Influence of blanching treatments on colour, texture, chlorophylls content and sensory quality of broccoli (Brassica oleracea L.)

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Objective

The main objective of this work was to evaluate texture (maximum force and energy), colour (CIE *L**a*b* coordinates), chlorophylls and pheophytins content, and sensory characteristics of thermally processed broccoli, under five isothermal conditions ranging from 70º to 90ºC.

Introduction

Blanching is a thermal treatment often used to improve the quality of frozen vegetables, since it inactivates endogenous enzymes responsible for quality degradation during storage under frozen conditions.

Optimisation of the blanching processes requires the knowledge of the relationship between quality parameters and thermal process conditions.

Colour and texture are important quality attributes for consumers. The effect of blanching treatments on both parameters has been studied by some authors, such as Lau, Tang & Swanson (2000) in green asparagus, and Song, An & Kim (2003) in soybeans.

In general, heat treatments applied to green vegetables degrade greenness and chlorophyll pigments (Tijskens, Schijvens & Biekman, 2001), and promote softness of the cellular tissues.

Broccoli is a vegetable with healthy nutritional characteristics (high vitamin C and soluble fibre contents). However, it is a very perishable product, and consequently blanching and freezing may preserve its quality.

Materials & Methods

Fresh broccoli (*Brassica oleracea* L.)

Provided by an orchard near Lisbon

Sorted & washed

Blanched in a thermostatic water bath

Temp: 70º-90ºC; times: 2- 40 min

Cooling (2 min) & dried

Analysis

Colour evaluation:

- 30g of broccoli was triturated;
- CIE L*a*b* system, using an illuminate C;
- colour behaviour expressed by -a*/b* and Hue(hº*)= $\tan^{-1}$ b*/a;
- data presented are averages from 30 measurements.

Firmness assessment:

- shearing test performed with a Kramer cell;
- 30g of broccoli samples;
- test speed was 8 mm s^{-1} ;
- full-scale load was 500kg;
- maximum peak force (N) and energy (area below the curve - Nmm) were recorded;
- 12 replications per sample.

Chlorophylls and pheophytins:

Extracted and measured by a spectrophotometric method, described by Vernon (1960).

Sensory evaluation:

- Quantitative Descriptive Analysis was used according to Stone et al. (1974);
- Six trained panellists;
- Three descriptors (colour, flavour and texture), using a non-structured nine-point scale, from 1.0 to 9.0, corresponding to very good and very poor, respectively.

Data Analysis

Textural (maximum force and energy) and colour (-a*/b* and hº*) parameters were modelled according to a zero-order kinetics model (Eq.1), assuming an Arrhenius-type dependence of the rate constants on temperature (Eq 2):

$$C = C_0 - kt \quad \text{(Eq. 1)}$$

$$k = k_{ref} \exp\left[-\frac{Ea}{R}\left(\frac{1}{T} - \frac{1}{T_{ref}}\right)\right] \quad \text{(Eq. 2)}$$

A one step non-linear regression was performed to all experimental data, using STATA 6.0 software.

An analysis of variance (one way ANOVA with replication) was performed to determine significant effects on data due to blanching time-temperature conditions.

Results & Discussion

The original, non-heated broccoli, average values (± standart deviation) for texture, colour and total chlorophyll and total pheophytins are presented in Table 1.

Table 1. Texture and colour parameters, and total chlorophyll / pheophytins content of non-heated broccoli.

	Texture		Colour				Total chlorophyll (mg/100g)	Total pheophytins (mg/100g)
	N	N.mm	L*	a*	b*	hº*		
Initial values	3209.8±110.4	31208.0±1392.5	47.59±0.52	7.54±0.32	23.10±0.52	118.53±2.81	27.15±1.43	24.52±0.20

Texture parameters (maximum peak force (N) and energy (N.mm)) decreased significantly ($p<0.05$) with an increase in heating temperature and process time (Figs. 1a and 1b)

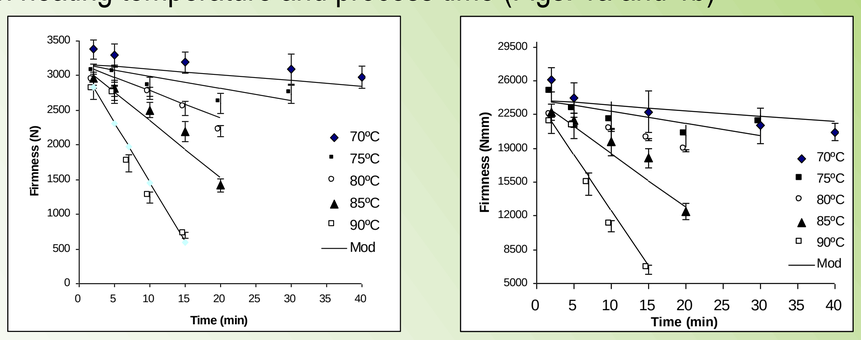

Fig 1. Firmness (a) maximum peak force (N) and (b) energy (N.mm)] changes of broccoli, during blanching treatments. (◆) 70ºC, (■) 75ºC, (○) 80ºC, (▲) 85ºC, (□) 90ºC, (—) model predicted data.

The hº* colour values decreased significantly ($p<0.05$) with intensity of treatment (Fig 2), changing from a bright green to a brownish olive green. The –a*/b* values increased significantly ($p<0.05$) with time and temperature of blanching treatment (data not showed).

The blanching process degraded total chlorophylls content and increased the total content of pheophytins (see Fig 3).

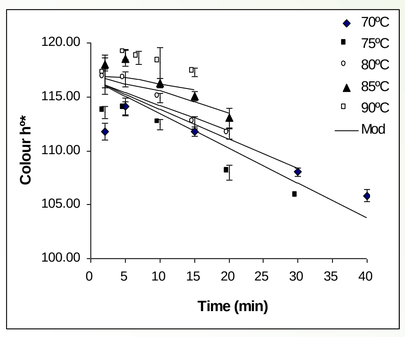

Fig 2. Hue angle (hº*) of thermally treated broccoli. (—) model predicted data.

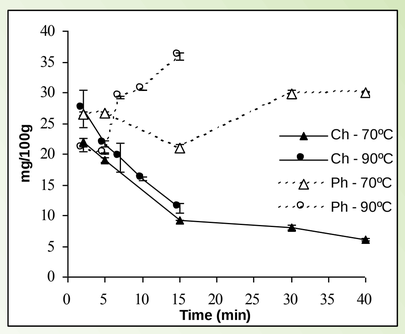

Fig 3. Blanching effect on chlorophylls and pheophytins contents of broccoli, at 70º and 90ºC.

Table 2 presents the kinetic parameters, reaction rate constants and activation energies (±standard error), using Eq1 and Eq2, for colour and texture quality factors of thermally treated broccoli.

Table 2. Kinetics parameters for colour and texture.

	Colour		Texture	
	-a*/b*	h*	N	N.mm
Ea ($kJmol^{-1}$)	28.53±3.85	29.55±4.67	158.34±4.67	154.96±5.36
$k_{T=80ºC}$ (min^{-1})	0.005±0.001	0.24±0.01	38.8±1.82	268.51±14.52

The effect of blanching on broccoli colour, flavour and texture sensory quality attributes is presented in Fig 4 (a, b, c, respectively). It can be observed that those attributes suffered significant changes ($p<0.05$) during blanching time.

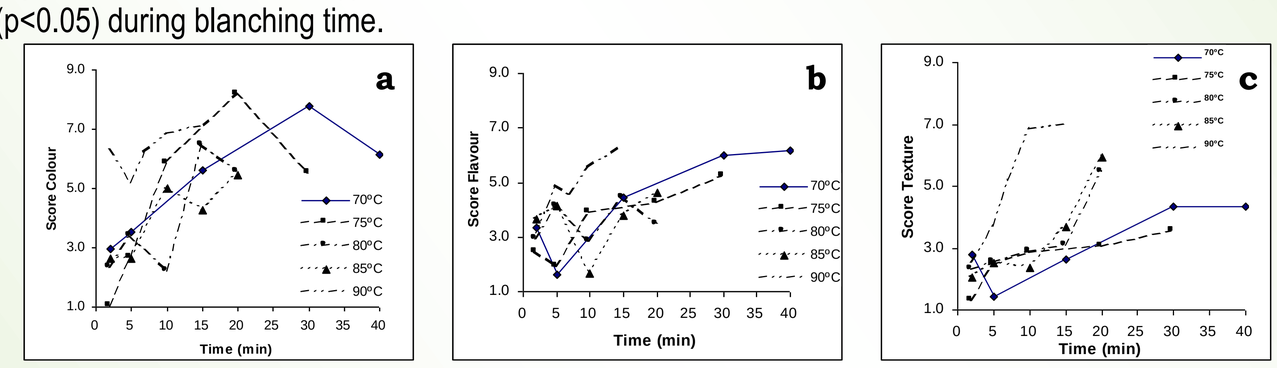

Fig 4. Blanching effect on sensory parameters: a – colour, b – flavour and c – texture, of broccoli.

High correlations were found between physical measurements (maximum force and hº* colour parameter) and sensory perceived changes of texture and colour. The correlation coefficients were 0.95 and 0.77, respectively.

Conclusions

This study revealed that physical and chemical properties of broccoli were greatly affected by blanching treatment conditions. Moreover, a decrease in sensory indexes is expected with the increase of heat treatment severity. The results showed a direct correspondence between the physical measurements (colour and texture) and sensory evaluation.

References

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