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Qualidade, Segurança & Inovação

Actas do 5º Encontro de Química de Alimentos

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Sociedade Portuguesa de Química

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Kinetics of frozen stored green beans *(Phaseolus vulgaris,* l.*)* quality changes: vitamin C, reduced sugars and starch

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Objective

Quantify the kinetics for vitamin C (AA and DHAA) and starch degradation and reduced sugars content increase, in frozen stored green beans.

Introduction

Frozen vegetables consumption has increased in the past years, and also the consumer's concern about food security, quality, shelf-life and convenience, contributing for the increase in today's meals nutritional quality. Although freezing is a good preservation technique, important quality losses do occur in vegetables during frozen storage and mainly throughout the distribution chain. Examples of quality attributes that can degrade are texture, vitamin, flavour, and aroma.

During freezing the degradation of ascorbic acid can follow three different pathways: mild oxidation, aerobic pathway, and catalysed by copper or iron (Cu^{2+}/Fe^{3+}). The rate of degradation depends on the product, but generally a first order or apparent first order reaction kinetics is expected [1]. The behaviour of AA degradation has been observed to follow Ahrrenius behaviour with temperature.

Starch in vegetables can hydrolyse [2] and thus be considered a good indicator of frozen vegetables shelf-life [3]. The reduced sugars content increase is related to the decrease in pH of low protein foods, due to freeze concentration [4], therefore increasing the rate of acid catalysed hydrolysis. Acid-catalysed degradation of starch can be modelled by a first order or apparent first order kinetics.

Results and Discussion

Frozen green beans were distributed into three laboratory freezers (Fitotherm, model S550 BT) at the temperatures of -7, -15 and -30°C±1°C. The samples were analysed over a period of 250 days and sampled from random locations inside the freezer.

Ascorbic Acid content (AA) and Dehydro Ascorbic Acid (DHAA) were quantified by the Zapata & Dufour method [5]. Starch content was measured according to Norma Portuguesa NP-1420, 1987 [6].

Figure 1 presents degradation data for ascorbic acid and starch at -7°C. Kinetic parameters obtained using a one step non-linear regression to the all data, are presented in Table 1.

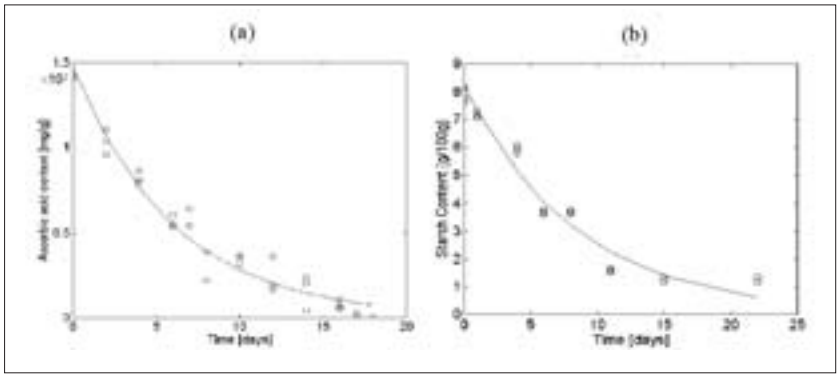

Figure 1
Degradation data: (a) ascorbic acid and (b) starch at -7°C. Continuous lines are model predicted values

Table 1
Ascorbic acid, starch and reduced sugars kinetic parameters

Parameter	Ascorbic acid	Starch	Reduced Sugars
C0 (g/100g)	146.1×10^{-3} $\pm2.412\times10^{-3}$	8.211±0.119	1.145±0.329
kref × 10^{-2} (day^{-1})	15.61±0.351	9.896±0.077	3.744±0.771
Ea × 10^{3} ($J.mol^{-1}$)	3.861±0.926	12.331±1.204	6.050±7.819*
SE	8.565	0.915	1.562

*** Non-significant model parameter.**

Ascorbic acid & Dehydro ascorbic acid content

During the blanching and freezing processes, no significant losses occurred to vitamin C, where the levels of AA and DHAA remained equal to the fresh product. However, significant losses occurred during frozen storage. Similar results were already observed by Favel, 1998 [7]. Ascorbic acid oxidation along frozen storage followed a first order reaction kinetics with an Arrhenius behaviour with storage temperature. As expected, ascorbic acid oxidation exhibited a low activation energy and, therefore, a low sensitivity to temperature decrease during frozen storage.

Reduced Sugars & Starch content

The reduced sugars content increased quite rapidly during storage time. This may be at the expense of acid catalysed starch hydrolysis, where starch content decreases

also significantly ($p<0.05$). Therefore, the starch content decrease and reduced sugars increase are correlated with a correlation coefficient of -0.8099.
Starch hydrolysis is not a very temperature sensitive reaction (Ea=1.233×104 J.mol-1), but the Arrhenius equation is necessary to describe the kinetic rate with storage temperature (t{Ea}>tcrit).

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