Safety of frozen vegetables: A case study on carrots

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Objective

The goal of this work was to quantify the impact of the freezing operation *per si* and frozen storage, at two temperatures (-7º and –20 ºC), on total aerobes, yeast and moulds levels on shredded carrots (*Daucus carrota* L.).

Keywords: Shredded carrots, freezing storage, microbiology, safety

Introduction

Freezing is one of the most effective processes of food preservation. Consumers are confident in frozen foods, which is a consequence of proven safety and quality characteristics of the products. However, safety depends strongly on the quality of the raw materials, the hygienic conditions when handling both at industrial and home processing, and on the temperature conditions during the entire logistic chain. Bacteria survival depends upon a number of factors, such as type of microorganism, freezing process, rate of freezing, storage temperatures and freeze-thaw cycles.

Freezing Process

Before vegetables processing, it is essential to remove adherent soil and dust through surfaces washing

Raw Material

Soil is the primary source of vegetables contamination. Soils frequently contain as many as 10^8 bacteria per gram. Around 10^6 may be in spore state. Many of these microorganisms may contaminate plant tissues during harvesting and/or handling.

Vegetables blanching is done with steam or hot water

Temperature range 75-95 ºC for 1-10 min.

The time/temperature combination depends on the vegetables

Blanching

Blanching reduces microbial content of foods, and acts at enzymatic level reducing activity of several enzymes, responsible for quality degradation during storage. Nevertheless, food sensory attributes may be sacrificed.

Freezing may be fast or slow

Freezing

Besides the proven influence of the freezing velocity on food quality attributes, it also affects microbial activity. In fast freezing processes a greater temperature shock occurs, drip loss is reduced, thus yielding less microbiological problems.

Temperatures around –18ºC

Storage

The minimum growth temperatures for bacteria are generally higher than storage in frozen conditions.

Foods stored at –5 ºC to –10 ºC present a greater reduction in viable microbial count than foods at lower temperatures.

At temperatures around –20 ºC, losses in cell viability are evident, particularly in the early days of storage.

Material and Methods

Samples preparation

Shredded carrots were obtained from a producer. At its arrival at the laboratory, carrot samples were frozen in a vertical forced air freezer (Refriger). The average air temperature was –40 ºC and samples were frozen till –35 ºC (temperatures monitored with thermocouples). Frozen carrots (~100g) were packed into polyethylene bags (22X35 cm), sealed and stored in laboratory freezers at –7ºC and –20º ±1ºC (S550 BT, Fitotherm). Raw carrots, samples immediately after frozen, and samples along storage in frozen conditions, were analyzed.

Microbiological analysis

Twenty grams of each sample were mixed with 180 mL of tryptone-salt broth (Biokar) and homogenized in a Stomacher for 1.5 minutes. Samples suffered a ten-fold dilution for subsequent microbiological analyses: (i) enumeration of total aerobic mesophilic flora on plate count agar (Biokar) according to ISO 4833:2003 (five replicates); (ii) enumeration of yeasts and moulds on rose bengal chloramphenicol agar (Biokar) according to ISO 7954:1987 (five replicates).

Statistical analysis

Data was compared by analysis of variance (ANOVA, Statistica 6.1, StatSoft, Inc., Tulsa, OK, USA). A least significant difference test ($p<0.05$) was performed for mean comparisons.

Results and Discussion

Results of total aerobic mesophilic counts on shredded raw carrots, after freezing and during storage at -7 and –20ºC, are shown in Figure 1. The number of microorganisms detected in raw carrots suffered a significant decrease of 30%, after the freezing operation. For samples stored in frozen conditions, an even higher reduction was observed, specially notorious for storage periods higher than 3 days. No differences were distinguished between results obtained at –7 and –20 ºC (i.e. no significant effect of stored freezing temperatures was observed).

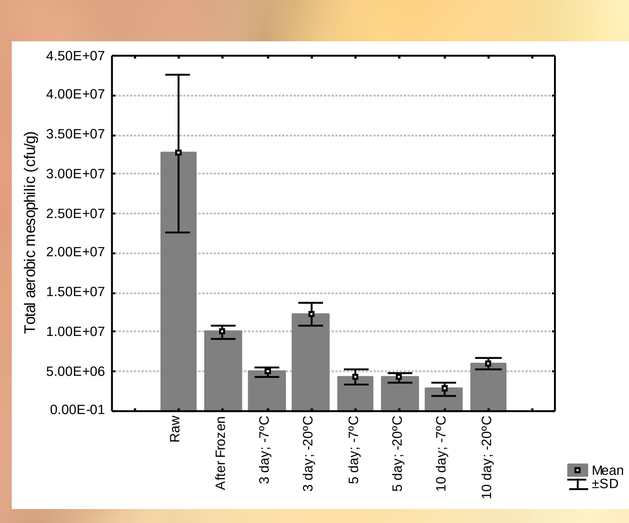

Figure 1. Total aerobic mesophilic counts in shredded raw carrots, after freezing and during storage at –7 ºC and –20 ºC. Vertical bars denote standard deviation (SD) of experimental data.

Results of yeast counts are presented in Figure 2. Initial yeast counts in raw carrots suffered a significant ($p<0,05$) decrease when compared to frozen carrots stored -7 and –20ºC.

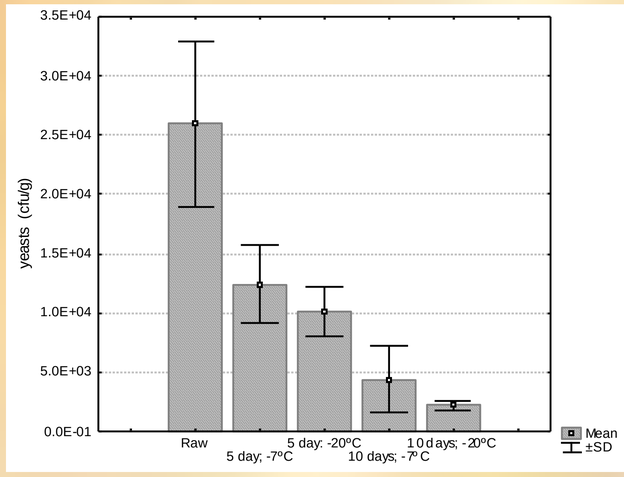

Figure 2. Yeasts counts in shredded raw carrots and during storage at –7 ºC and –20ºC. Vertical bars denote standard deviation (SD) of experimental data.

Frozen storage reduced yeast counts, indicating that the combination of freezing and frozen storage adversely influenced the survival of yeasts in shredded carrots. A gradual decline along storage time can be perceived at both temperatures. Samples at –20 ºC presented significant lower yeast counts ($p<0.05$) than samples at –7 ºC, at the tenth day of storage.

Moulds were not detected in all analyzed samples.

Experimental data obtained in this work clearly indicate the influence of freezing and frozen storage on microbial load of shredded carrots.

Conclusions

Freezing operation reduced significantly total aerobic mesophilic microorganisms in raw shredded carrots. If frozen samples are stored at –7 ºC or –20 ºC, greater reductions will be observed.

For yeasts, the lower the frozen storage temperature the better the preservation effect, as the number of colonies decreased.

Acknowledgements:

Projecto Agro 822 “Novas Tecnologias de Processamento de Hortofrutícolas Congelados”

Teresa Brandão acknowledges finantial support to Fundação para a Ciência e a Tecnologia (grant SFRH/BPD/11580/2002).