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Impact of thermal blanching and thermosonication treatments on watercress (*Nasturtium officinale*) quality: process optimisation and microstructure evaluation

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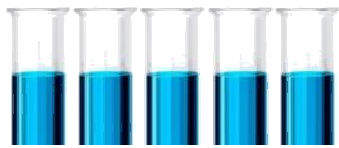
Watercress (*Nasturtium officinale*)

- Family Cruciferae (mustard family), grows in and around water
- consumed in salads, soups and other recipes
- prevention of cancer and related diseases
- short shelf life of nearly seven days

Freezing allows a longer period for distribution and storage

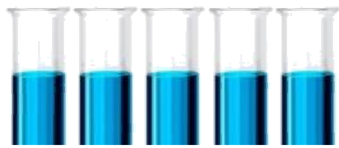


Pre-Treatment

Hot water immersion

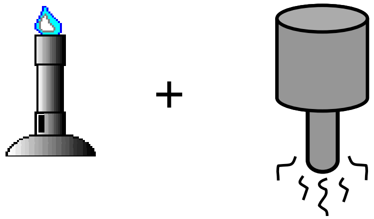
- stabilises foods
- destroys microorganisms
- inactivates enzymes

- impairs sensory properties
- reduces the contents or bioavailability of some nutrients



Thermosonication

Heat + Ultrasound



Peroxidase Activity

Thermosonication is more effective than thermal treatments in watercress peroxidase inactivation

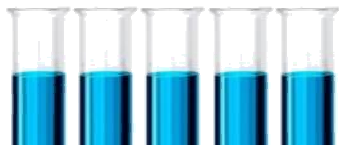
90 ºC	Heat (1.15 min)	Thermosonication (4.4 s)
Peroxidase	↓ 90%	↓ 90%
Vitamin C retention	29.1%	94.4%

Thermosonication treatments can be a good alternative to the traditional heat blanching processes

Objective

Study:

- Watercress blanching optimisation



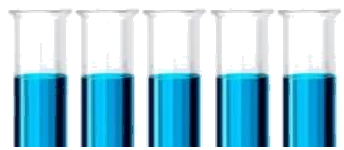
Materials and Methods

- Vitamin C retention maximisation - objective function

- 90% inactivation in watercress peroxidase - constraint

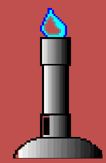
- Colour *a*-value

- Microstructure analysis

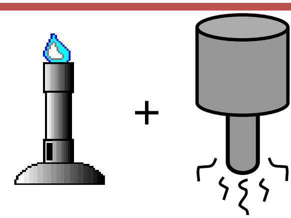


Materials and Methods

Heat blanching



Thermosonication (heat+ultrasound) blanching



(20 kHz; 125 W)

T °C
82.5
85
87.5
90
92.5

Time range

0-2 min

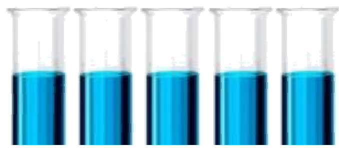


Table 1- Studied watercress kinetic parameters for heat and thermosonication treatments

Quality parameter	Treatment	Model	Kinetic parameter		Reference
Peroxidase	**Heat**	*Biphasic first-order*	C_{01} (μmol.min^{-1}.mg protein^{-1})	0.49±0.08	Cruz et al. (2006)
			$k_{1\ 84.6\ °C}$ (min^{-1})	18.01±13.98	
			E_{a1} (kJ.mol^{-1})	420.72±114.94	
			C_{02} (μmol.min^{-1}.mg protein^{-1})	0.48±0.06	
			$k_{2\ 84.6\ °C}$ (min^{-1})	0.24±0.14	
			E_{a2} (kJ.mol^{-1})	351.65±80.91	
			R^2	0.94	
	Thermosonication*	*First-order*	C_0 (μmol.min^{-1}.mg protein^{-1})	1.01±0.05	
			$k_{87.5\ °C}$ (min^{-1})	9.64±2.21	
			E_a (kJ.mol^{-1})	496.45±65.52	
			R^2	0.97	
Colour (*a* parameter)	**Heat**	*Reversible first-order*	C_0	0.96±0.01	Cruz et al. (2007)
			C_e	1.01±0.02	
			E_a (kJ.mol^{-1})	422.37±126.63	
			$k_{87.5\ °C}$ (s^{-1})	0.028±0.024	
			R^2	0.99	
	Thermosonication*	*Reversible first-order*	C_0	1.01±0.01	
			C_e	1.09±0.01	
			E_a (kJ.mol^{-1})	187.70±160.07	
			$k_{87.5\ °C}$ (s^{-1})	0.28±0.18	
			R^2	0.99	
Vitamin C	**Heat**	*First-order*	C_0	1	Cruz et al. (2008)
			E_a (kJ.mol^{-1})	150.47±42.81	
			$k_{87.5\ °C}$ (min^{-1})	0.75±0.10	
			R^2	0.98	
	Thermosonication*	*First-order*	C_0	1	
			E_a (kJ.mol^{-1})	136.20±60.97	
			$k_{87.5\ °C}$ (min^{-1})	0.58±0.11	
			R^2	0.97	

***Ultrasound at 20 kHz and 125 W**

Results

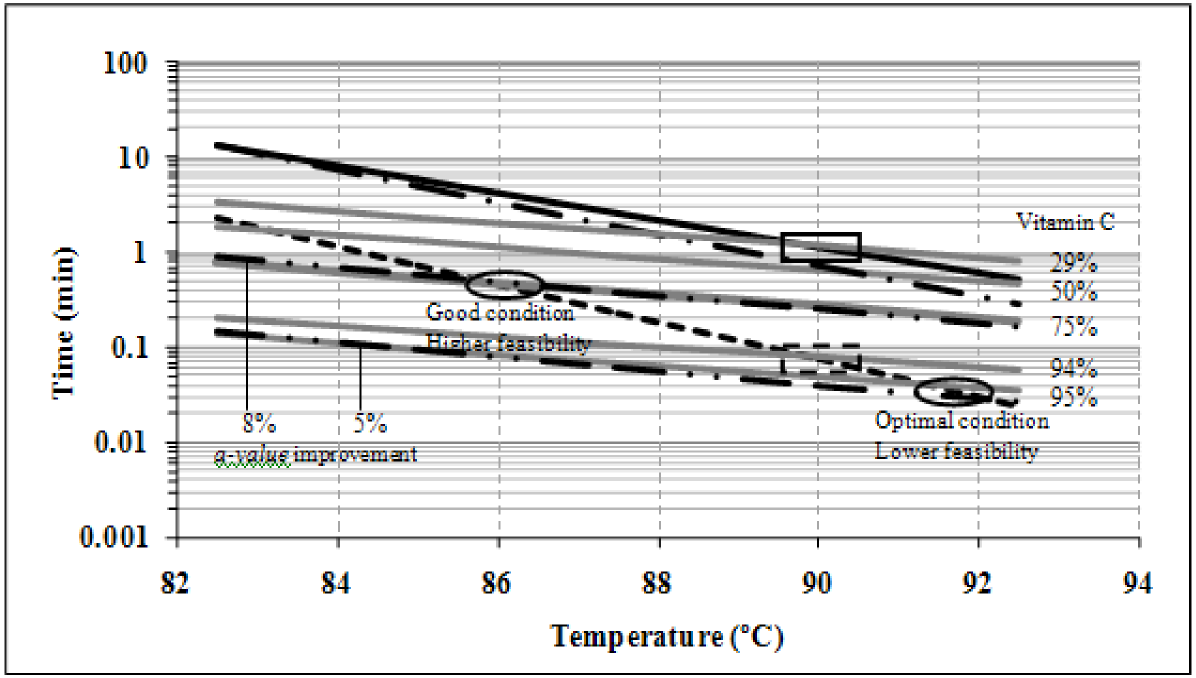
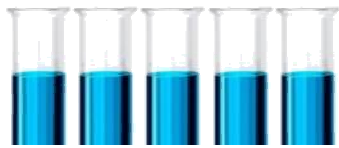


Figure 1- Graphical optimisation for heat and thermosonication watercress blanching in the temperature range of 82.5 to 92.5 ºC: (–) 90% of peroxidase inactivation with heat treatment; (--) 90% of peroxidase inactivation with thermosonication treatment. The grey lines correspond to 29, 50, 75, 94 and 95% of vitamin C retention for both treatments. 5% of greenness improvement with heat treatment is represented by the dashed dotted line; 5% and 8% of greenness improvement with thermosonication treatment are represented by the dashed double dotted lines. The continuous and dashed rectangular markers compare two time-temperature combinations at 90 ºC for heat and thermosonication, respectively. The elliptic markers indicate two time-temperature thermosonication combinations: 92 ºC, 2 s; 86 ºC, 30 s.

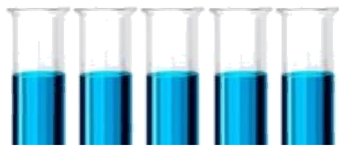


Results

Watercress initial values:

Vitamin C (50.40±5.77 mg.100 g fw^{-1})   *a*-value (-9.66±1.08)

Thermosonication	Optimal condition 92 ^{o}C 2 s	Better condition 86 ^{o}C 30 s
Peroxidase	↓ 90%	↓ 90%
Vitamin C retention	95%	75%
a-value improvement	5%	8%



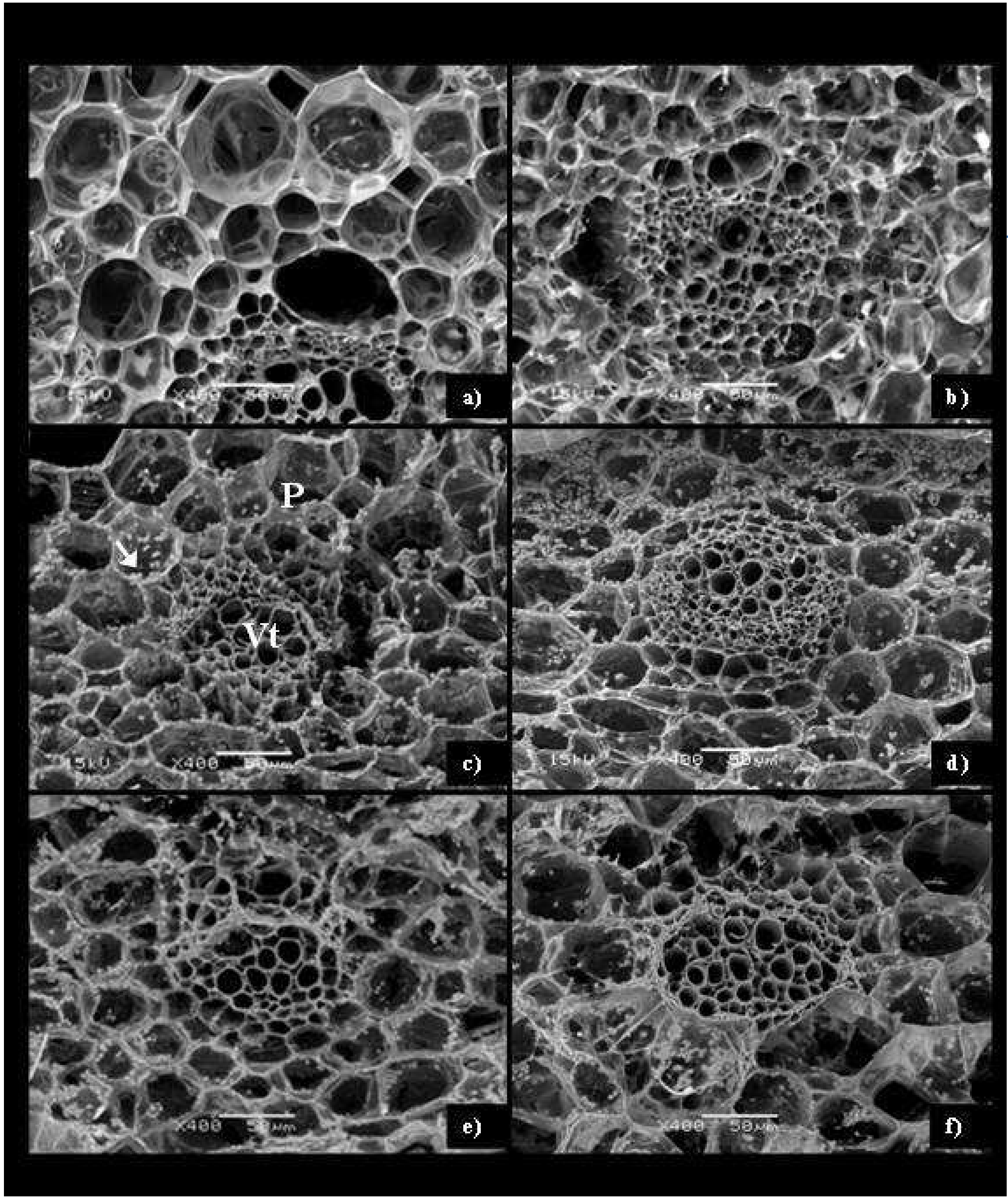
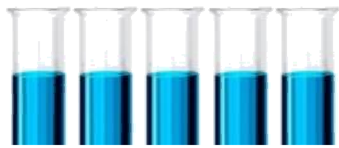


Figure 2- SEM micrographs of watercress cross section tissue at 400× magnification level: (a)-Fresh watercress; (b)-Thermosonicated watercress at 50 ºC, 60 s; (c)-Thermosonicated watercress at 92 ºC, 2 s; (d)-Heat blanched watercress at 92 ºC, 2 s (control); (e)- Thermosonicated watercress at 86 ºC, 30 s; (f)-Heat blanched watercress at 86 ºC, 30 s (control). P= parenchyma cells, Vt= vascular tissue, white arrow indicates the chloroplasts.

Conclusion

The proposed optimal thermosonication blanching conditions will improve the blanched watercress quality and consequently, contribute to the development of a high quality new frozen product.

A suitable scale-up study is mandatory for industrial production.



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VITACRESS

Thank You!