CARIBBEAN FOOD CROPS SOCIETY

23

Twenty Third Annual Meeting 1987

Antigua

Vol. XXIII

Potential for new lightly processed tropical fruit products

Robert E. Berry and Joseph H. Bruemmer

P.O.Box 1909, U. S. Citrus and Subtropical Products Laboratory, U.S.D.A. - A.R.S., Winter Haven, FL., 33883, USA.

The U. S. market for table-ready prepared fruit and vegetable products, such as fruit segments, slices, cut fruit and pieces is expanding. The vacuum infusion technique makes possible protection of cut and peeled surfaces using natural enzymes, edible coatings, antioxidants and/or nutrients to preserve natural quality attributes such as color, texture, nutrients and flavor. Infusion of pectinases has been used to separate peel, albedo and rag from grapefruit and oranges. The technique was also used to add color and nutrients. Applied to mango, papaya, pineapple, peach, apple and carambola slices and peeled fruit pieces, it will help preserve them for marketing.

Keywords: Fruit processing; Vacuum infiltration; Citrus

Introduction

In U. S. markets, demand has been greatly increasing over the past few years for prepared fresh fruit and vegetable or "salad-type" items. Grocery stores and supermarkets now routinely feature delicatessen and garden salad sections where such items are readily available. Many fast-food restaurants feature cut, sliced, prepared fruit and vegetable pieces as part of their salad bar. Limited-menu buffet and cafeteria style restaurants also are proliferating in most towns in the U.S. This creates great demand for this type of product. While such products usually offer good taste, color, nutrients and texture when freshly prepared, these attributes begin to deteriorate immediately. Thus the color either fades, turns brown or darkens; the texture becomes mushy, or soggy, the flavor becomes unbalanced and less intense and nutrients are lost to oxidation or through internal reactions. Such products rarely retain satisfactory fresh quality more than a few days to a week, at most.

A process has been developed which can add protectants to these cut surfaces, or internal structures within the cut piece. This prolongs and enhances the quality by retarding deteriorating reactions, whether at the surface or internal. The process, known as vacuum infusion was initiated at our laboratory about 10 years ago, for the purpose of removing or lowering the amount of the bitter principle, naringin, in grapefruit.

Bruemmer et. al (1978) showed the process could also be applied to removing peel and separating sections in grapefruit with very little hand labor or loss of quality. This paper reviews some of these results and similar studies and also develops some additional potential applications of the vacuum infusion process for other tropical fruits.

Vacuum Infusion for Debittering Grapefruit

Early studies of the grapefruit bitterness problem showed that the factor causing much of the bitterness resided in the albedo portion of the peel, the membranes surrounding and separating the fruit segments, and in the core material, which is also mostly albedo (Sinclair, 1972). Studies by Ting (1958), of grapefruit juice and Olsen and Hill (1964) on grapefruit concentrate, showed bitterness could be reduced by treatment of the respective products with naringinase, which was separated from commercial pectinase preparations. The primary problem was getting the naringinase to penetrate into the albedo material. In studies at our laboratory, Roe and Bruemmer (1976) determined that the best approach to incorporating the enzyme into the albedo was by vacuum infusion. They first scraped, perforated, or thinly peeled off the flavedo. By withdrawing the air from a lab desiccator containing the fruit submerged in a beaker of the solution, and then releasing the vacuum, the solution was able to saturate the albedo.

A medium sized grapefruit soaked up about 100 ml. of solution under these conditions. Using this method, they were able to reduce the naringin content by about 8% to 81% depending on conditions. These results are indicated in Table 1. Naringin content reduction depended on amount of naringinase, and time, as indicated. Best results were obtained with 60 min treatment at 50 ^{o}C, using a solution of 350 Units per liter of a commercial preparation of the enzyme.

Table 1 Reduction of naringin in grapefruit by vacuum infusion with naringinase at 50^{o}C.

Naringinase (U/l)	Time (min)	Naringin (%)	Reduction (%)
0	30	1.03	-
70	30	0.95	8
175	30	0.81	21
350	30	0.51	51
70	60	0.54	48
175	60	0.35	66
350	60	0.20	81

Taste panel results using the triangle taste discrimination of difference method, described by Larmond (1967), indicated a general confirmation of the analytical results. Lower levels of the enzyme or lesser time resulted in products that were not significantly different from the untreated control samples in bitterness. A summary of their most significant flavor results is given in Table 2.

Table 2 Reduction of bitterness in grapefruit vacuum infused with naringinase solution.

Naringinase treatment (U/l)	(min)	Tasters 1	2	3	4	5	6	Sum
350	60	2	1	2	2	2	1	10
175	30	3	3	3	3	3	3	18
350	30	2	2	1	2	1	2	10
350	60	1	1	2	1	2	1	8

Samples 3 & 4 different from 1 & 2 at the 99% confidence level.

Vacuum Infusion Peeling and Sectionizing

Another major problem with fresh grapefruit that seemed amenable to application of the vacuum infusion process was the separation of the peel and individual fruit segments. While grapefruit sections in can and glass have long been a very desirable consumer product, the high cost of hand labor involved in preparing the product has become almost prohibitive in recent years. Whereas there were about 15 Florida citrus processors who produced this product about 12 years ago, now there are only two. Bruemmer et.al (1978) showed vacuum infusion could be used to alleviate the peeling/sectionizing problem in grapefruit. Using this approach the processing costs could be reduced because the 60% loss of fruit flesh and juice which accompanied the conventional cut-fruit, hand method, was virtually eliminated. Quality of the conventionally processed product is comparatively low also because of heat damage from softening peel with steam, and use of hot lye baths to finish the sections (i.e. remove adhering pieces and strings of albedo, peel, core material, etc.). These heat treatments are not required with the enzyme digestion method, thus improving product quality.

They compared 6 different types of commercially available pectinase preparations, using vacuum infusion to get the enzyme to penetrate into the interior of the fruit. As shown in the results summarized in Table 3, all 6 were effective after 30 to 45 minutes at 50 ^{o}C though two of them, B and F achieved this within 15 minutes after incubation. These preparations contained combinations of pectinesterase, cellulase, polygalacturonase (PGA) and polymethylgalacturonase (PMGA). They found effectiveness of the enzymes seemed to correlate best with content of PGA and PMGA.

Table 3 Comparison of 6 commercial pectinases for grapefruit peeling and sectionizing.[1)]

Treatment times	Pectinase brands					
	A	B	C	D	E	F
15 min	10	8	9	11	13	7
30 min	6	6	7	7	8	7
45 min	5	4	4	4	4	4

1) Criteria: peeling ease, lack of adhering albedo, ease in removing sections, appearance; Scores determined by assigning values; 1=good, 2=fair and 3=poor. Avg. sums of 4 scores for 6 fruits. Lower score = more effective.

For treating the fruit, the peel was scored in quadrants, by hand, using a sharp knife, and barely cutting through the flavedo (colored layer of the peel). The fruits were then submerged in a solution of enzyme in water, and the container placed into a heavy-walled desiccator attached to a vacuum pump. A vacuum of 71 cm (28 in.) Hg was drawn on the apparatus for about 5 min. During this time the solution foamed and bubbled as the fruit was being degassed. The vacuum was then released and the interior of the desiccator allowed to resume atmospheric pressure. During this time about 100 ml. of the enzyme solution was drawn into the fruit to replace the gases that had been removed. After removal from the solution, the fruit were placed into individual plastic bags and incubated for 30 minutes at 50 ^{o}C. They were then removed and peeled. At this point the peel fell easily away from the fruit and remaining rag and peel "strings" had been dissolved, or were easily washed away with a gentle stream of water. The segments, thus removed, were packed in plastic bags, either dry, or with juice.

Grapefruit sections prepared by pectinase treatment were dry and intact and had an excellent fresh fruit flavor. They were completely recovered as intact sections whereas those prepared by the conventional method were wet and appeared smaller due to a 30% to 40% loss of the juice vesicles remaining attached to the segment membranes. The cut sections also sustained a drip loss of over 10% after 3 days at 4.4 ^{o}C, whereas the new sections did not have this loss. The enzyme processed sections were unanimously preferred by an experienced taste panel for flavor, texture and appearance.

Some Potential Applications to Tropical Fruit

The discovery that vacuum infusion is an effective way of introducing materials into the interior or onto the surface of cut or peeled fruit suggests some other potential uses of this technique with regard to tropical fruit. The mango is one of the most widely grown fruits around the world, and yet a large portion of the crop is lost each year, due to anthracnose or other surface blemish problems. It is also a difficult fruit to peel due to its diversity of shapes and types. A simple skin-scoring enzyme diffusion process using pectinases or other enzymes might prove as effective for mangoes as for grapefruit. With mangoes, this could lessen the losses due to surface blemishes by providing a lower cost removal of the surface skin, and an easier approach to peeled mango products. This method should also be effective for removing peel from papaya, oranges, tangerines and other mandarin type oranges. Perhaps with lipases or other appropriate enzymes, it would be useful for peeling avocados.

Another potential application is the protection or preservation of color on cut surfaces of tropical fruit. Often the color fades or darkens, (usually turning brown), after fruit are cut and exposed to air, as in mangoes, papayas, peaches, apples, and bananas. The cut surfaces could be infused with substances like bisulfite or benzoate solutions to inhibit browning. With recent moves in the U.S. to disallow sulfite additives in foods however, the infusion of other antioxidant agents or browning inhibitors such as ascorbic acid (Vitamin C) might be more appropriate. The method also allows the incorporation of protective coatings such as gelatins, cellulose derivatives, etc. which are edible and relatively tasteless but form a protective layer over the cut surface. Similarly, protective coatings would retard flavor loss of volatiles and help maintain balanced flavor in delicately flavored tropical fruits, e.g. pineapples, papayas, and mangoes. Likewise, nutrients such as protein from gelatins, vitamins and minerals could be incorporated to enhance the nutritive value, or to prepare new dietary supplements.

Another possibility, already demonstrated in the studies of Bruemmer et. al (1976) is the incorporation of flavored or colored agents to change or enhance the surface color. Different juices could be colored or mixed with other juices of other colors and infused onto the surface and interior of cut fruit. For example, cut pieces of papaya could be infused with a blend of vitamin C to avoid darkening, orange juice (for flavor) and cherry juice (for color). The possibilities are only limited by the imagination and creativity.

Finally, an area where cut tropical fruits suffer as badly as any, the loss of textural quality, also affords an opportunity to apply the infusion method. Infusion of calcium citrate, chloride or other salts can help retain turgidity and crispness in cut surfaces.

The development of "mushiness" or "sogginess" in cut surfaces is a common trait observed with most fruit but is especially notable in papaya, mango, carambola, apples and peaches. Some of the coatings or other protective agents mentioned above could also be effective in this respect.

References

Bruemmer, J. H., Griffin A.W. and Onayemi, O. (1978) Sectionizing grapefruit enzyme digestion, Proc. Fla. State Hort. Soc. **91** 112-114

Larmond, E. (1967) Methods for sensory evaluation of foods, Can. Dept. Agric. Publ. #128A 15-16

Olsen, R. W. and Hill, E.C. (1964) Debittering of concentrated grapefruit juice with naringinase, Proc. Fla. State Hort. Soc. **57** 321-325

Roe, B. and Bruemmer, J.H. (1976) New grapefruit product: debitterizing albedo, Proc. Fla. State Hort. Soc. **89** 191-194

Sinclair, W. B. (1972) The Grapefruit, its composition, physiology, and products, Univ. of California, Div. Ag. Sci., 137

Ting, S. V. (1958) Enzymic hydrolysis of naringin in grapefruit, J. Agric. Fd. Chem. 6 546-549