Evaluation of Quality Changes During Frozen Storage of Watercress (*Nasturtium officinale R. Br.*)

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· OBJECTIVE

Evaluation of quality parameters, such as colour, vitamin C and chlorophylls contents, during watercress frozen storage, at three different temperatures (-7, -15 and -30°C).

· INTRODUCTION

Watercress is one of the most nutritious vegetables, being a rich source of vitamins A (as β-carotene) and C, calcium, folic acid, iron, phosphorous, iodine and fibre (Vitacress report, 2001). Consequently, in dietary terms, it is a very important product, with a wide application in the Portuguese culinary (soups and salads).

Although frozen storage is well known for its excellence in preserving vegetables' quality, to produce a new and healthy frozen watercress product, it is necessary to study the effect of frozen storage on its quality parameters.

Vitamin C is easily degraded by blanching and during the freezing process.

The colour changes during frozen storage of green vegetables are attributed to the fading of the chlorophylls. Pheophytisation is the major chlorophylls degradation pathway, whereas chlorophylls (vivid green) are converted into pheophytins (olive brown) (Martins and Silva, 2002).

Residual peroxidase activity assay is a good criterion to confirm enzymes inactivation during blanchig, which is a cause of quality losses during frozen storage (Martins and Silva, 2003).

· MATERIALS AND METHODS

⏭ *Sample Preparation*

Fresh watercress was obtained directly from the field in Algarve. Watercress leaves were sorted, washed and blanched (20 sec at 95°C) in water. After cooling and drying, watercress was moulded in a rectangular form (4.6 x 3.3 x 1.8 cm³) and frozen in an air blast freezer at –25°C. Frozen watercress parallels (approximately 90g) were packed in polyethylene bags (3 parallels/bag) and stored at –7, -15 and –30°C, for a total of 15 months. Samples were randomly collected weekly in the first 6 months, fortnightly in the following trimester and monthly after the 9th month.

⏭ *Vitamin C*

Total vitamin C content was obtain as the sum of ascorbic (AA) and dihydroascorbic acids (DHAA) contents, quantified by a HPLC technique.

 # replicates: 6 for each storage temperature and time.

⏭ *Colour*

The co-ordinates *L*, *a*, and *b* from the *Hunter* Colour Space System were measured with a *tristimulus* colorimeter (CR 300, Minolta Corporation, Japan).

Colour functions used:

- Hue angle $H°=(\tan b/a)^{-1}$
- Total colour difference $TCD_H=((L-L_0)^2+(a-a_0)^2+(b-b_0)^2)^{1/2}$

L_0, a_0 and b_0 - initial values

Samples were homogenised with deionised water and placed in a Petri dish for measurements.

 # replicates: 9 for each storage temperature and time.

⏭ *Chlorophylls*

A spectrophotometric method was used to quantify *Chlorophylls a* and *b*, and *Pheophytins a* and *b*.

 # replicates: 3 for each storage temperature and time.

⏭ *Peroxidase*

Peroxidase residual activity was determined by a spectrophotometric method.

 # replicates: 3 for each storage temperature and time.

· CONCLUSIONS

- Quality losses occurred mainly at -7°C.
- At the lowest storage temperatures (-15 and -30°C), frozen watercress presented good quality retention.

· RESULTS AND DISCUSSION

➡ Vitamin C, ascorbic and dehydroascorbic acids

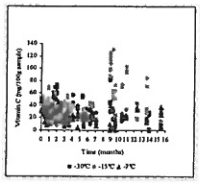

Figure 1. Vitamin C content along frozen storage, at different temperatures.

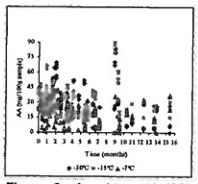

Figure 2. *Ascorbic acid (AA)* content along frozen storage, at different temperatures.

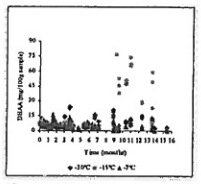

Figure 3. Dehydroa*scorbic acid (DHAA)* content along frozen storage, at different temperatures.

Vitamin C, ascorbic and dehydroascorbic acids

- a slight decrease was observed, tending to equilibrium, at -7 °C.
- a slight decrease was observed in the first 9 months of storage at -15 and -30 °C; high data dispersion after that period.

Vitamin C

- equilibrium concentration was around 20mg/100g at –7 °C; almost 50% of total vitamin C suffered degradation.

➡ Colour

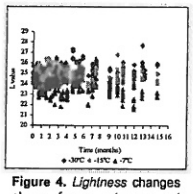

Figure 4. *Lightness* changes along frozen storage, at different temperatures.

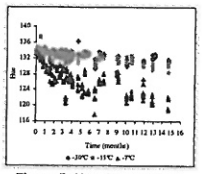

Figure 5. *Hue* changes along frozen storage, at different temperatures.

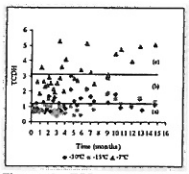

Figure 6. TCD_H mean values along frozen storage. ***(a)*** small difference, ***(b)*** evident difference and ***(c)*** notorious difference.

- ***Lightness* (L-value)** ⟶ remained constant along storage, with a smooth decrease for the highest temperature (-7 °C).
- ***Hue* (H°)** ⟶ *H°* values decreased for the all tested temperatures (higher variation at –7°C). The total variation of H° was approximately 12° at -7°C, and 4° at both lowest temperatures (-15 and -30 °C). This variation reflects a watercress yellowing, specially evident at –7°C.
- **Total colour difference (TCD_H)** ⟶ *small difference* for the lowest temperatures (-15 and –30°C). TCD_H increased along storage at -7 °C, from an *evident* to a *notorious* difference.

➡ Chlorophylls

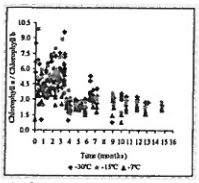

Figure 7. *Chlorophyll a / Chlorophyll b* changes along frozen storage, at different temperatures.

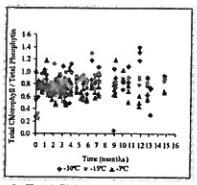

Figure 8. *Total Chlorophyll / Total Pheophytin* changes along frozen storage, at different temperatures.

- ***Chlorophyll a/b* ratio** ⟶ decreased along the first 3-4 months, remaining approximately constant till the end of storage, for all the tested temperatures. The ratio decrease might be due to some *enzyme activity* (chlorophyll a / chlorophyll b cycle) (Krautler, 2002) during the first storage term.
- ***Total chlorophyll/pheophytin* ratio** ⟶ results were constant at the highest temperatures (-15 and –30°C) and slightly decreased at –7°C. This is in agreement with the fact that antioxidants (as ascorbic acid and β-carotene), which watercress has in substantial quantity, protect chlorophylls from degradation (Yamauchi and Watada, 1997). At –7°C chlorophylls degradation occurs essentially due to *pheophytisation*.

➡ Peroxidase

- **Peroxidase activity** decreased, following an identical pattern for the three temperatures and reaching a residual value.

The decrease was particularly relevant in the first 3,5 storage months.

The final residual mean value was approximately half the initial one (≈2 Abs×1000 s⁻¹).

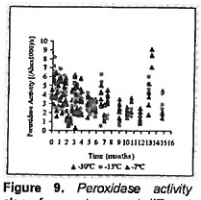

Figure 9. *Peroxidase activity* along frozen storage, at different temperatures.

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