**NOTA TÉCNICA**

# Effect of freezing and osmatic dehydration on strawberry of the chandler variety

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Abstract: *The effects of freezing and osmotic dehydration on the physical-chemical and sensorial characteristics of strawberries of Chandler variety were investigated. Four physical-chemical analysis (º Brix, pH, tritable acidity and total sugar) were done and a valuation of sensorial attributes was performed, using the describable quantitative analysis (DQA) with structured scale of 9 points. Four treatments were applied to the strawberries: freezing in a household refrigerator without osmotic dehydration (CST), freezing in a household refrigerator with osmotic dehydration (CCT), freezing in a freezer without osmotic dehydration (FST) and with osmotic dehydration (FCT) pre-treatment, using a 65º Brix solution . The freezing of the strawberries with osmotic dehydration treatment (FCT) obtained the best means in the physical-chemical analysis and in the four sensorial attributes valued (color, appearance, texture and flavor).*

Key words: *Freezing, osmotic dehydration, strawberries*

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Resumo: *Os efeitos do congelamento e da desidratação osmótica nas características sensorais e físico-químicas em morangos da variedade Chandler foram investigados. Diversas análises físico-químicas (º Brix, pH, acidez titulável e açúcares totais) e avaliação dos atributos sensoriais foram realizados, utilizando-se a análise descritiva quantitativa (ADQ) com escala estruturada de 9 pontos. Aplicaram quatro tratamentos nos morangos: congelamento em um refrigerador sem tratamento osmótico (CST) e com um tratamento osmótico (CCT) prévio, congelamento em um freezer sem tratamento osmótico (FST) e com tratamento osmótico (FCT) prévio, empregando-se uma solução de sacarose de 65º Brix. O armazenamento em freezer com desidratação osmótica (FCT) obteve as melhores médias nas análises físico-químicas e nos quatro atributos sensoriais avaliados (cor, aparência, textura e sabor).*

Palavras-chave: C*ongelamento, desidratação osmótica, morangos*

# 1 Introduction

There is an increased demand for processed fruits which maintain quality similar to fresh fruits. Several techniques have been developed to partially remove water from fruits and vegetables in order to increase shelf-life of produce, reduce aroma losses in dried and semi-dried foodstuffs , and retain maximum quality in the final product (CHARDONNET *et al.*, 2001).

The strawberry is considered one of the most important fruits, commonly used in desserts, since it is very tender, however it is also highly perishable and has a high cost. So, consequently, the most relevant problems for this fruit are those related to packing, transportation and conservation (HENRIQUE e CEREDA, 1999).

The strawberry variety Chandler, natural of California, USA, which was introduced in Brazil by the Horticultural Section of IAC (Agronomic Institute of Campinas), has a high quality to be consumed fresh with an exceptional quality regarding to color and flavor, and also showing good resistance to physical damages (MORRIS *et al.*, 1988).

Since it is a very perishable fruit, the strawberries are generally stored for no longer than six days, in a temperature range from 0 to 4$^o$C, afterwards it passes through a reduction in the aroma and palate properties, and in its characteristic brightness (SCALON *et al.*, 1996).

At room temperature, without cooling, the strawberries maintain their quality at most for two days, when they start being extremely ripe or rotten (BLEINROTH, 1986). Many studies have been developed in order to evaluate the efficiency of different pre-freezing treatments in strawberries, to minimize the losses, specially of texture, that occur during its freezing (FUSTER *et al.*, 1984).

The aim of this work was to compare the effect of two kinds of freezing in pre-treated strawberries samples, with and without osmotic dehydration, using the physical chemical analysis and the sensorial analysis to evaluate the quality of the final product.

# 2 Material and methods

## 2.1 Raw material

The strawberries of Chandler variety were obtained from the city market of Curitiba, Paraná, and immediately transported to the laboratory, without cooling, during a period of one hour, at most. The fruits were processed right after its arrival in the laboratory.

## 2.2 Processing

The stages followed during the strawberries processing are described in Figure 1.

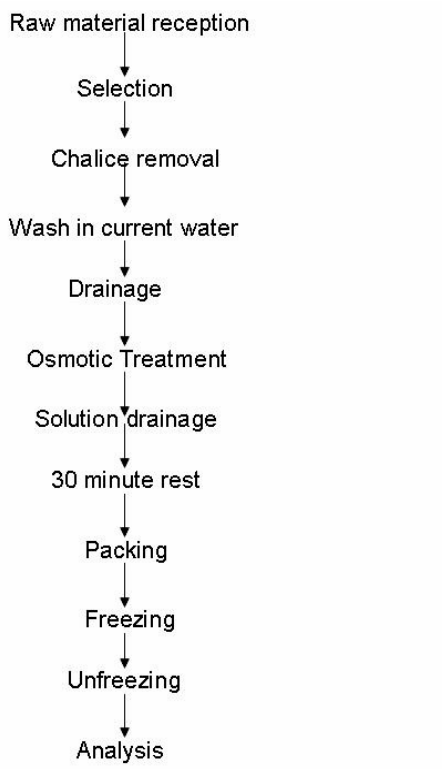


Figure 1 - Scheme of the processing of Chandler variety strawberry

### 2.2.1 Sample preparation

The strawberries were selected according to its appearance and firmness, and the fruits with some imperfection or deterioration were discarded. The selected fruits were left for ten minutes under fresh current water to remove the dirt and then put in a sieve to drain the wash water. Then, a longitudinal cut of the strawberries was performed, in a symmetrical way, to apply the treatment (osmotic dehydration).

### 2.2.2 Osmotic treatment

The samples were immersed in a sucrose solution of 65º Brix (after a cooling-off period) and then they were left resting in this solution for one hour and a half at room temperature. Afterwards, the strawberries were removed and put in a sieve to run out the exceeding solution. The dehydrated samples were disposed in a polypropylene recipient, leaving a distance between the strawberries (in order to avoid the aggregated formation), using a polyethylene film to wrap up the recipient, and then the recipients were frozen in an horizontal freezer and in a household refrigerator, during a period of three days.

### 2.2.3 Treatments

There were applied four different treatments on the strawberries:

- CST: Household refrigerator without treatment;
- CCT: Household refrigerator with osmotic treatment;
- FST: Freezer without treatment;
- FCT: Freezer with osmotic treatment.

## 2.3 Final product evaluation

The final product was unfrozen to be evaluated. The product unfreezing was done in a refrigerator at 5ºC temperature during a period of six hours.

### 2.3.1 Physical chemical analysis

The following physical chemical analysis were done in the treated strawberries:

- pH: using a potentiometer, model 710 A, ORION, according to the IAL methodology (1985);
- Titrable acidity: determinated by titration according to the analytical patterns of IAL (1985);
- Soluble Solids (º Brix): using a workbench refratometer WY1A, mark ABBE;
- Total Sugar: it was determinated according to IAL methodology (1985).

### 2.3.2 Sensorial analysis

The samples from the different treatments were subjectively evaluated as color, appearance, texture and flavor by a staff of 15 testers. It was used the quantitative describable analysis (QDA) with structured scale of 9 points. The samples were encoded and disposed in white plates, and after it was requested to perform the sensorial analysis in the following sequence: color, appearance, texture and flavor (DUTCOSKY, 1996). The obtained data were statistically evaluated with the Bartllet test, variance analysis (ANOVA) and Tukey test (mean comparation), using the MSTAT-C program, version 2.10 (KOEHLER, 1999).

# 3 Results and discussion

## 3.1 Physical chemical analysis

In Table 1 are shown the values obtained from the physical chemical analysis of the four different treatments applied:

| Treatments | $^o$ Brix | pH | *Titrableacidity* ($g/100g$) | *Total Sugar* ($g/100g$) |
|---|---|---|---|---|
| CST | 6,41 $^c$ | 3,51 $^a$ | 0,76 $^a$ | 5,77 $^c$ |
| CCT | 9,46 $^b$ | 3,35 $^b$ | 0,84 $^a$ | 6,79 $^b$ |
| FST | 6,30 $^c$ | 3,51$^a$ | 0,72 $^a$ | 5,03 $^d$ |
| FCT | 10,08 $^a$ | 3,42 $^c$ | 0,85 $^a$ | 8,51 $^a$ |
| CST - Household refrigerator without osmotic treatment | | | CCT - Household refrigerator with osmotic treatment | |
| FST - Freezer without osmotic treatment | | | FCT - Freezer with osmotic treatment | |
| The values represented by the same letters are not statistically different (p>0,05) in each column. | | | | |

Table 1 - Physical chemical characteristics of the treated strawberries.

Regarding to the soluble solids concentration ($^o$Brix), there was not statistically significative difference between the strawberries that did not pass for osmotic dehydration. The samples that were osmotically dehydrated had a significative increasing of 35% in soluble solids in comparison with the mean of the samples without osmotic treatment. This difference is explained by the strawberries immersion in the sucrose solution at 65% during 90 minutes, in which occurred a diffusion between the concentrated solution and the intracellular liquid of the strawberry. Berbari *et al.* (1998), obtained higher values of soluble solids in samples of Chandler variety strawberries, with an exposition time of 30 minutes in the solution. Regarding to pH, there was a significative difference (p<0,05) between the values obtained in the samples osmotically dehydrated in comparison with the samples without treatment. According to Figure 2, there was an inverse behavior between the titrable acidity and pH values of the treatments.

Sahari *et al.* (2004), found out equal pH values in strawberries from the Kordestan variety (Iran), frozen at -12$^o$C, and the acidity levels were higher in three temperature ranges (-12$^o$C, -18$^o$C and -24$^o$C).The storage time and dehydration by the sugar utilization have many effects in hydrogen ions, therefore, pH is important for the evaluation of quality and efficiency in industrial processes (SAHARI *et al.*, 2004). There was statistic difference (p>0,05) between all the treatments relating to the quantity of total sugar, since that the treatment FCT showed the best mean within the others.

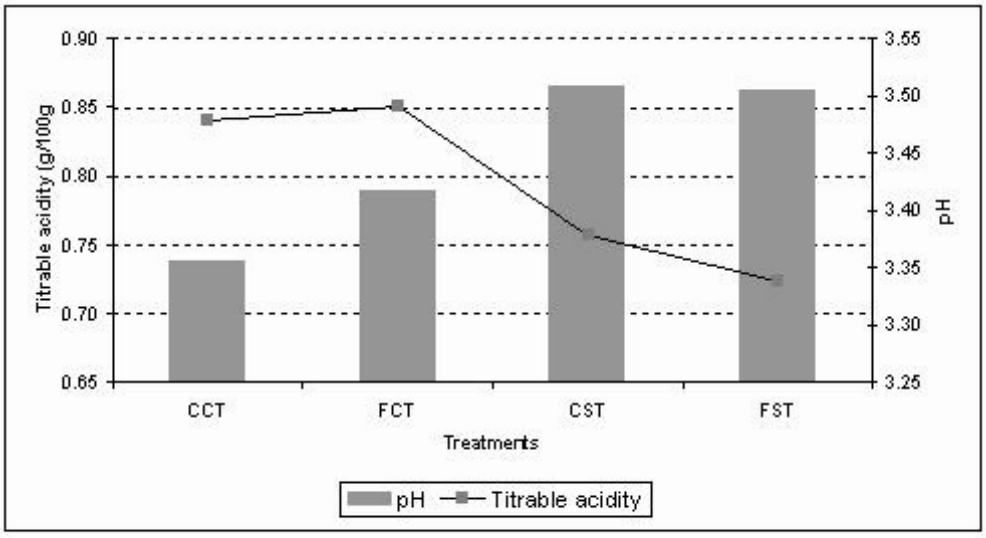


Figure 2 - Relation between titrable acidity x pH of the samples frozen with and without osmotic treatment

CST - Household refrigerator without osmotic treatment, CCT - Household refrigerator with osmotic treatment, FST - Freezer without osmotic treatment, FCT - Freezer with osmotic treatment

### 3.2 Sensorial analysis

In Table 2 are shown the mean values from the evaluated attributes of the treated samples. There was not statistic difference at 95% level of probability between the samples with osmotic treatment regarding to color, and the sample stored in freezer obtained the best mean, showing the grade 7 in the structured scale, corresponding to "liked regularly" in the hedonic scale.

The appearance obtained similar means if compared with color values, so, there was not statistic difference between the categories (with osmotic treatment and without osmotic treatment). CST obtained the worst mean between the treatments regarding to texture, corresponding in the structured scale to the grade 4, and in the hedonic scale to "dislike lightly", whereas the sample FCT obtained the best acceptance. There was statistic difference ($p<0,05$) between all the treatments relating to flavor, since it was the attribute most prejudiced by the treatments of freezing and osmotic dehydration. The sample CST, which contained a higher quantity of water, lost a considerable quantity of exudate during the unfreezing period, affecting the flavor. The sample FCT showed a better acceptance due to a higher quantity of sugar (osmotic dehydration) and a better conservation of cellular integrity. In Figure 3 are shown the means of the four attributes evaluated for each treatment.

| Treatments | Color | Appearance | Texture | Flavor |
|---|---|---|---|---|
| CST | 6,70 $^{ab}$ | 5,88 $^{b}$ | 3,96 $^{b}$ | 2,78 $^{c}$ |
| CCT | 7,57 $^{a}$ | 7,20 $^{a}$ | 5,87 $^{a}$ | 5,47 $^{ab}$ |
| FST | 5,63$^{b}$ | 5,70 $^{b}$ | 4,10 $^{b}$ | 3,58 $^{bc}$ |
| FCT | 7,56 $^{a}$ | 7,35 $^{a}$ | 6,39 $^{a}$ | 6,54 $^{a}$ |
| CST - Household refrigerator without osmotic treatment | | | CCT - Household refrigerator with osmotic treatment | |
| FST - Freezer without osmotic treatment | | | FCT - Freezer with osmotic treatment | |
| Data with the same letters are not statistically different (p>0,05) in each column | | | | |

Table 2 - Mean of the attributes obtained at sensorial analysis

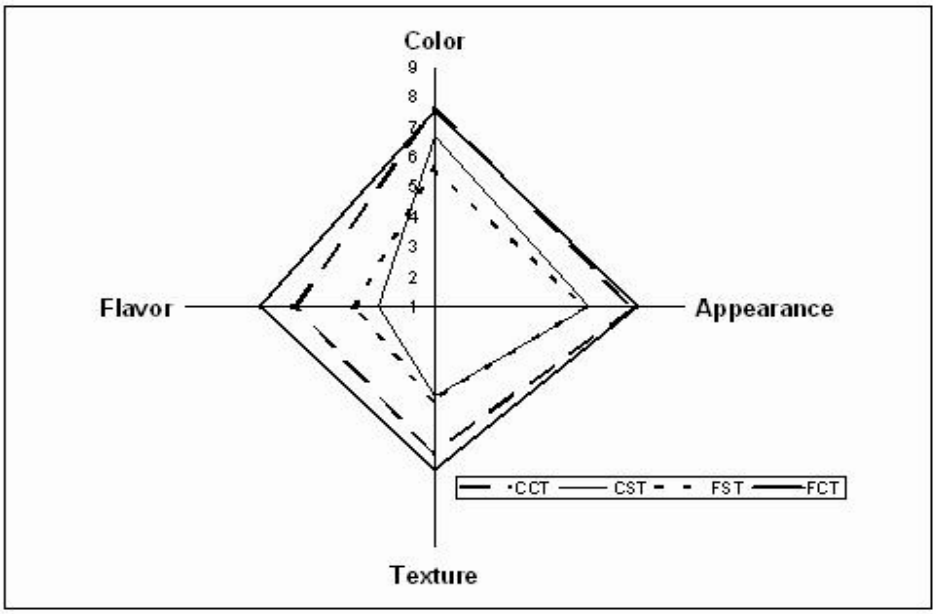


Figure 3 - Structured Scale of the attributes evaluated

CST - Household refrigerator without osmotic treatment, CCT - Household refrigerator with osmotic treatment, FST - Freezer without osmotic treatment, FCT - Freezer with osmotic treatment

## 4 Conclusion

The osmotic treatment had a great influence on the physical chemical properties in the frozen samples of the strawberries analyzed in this work. There was an increase in the quantity of soluble solids in the treated samples, and a decrease of the pH values. The concentrated sucrose solution ($65^{o}$ Brix) caused an increase in the pH and a decrease in the titrable acidity values.

Regarding to total sugar, the samples with osmotic treatment had an increase of 29,5% in the quantity of reducer sugars compared with the samples without treatment.

The sensorial attributes more affected by the freezing and unfreezing processes were texture and flavor. The color and appearance of treated strawberries obtained higher means than strawberries without osmotic treatment. The freezing in a freezer with osmotic treatment (FCT) obtained the best means in all the sensorial characteristics evaluated. In general terms, the combination of the osmotic dehydration and freezing processes might be very useful to the conservation of fruits with short shelf-life.

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