A process to prevent browning of frozen avocado halves and chunks

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ABSTRACT

The successful processing of avocado fruit for frozen products such as halves and chunks, relies on the prevention of fruit browning, as well as the maintenance of taste. Previous work showed that browning could be prevented by the use of anti-oxidants such as ascorbic acid, but at the concentrations required, product taste was adversely affected. In order to overcome these problems, a heat treatment was developed. After fruit had been ripened to the correct softness, cleaned externally with a microbial disinfectant, peeled and sliced, fruit was dipped into boiling water for sufficient time to inactivate the browning enzyme polyphenol oxidase (PPO), as well as leach phenolics from the cut surface of the fruit.

The latter prevents enhanced flavour and bitterness associated with storage of frozen avocado. Thereafter, fruit was rapidly frozen in liquid nitrogen, packed and stored. On defrosting, the treatment was shown to be highly effective, in that fruit browning did not occur for a number of hours after defrosting.

INTRODUCTION

A successful frozen avocado product will have to exhibit certain characteristics. Amongst the most important, will be a lack of product browning after defrosting, and an acceptable taste. Taste will include the lack of any off tastes, as a result of cell destruction, microbial activity or the treatments imposed to prevent browning. In addition, the product should have the correct consistency (softness) after defrosting.

Other commercial frozen avocado products are available, but in order to prevent browning due to the presence of the browning enzyme polyphenol oxidase (PPO) (Kahn, 1997), which is released into the cell cytoplasm and comes into contact with the phenolic substrate (Vauhan & Duke, 1984) due to cell damage on the cut edges of the fruit, high concentrations of anti-oxidants are used (Kahn, 1977). This clearly affects taste of these products.

Considerable progress has been made during the past few years (Bower & Dennison, 2003; 2004) in achieving potential production of an acceptable product. The objectives of the project were to produce a product in which:

- fruit taste and texture is maintained as far as possible and is acceptable to the consumer;
- there should be no taste of anti-oxidants and if possible none should be used;
- the product should have good visual appeal;
- there should be a long shelf life.

The purpose of this paper is to outline the overall procedures used to achieve these quality parameters, and indicate the critical steps involved in success, as well as the issues which will need attention in the commercialization of the product.

MATERIALS AND METHODS

As the fruit is to be frozen (Boyle *et al*., 1977), a certain amount of tissue destruction due to ice crystals can be expected, especially on defrosting (Harker, *et al*.,1977). This could seriously affect the texture and thus overall taste of the product. It is therefore essential that the processing only be undertaken at the correct degree of softness in the fruit ripening cycle. This was estimated using a TYP densimeter. It was found that a softness of 55 to 60 on a scale of 0 to 100, where 100 is hard and 0 soft, is critical to later product quality. Discussions with a commercial producer indicate the correctness of these values. Commercially, acceptable means of determining this will be necessary. This may be done as shown in Fig.1.

Figure 1. Testing for softness before processing.

After fruit is deemed to be of correct softness, surface sanitization was done with a sanitizing agent (Tarter & Singh, 1994) so as to decrease risk of microbial infection. This would be a normal part of any HACCAP process, and although important form this point of view, should not otherwise affect the product.

After fruit were cut, a critical step to prevention of later browning was introduced. The browning enzyme, PPO, can be inactivated by a number of techniques. As the envisaged storage temperature can be expected to inactivate the enzyme during storage, but not denature it, browning can, in the absence of any other anti-oxidant, result in browning once the product is defrosted. An option of heat denaturation was chosen (Fig. 2). It is important that the temperature and time of fruit exposure to high temperature be controlled. A heated water bath method was found to be most satisfactory. Fruit was dipped in boiling water such that the tissue temperature reached approximately 80ºC. This could be achieved in a short time, so that the fruit was not otherwise damaged. The fruit was then rapidly cooled. This process was found to have an additional effect, in that phenolics, which form the substrate for the PPO browning reaction (Vauhan & Duke, 1984) were found to be leached from cut tissue surfaces.

Figure 2. Heating prior to freezing.

Not only did this have a positive effect on later browning reactions, but a bitter taste or excessive flavour enhancement found to occur with freezing (Bower & Dennison, 2003) was eliminated. This was in fact eliminated to such an extent that a somewhat bland flavour resulted. However, it is believed that in commercial operations this problem can be eliminated by adjusting time in the water bath.

Once the critical step in browning prevention was concluded, fruit was rapidly frozen in liquid nitrogen. It was again found that the freezing step is critical to later product quality. It is believed that although freezing should be rapid to prevent ice crystal formation (Boyle *et al*., 1997), the temperature should not be allowed to become too low as cracking occurs. Further, it is believed that this stage of the process may contribute to an unacceptable loss of texture after defrosting. Observations are that blast freezing to a temperature considerably higher than that created by liquid nitrogen, is preferable.

Various forms of packaging have been tested (Bower & Dennison, 2003; 2004). This has included vacuum packaging and modified atmosphere packaging. No advantages were found for modified atmosphere packaging, and vacuum packaging is not favoured by some people due to a perceived risk to food safety (Pao & Petracek, 1997). A polyethylene or polypropylene pack appears to work well.

CONCLUSIONS

This project has shown that it is possible to produce cut and ready to eat avocado portions which can be frozen, and as a result maintain good appearance for a considerable time. Fruit has been kept for an excess of six months, with no discernable deterioration.

The greatest problem facing a producer of such products is generally fruit browning, and this has been eliminated by the heat treatment method described. No anti-oxidants such as ascorbic acid were found to be necessary, and yet the product does not brown after a number of hours post defrosting (Fig. 3). It is considered that this factor will be of considerable value to the food service industry.

Figure 3. Fruit a number of hours after defrosting, showing no browning.

Product texture may still be a problem. However, careful selection of fruit of the correct softness will be vital, and observations that blast freezing rather than liquid nitrogen as a freezing technique appear to result in a better product, which may solve this problem.

It is believed that the basic research for this product is complete. Some refinement is possible, but this can probably be done during the commercialization phase which will be necessary for product production. The outlines provided, should be considered as such, and details may change with implementation of the technology. This may differ in different operational settings.

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