South African Avocado Growers' Association Yearbook. 2004. 27:32-34.

Alternative avocado products

J P Bower and M T Dennison

Horticultural Science, University of KwaZulu-Natal
Private Bag X01, Scottsville 3209, South Africa
E-mail: bowerj@ukzn.ac.za

ABSTRACT

Avocados in South Africa are presently sold as a fresh product, as well as for processing into oil or pulp. A ready to eat cut and peeled product is absent from this portfolio. Previous work in this regard has shown that it is possible to produce a fresh cut and chilled or frozen product. However, to prevent browning, anti-oxidants were used and vacuum packaging to further prevent browning, employed. In the case of the fresh product, tissue collapse and off-taste occurred, due to a suspected endogenous yeast organism. Vacuum packaging may create a food safety risk. The frozen product contained an off-taste when defrosted. To counter these problems, tests were conducted with modified atmosphere packaging, containing decreased oxygen and enhanced carbon dioxide levels. In addition, a pre-ripening carbon dioxide shock treatment to modify the phenolics, was applied. Further, the degree of softness required for the frozen product was investigated and a pasturisation process applied. Results showed that there was no advantage to modified atmosphere packaging, if oxygen was present in the mix. However, the pasturisation process eliminated post production collapse of the fruit, the associated off-tastes, and considerably decreased fruit browning potential, to the point where use of anti-oxidants such as citric acid are unnecessary. These can be used as an optional taste factor, as a taste panel found defrosted frozen product acceptable with and without. The most attractive and versatile product is that of frozen halves and slices, which were deemed by a taste panel, to be acceptable for purchase.

INTRODUCTION

Previous work by Bower & Dennison (2003) demonstrated that there is a potential for producing both fresh cut and frozen avocado halves, slices and chunks. The products had good visual appeal, especially the frozen product, and in addition the latter appeared to have a substantial shelf life. However, although the products generally had a good appearance, a number of problems were found to exist, which could decrease marketability.

In order to decrease the potential for browning due to polyphenol oxidase (PPO) activity Vaughan & Duke (1984), common anti-oxidants were used. However, the concentration necessary resulted in a sharp taste, that was not appealing to some of the taste panels. For the PPO browning reaction to take place, oxygen is necessary (Mayer & Harel, 1979). As a result, a vacuum pack was used. While efficient in preventing browning, there is a possibility that some degree of anaerobic respiration took place, as a fermentation off-taste occurred in the fresh cut fruit, despite storage at low temperature. In addition, the possible risk of food safety hazards in an anaerobic pack, even if the product is at low pH (Pao & Petracek, 1997) may be too high for commercialisation. In the case of the fresh cut product, a discoloration (water soaked appearance) which extended from the seed cavity into the flesh was often prevalent after a number of days. The cause is not known, but may relate to an endogenous pathogen, possibly a yeast or fungus. Tissue tended to collapse and an off-taste developed. The problem needed to be solved for the product to be widely acceptable. In the case of the frozen product, a taste enhancement, perhaps due to phenolics being altered in some way during the freezing and thawing process, could be a problem if the anti-oxidant concentration is reduced.

The objectives of the research were thus to improve the products, so that the need for high concentrations of anti-oxidants can be eliminated. At the same time, in the case of the frozen product, the potential taste enhancement after thawing needed to be altered. In addition, a process which did not require a low oxygen or vacuum pack needed to be developed.

MATERIALS AND METHODS

There were two primary objectives of the work, being the eradication of the tissue collapse most probably caused by either an endogenous pathogen or oxidative rancidity, and elimination of browning without the addition of high concentrations of anti-oxidants. Pao & Petracek (1997) showed that citric acid worked well for this purpose in citrus fruits. In addition, the surface pH of the fresh cut fruit was reduced to less than

4.6. This would suit the need to reduce browning potential, as PPO activity will be considerably reduced at this pH (Kahn, 1977). The previous work of Bower & Dennison (2003) showed that often used concentrations of citric acid resulted in fruits with an overwhelming taste of the acid, rather than the fruit. If the concentration was sufficiently reduced, then the problem of off-taste after thawing remained. An overall outline of the procedures adopted were thus as follows:

Fruits were allowed to ripen to a softness of 50 to 55 on a densimeter marked from 100 (hard) to 0 (soft). Fruits were chilled, to decrease potential for browning during the processing stage (Kahn, 1977), after which they were dipped in a chlorine based solution for surface sterilisation (Tarter & Singh, 1994). Thereafter fruit were cut and further processed.

An intermediate step was added between cutting and freezing or, in the case of fresh cut product, direct packaging. The aim of this step was to decrease the potential for tissue browning and eliminate the endogenous pathogen or oxidative degradation which occurs. Two methods were tested.

Thereafter, fruit were prepared for packaging as fresh cut by testing various concentrations of a number of anti-oxidants at various concentrations. In addition, modified atmospheres as well as standard atmosphere was used (Gorney, 1997). Packaging was in a micro-perforated polypropylene bag with anti-mist coating. Storage was at 2^0C.

In the case of the frozen product, after the intermediate step, fruit were dipped into liquid nitrogen for rapid freezing so as to maintain ice crystals as small as possible (Harker *et al*., 1997). After freezing, the same range of anti-oxidants were applied to the fruit, which were then packaged into the same material as the fresh cut product, and stored at -18^0C.

Figure 1. Packaged and frozen avocado fruit after 6 months storage at -18^0C. Left is a fruit without anti-oxidants, right fruit treated with citric acid

Figure 2. Fruit untreated with anti-oxidants after defrosting

Figure 3. Fruit untreated with anti-oxidants after 2 hours in normal atmosphere

RESULTS AND DISCUSSION

One of the two processes used after fruit cutting had excellent results, eliminating the tissue collapse due to oxidative degradation or endogenous pathogens. This was the case for both the fresh cut as well as frozen product. In

the case of the fresh cut product, no advantage could be found by using a modified atmosphere in the pack. Of the anti-oxidant systems used, citric acid at a low concentration proved to be acceptable in terms of maintaining product appearance and taste. The product appeared to have an acceptable shelf life of approximately one week, although some desiccation of the fruit surface was evident which detracted from both the appearance as well as texture and taste. This problem will have to be addressed if the fresh cut product is to be viable. In addition, maintenance of the cold chain will be essential.

The frozen product was more successful than the fresh product. The appearance was excellent, even after six months in storage. Of importance, however, was the temperature to which the product was taken during the freezing process. If the temperature is too low, then fruit cracking occurs. Correct control of the freezing process should, however, not be a problem. The product in package, after six months storage, is shown in Figure 1.

On removal from the pack after defrosting at room temperature, the product still had a good appearance (Figure 2), which remained good for a considerable time. After two hours there was still no sign of browning as normally associated with cut avocado exposed to the atmosphere. This is evident from Figure 3.

Taste of the frozen product was considered acceptable by the taste panel. The intensification of certain flavours or off-flavours found in previous work, was absent. Some of the characteristic avocado taste had been lost, making the product somewhat bland, but this was not seen as a negative factor, especially if the product is to be used in the food industry, as a part of, for instance, salads.

The use of anti-oxidants for browning prevention was found to be unnecessary. However, a low concentration of citric acid was found acceptable and in some cases preferable to the control fruit, by about half of the taste panel. This could be an optional part of the process, depending upon the target market.

CONCLUSIONS

Many of the problems associated with the fresh cut and frozen product have been minimised or eliminated. Thus, it is our contention that a technically viable range of commercial products is now possible. The best product, due to the shelf life and ability to transport and distribute in a sound condition, is probably the frozen one. While further work could be done with respect to simplifying the process, it is believed that the system is now at a stage that an up-scaling to a factory situation is necessary. There are a number of advantages of the processing system. These include the absence of fruit surface browning after defrosting and exposure to atmosphere for extended periods, the lack of need to add any anti-oxidants, thus providing a completely natural product or the option of citric acid coating for flavour enhancement, and the fact that a modified atmosphere or vacuum pack is unnecessary.

LITERATURE CITED

BOWER, J.P. & DENNISON, M.T. 2003. Progress in the development of avocado products. *South African Avocado Growers' Association Yearbook* 26: 35-39.

GORNEY, J.R. (ed.). 1997. CA'97. Procedings Vol. 5: Fresh-cut fruits and vegetables and MAP. *Postharvest Hort. Series* 19: 30-66.

HARKER, F.R., REDGWELL, R.J. & HALLETT, I.C. 1997. Texture of fresh fruit. *Hort Rev*. 20: 121-224.

KAHN,V. 1977. Some biochemical properties of polyphenoloxidase from two avocado varieties differing in their browning rates. *J. Food Sci*. 42: 38-43.

MAYER, A.M. & HAREL, E. 1979. Polyphenol oxidases in plants. *Phytochemistry* 18: 193-251.

PAO, S. & PETRACEK. 1997. Shelf life extension of peeled oranges by citric acid treatment. *Food Microbiol*. 14: 458-497.

TARTER, M. & SINGH, R.P. 1994. Storage of mechanically peeled oranges and grapefruit. *Postharvest Biol. and Technol*. 4: 117-124.

VAUGHAN, K.C. & DUKE, S.O. 1984. Function of polyphenol oxidase in higher plants. *Physiol. Plant*. 60: 106-112.