

**The Preservation of Frozen Food Quality and
Safety Throughout the Distribution Chain**

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Plenary 1

Design and Optimization of Food Processing Conditions

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Summary

The main research objectives of the group are the design and optimization of food processing conditions. Most of the work already developed is on the use of mathematical modeling of transport phenomena and quantification of degradation kinetics as two tools to optimize the final quality of thermally processed food products.

Recently, we initiated a project with the main goal of studying the effects of freezing and frozen storage on orange and melon juice pectinesterase activity and quality. The main criterion to adequately pasteurize orange juice is a two decimal reduction of the activity of the enzyme. Preliminary experiments with orange and melon juices and previously published work for march white grapefruit pulp indicated that freezing storage is effective in reducing the pectinesterase activity. The final objective is to determine if the freezing storage of these juices, before pasteurization, can offer advantages in terms of the final product quality and total energy consumption.

Finally, we have also been developing computer programs to model the heat transfer during the freezing process of solid foods. We have plans to further improve these models in order to have the possibility of predicting the effect of storage medium temperature fluctuations on the product temperature and quality.

Effect of Frozen Storage on Orange and Melon Juice Pectinesterase Activity

Abstract

The pectinesterase (PE) enzyme causes clarification and gelation in citrus juices. Usually, to prevent these undesirable effects, the PE is 90 to 99% inactivated thermally by a pasteurization process. This process causes also the degradation of quality parameters, such as flavour, colour and nutrient losses. Therefore, if freezing and frozen storage inactivate part of the PE, this unit operation could be used as pre-treatment before pasteurization. Freezing causes much less damages to the product. The objective of this work is the investigation of the potentialities, in terms of minimizing the quality degradation and increase economic profits, of using the freezing process as a way of storage raw material and pre-processing before pasteurization of orange and melon juice. The main task is the quantification of the freezing and frozen storage effects on the orange and melon juice PE activity.

Description

One of the main concerns of the food processing industry is the preservation of sensorial and nutritional characteristics of the raw material as much as possible.

Fruits are a category of foods that when processed show easily undesirable changes in texture, colour and flavour. Furthermore, fruit processing causes nutrient losses. There is a great demand for fresh like fruit products. Appearance, flavour and texture determine the consumer preference for a particular food product (Fennema 1976).

The juices are among the several products derived from fruits. Nowadays, at the world-wide level, the citrus juices are the most important among the fruit juice industry. The greatest producer and exporter of orange juice is Brazil (Anon 1996). Europe is a big consumer and importer of citrus juice. The European production is not enough to attend its own demand. Portugal has a great potential to exploit the orange culture and

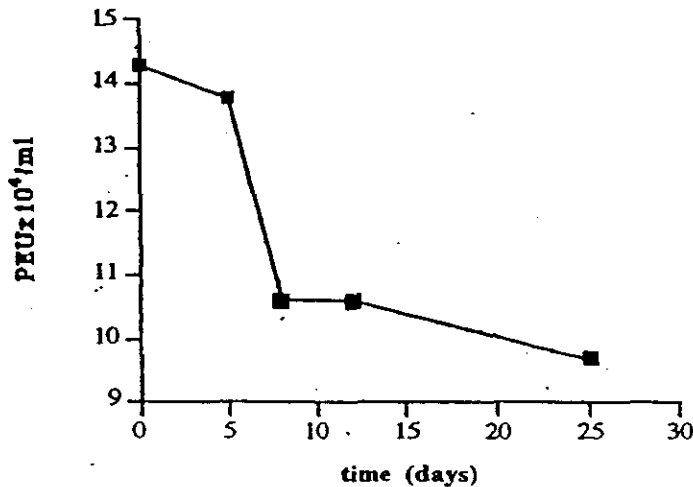


Figure 1 - Effect of frozen storage, at -18°C , on orange juice PE activity.

industrialize its production. Thus, Portuguese production could participate in the orange juice European market.

The pure orange juice is probably the most consumed fruit juice in the world. Furthermore, in the latest years, mixed juices (e.g. orange plus carrot, orange plus peach) have been commercialized with a very good success.

One of the greatest producers of melon is Spain (Anon 1971; Nath and Ranganna 1977). This fruit is usually consumed "in natura". The use of melon by the juice industry could be a great incentive for agricultural exploitation, specially in countries, like Portugal, with suitable environmental conditions.

Cloud is the suspended material of orange juice (Kørner *et al.* 1980). The major concern in citrus juices manufacturing is the cloud retention (Wicker *et al.* 1987). According to several authors (Amstalden and Montgomery 1994, 1995; Atkins and Rouse 1953; Marshall *et al.* 1985; Seymour *et al.* 1991a,b; Versteeg *et al.* 1980) cloud loss is due to the pectinesterase (PE) enzyme activity. Citrus fruits contain large amount of PE, that after juice extraction acts on pectin, thus destabilizing the cloud. A cloudy orange juice gives the consumer the idea of a natural fresh product. Hence, juice commercial value is lost if clarification occurs (Amstalden and Montgomery 1994, 1995; Atkinset *al.* 1952).

The juice cloud loss is avoided if a thermal treatment at high temperatures (e.g. 90°C , 1 min) for PE inactivation (Amstalden and Montgomery 1995; Atkins and Rouse 1953; Eagerman and Rouse 1976; Marshall *et al.* 1985; Seymour *et al.* 1991b; Versteeg *et al.* 1980) is used. However, this process produces undesirable "cooked" off-flavour and degrades juice aroma (Baker and Bruemmer 1972; Kiefer 1961; Seymour *et al.* 1991b).

People have become more aware about quality. Therefore, There is a need to develop alternative methods (minimal processing) that allow maximum retention of natural fruit properties. Versteeg *et al.* (1980) recommended the storage at -20°C to decrease the PE activity in concentrated orange juice. Seymour *et al.* (1991a) got some grapefruit PE inactivation during frozen storage. In preliminary assays for this research project significant reductions in orange (Figure 1) and melon juice PE activity, after frozen storage were observed.

A heat removal operation can be a likely solution to juice industry. Thus, freezing and frozen storage could be used as pre-treatment for PE inactivation followed by a less severe thermal treatment. Frozen storage causes less damages to the product than other methods (Del Rio and Miller 1979). Therefore, the juice quality could be improved.

Conclusions

The pectinesterase (PE) activity is intensely influenced by medium conditions, such as pH, total soluble solids and total acidity.

There are at least two enzymatic fractions of PE, one more thermal resistant than the other. The main causative agent of cloud loss in citrus juices is the thermostable PE.

No suitable method exists to stabilize the juice against pectinesterase other than thermal treatment. The pasteurization process, used to inactivate PE, causes also degradation of orange juice flavour, colour and aroma.

Frozen storage seems to offer potentialities for partial PE inactivation. However, studies on this subject do not exist for orange or melon juice. Juice frozen storage before pasteurization may result in higher quality products.

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