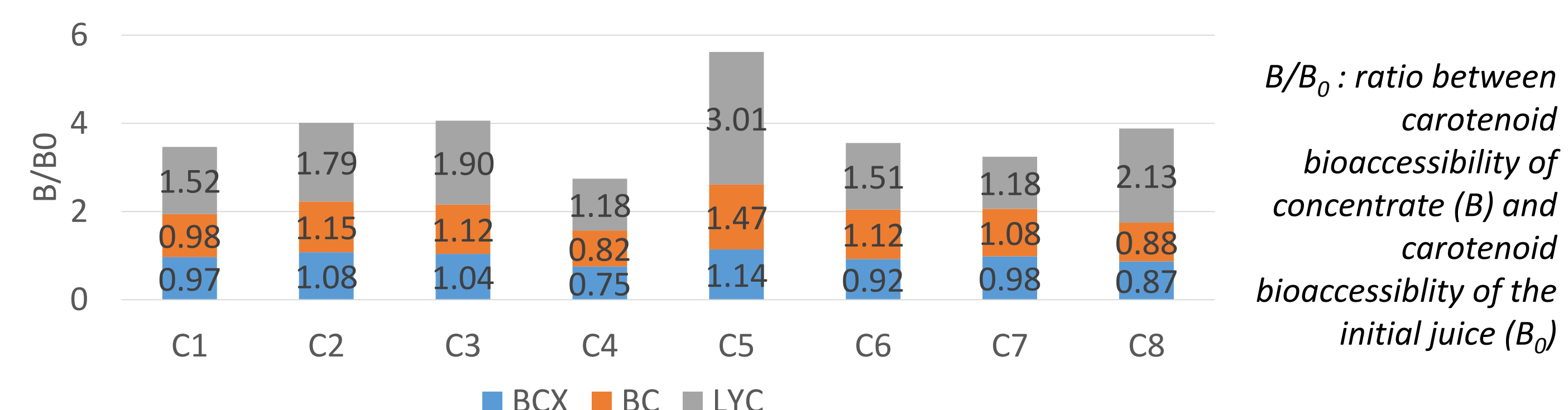
### Characteristics of the initial juice

Carotenoid Content $C_0$ ( $\text{mg}\cdot\text{kg}^{-1}$ )			Carotenoid Bioaccessibility $B_0$ (%)			D[90] ( $\mu\text{m}$ )	$\eta_{\text{limit}}$ (mPa.s)
BC	BCX	LYC	BC	BCX	LYC		
1.41	3.19	5.03	18.12	26.41	0.51	2152,2	3,2
(0.04)	(0.35)	(0.16)	(0.51)	(0.50)	(0.02)	(27,2)	(0,2)

Carotenoid content and bioaccessibility were different between the three carotenoids. Lycopene content was the highest but its bioaccessibility was the lowest.

### Process impact on carotenoid pool

Processing resulted in a four-fold increase in carotenoid content for all concentrates. So, carotenoid content was not impacted by any of studied operating parameters.

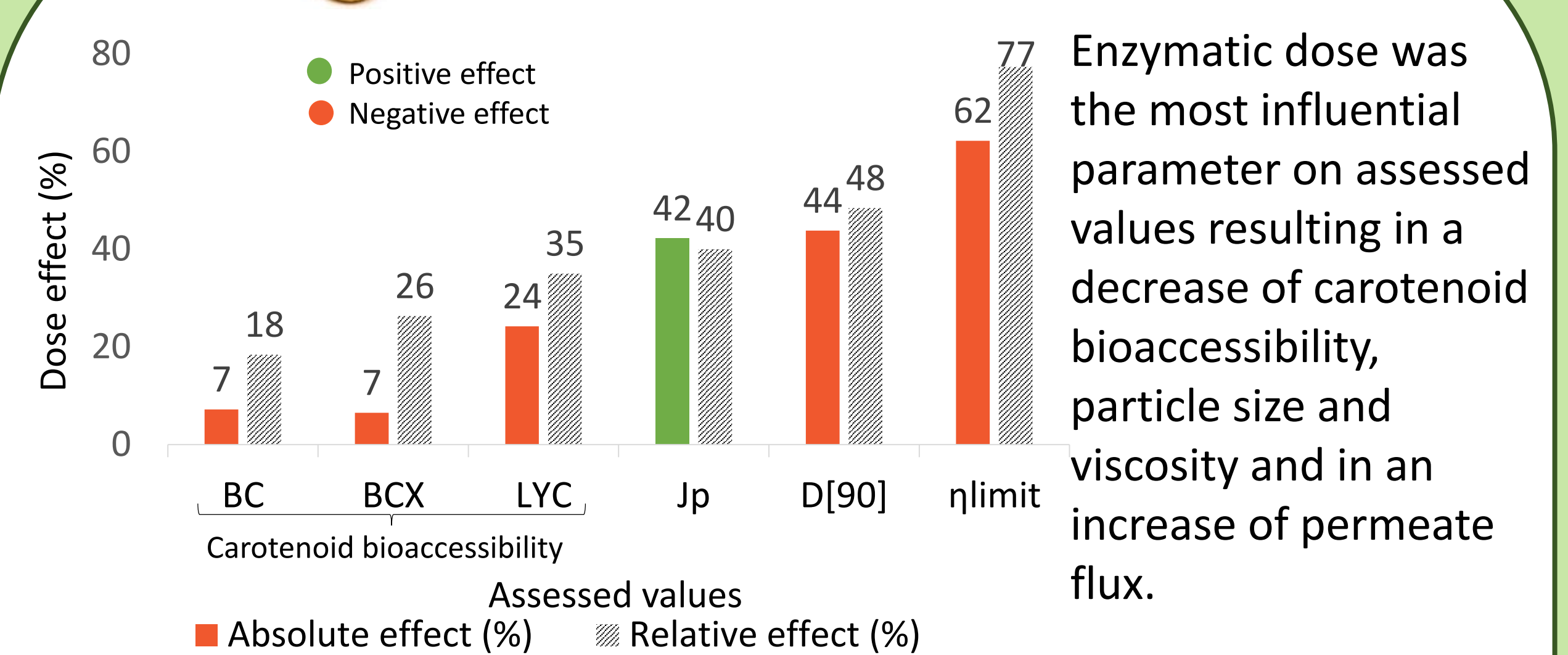


Carotenoid bioaccessibilities were effectively affected by processing and varied between concentrates. They were mainly modified by enzymatic liquefaction conditions.

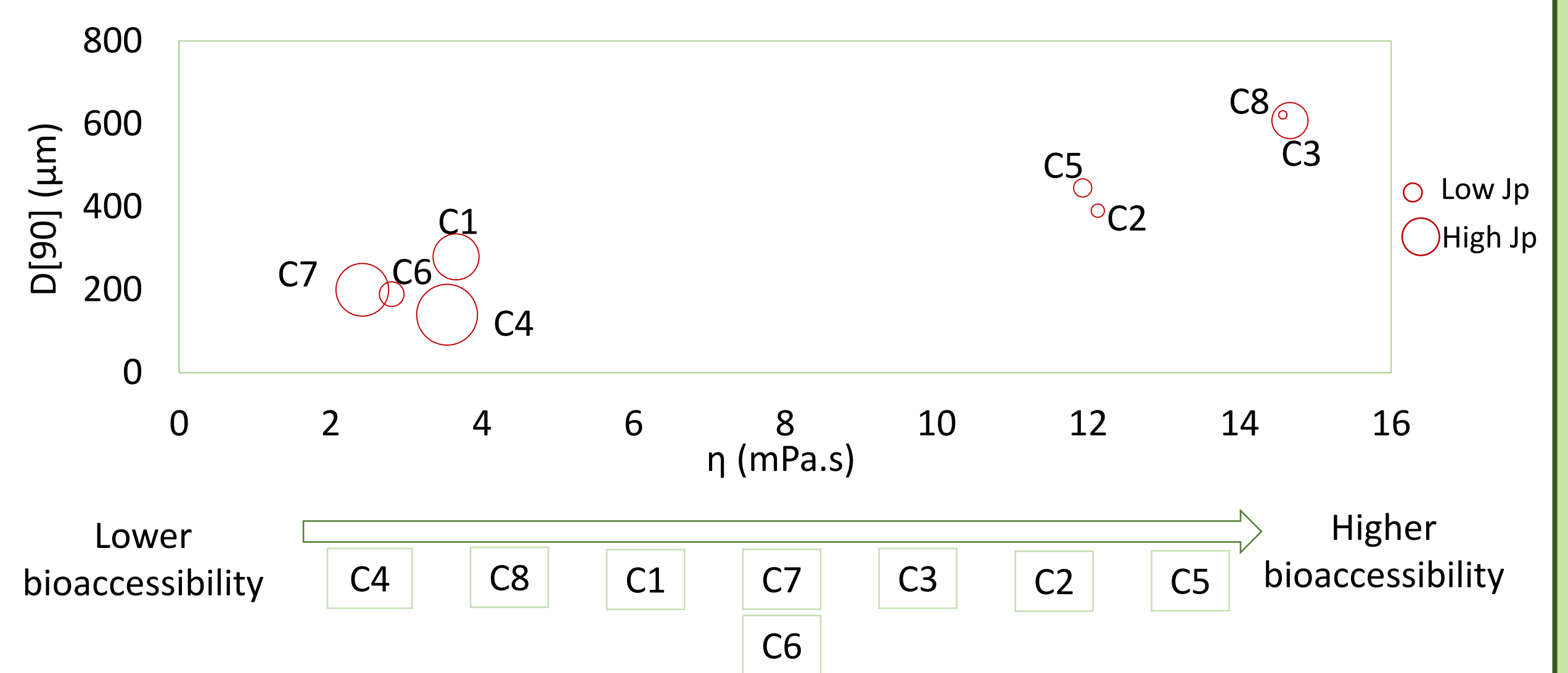
### Process performance

Permeate flux varied from 15 to  $121 \text{ kg h}^{-1} \text{m}^{-2}$ . It was strongly increased by the dose of enzyme, filtration temperature and crossflow velocity.

### Most influential operating parameters



### Relationship between physical characteristics, carotenoid bioaccessibility and process performance



No correlation between particle size ( $D[90]$ ), viscosity ( $\eta$ ) and bioaccessibility was highlighted. Concentrates with high  $J_p$  were characterized by low viscosity and low particle size.

## Conclusion

The dose of enzyme is the parameter to be focused on. It has to be optimized in order to find the best compromise between carotenoid bioaccessibility and process performance. The other parameters were selected to give the best carotenoid bioaccessibility. Further investigations are needed to better understand the relationships between the chemico-physical properties of the concentrates and carotenoid bioaccessibility.

## References

- <sup>1</sup> Polidori J., Dhuique-Mayer C. & Dornier M. (2018). Crossflow microfiltration coupled with diafiltration to concentrate and purify carotenoids and flavonoids from citrus juices. *Innovative Food Science and Emerging Technologies*, 45, 320-329.
- <sup>2</sup> Gence L., Servent A., Pouchet P., Hiol A. & Dhuique-Mayer C. (2018). Pectin structure and particle size modify carotenoid bioaccessibility and uptake by Caco-2 cells in citrus juices vs. Concentrates, *Food & Function*, 9, 3523-3531.