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SMALL SCALE PROCESS FOR CANNED CITRUS SECTIONS OR FRUIT SLICES

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ABSTRACT

A vacuum infusion enzyme/chemical system developed at our laboratory provides the basis for a new process for small scale preparation of preserved citrus sections or fruit slices. After their peels were scored with knives or penetrated with needles, fruit were submerged in the desired solution and placed under temporary low vacuum. After gases within the fruit had been evacuated, the vacuum was released allowing the surrounding solution to infiltrate the fruit. After a brief period of incubation the fruit was ready for easy processing into the desired product. When commercial pectinases were used with citrus fruit, peels were easily removed and sections separated cleanly, ready for packaging with minimum hand labor. Mango slices were placed in bags with oxygen, carbon monoxide, carbon dioxide, nitrous oxide and ethylene alone and in different combinations to promote post harvest ripening. Only those stored in oxygen or ethylene developed characteristic mango flavors. Materials of lower oxygen permeability were best for storage stability. The process can be used for treating cut surfaces of many fruits for enhanced color, flavor, nutrients or storage stability.

INTRODUCTION

Our laboratory has been studying processes for preparation of table-ready prepared fruit and vegetable products using the "vacuum infiltration" method. Last year I reported at the Caribbean Food Crops Society Meeting the potential of this process for a number of different tropical fruit products including fruit slices, separated citrus segments and fruit pieces with imparted colors, flavors, or nutrients (Berry and Bruemmer, 1988). This process, as successfully applied in our laboratory on a pilot scale, offers the potential for cottage industry applications: it can be carried out with low technology, relatively simple and inexpensive equipment, and readily available supplies.

We have applied the technique of vacuum infusion (or infiltration) to the removal of peel and separation of citrus sections in grapefruit as an approach to low thermal processing. By infiltrating an enzyme, the conventional usage of hot lye to remove residual albedo from citrus sections was avoided, resulting in better flavor quality, texture and stability and less product loss (Bruemmer et. al., 1978). As indicated last year, (Berry and Bruemmer, 1988) this technique also offers a method to impart enzymes, hormones, acidulants, nutrients and bioregulators into freshly cut or prepared fruit and vegetable pieces.

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Briefly, the vacuum infusion technique consists of a first step of penetrating the outer skin of the fruit or vegetable in order to make possible the infiltration of the desired components. This is followed by placing the product in a solution of the desired components, placing the sample under a low vacuum until the plant material has been degassed, as evidenced by the cessation of bubbles. At this point the sample is allowed to return to atmospheric pressure by releasing the vacuum. This allows the surrounding solution to penetrate into the interior of the plant material where it can act to impart the desired properties, such as peel loosening, nutrient enhancement, color enhancement, etc. For example, Roe and Bruemmer (1976) showed how grapefruit bitterness could be reduced by vacuum infusion of naringinase solution, through removal of the bitter principal, naringin.

METHODS AND MATERIALS

Removing peel and separating grapefruit sections

The process was further exploited, as reported here in 1987, for the removal of grapefruit peel and separation of fruit segments. That work has been carried further and will be described to help explain the technique and its advantages. First the fruit are scored by using a sharp knife and cutting gently through the flavedo (outer colored layer). This can also be achieved by passing the fruit over rollers with long, sharp needles or points on them or other circular sharp edges. About 12 to 24 grapefruit were treated at a time in our pilot studies. The fruit were placed in a plastic dishpan, obtainable at hardware and variety stores. An enzyme solution (commercial pectinase in water) was then poured over the fruit in sufficient quantity to barely cover the fruit. The pan of fruit was then placed in a small cabinet type vacuum oven which had a small vacuum pump attached, and a glass door through which the product could be observed. The door was sealed, the pump turned on and vacuum applied until bubbling (from the fruit being degassed) subsided. The vacuum was then released through an inlet valve by allowing air to enter the vacuum chamber. This allowed the surrounding pectinase solution to be drawn into the evacuated inner spaces within the fruit, especially the albedo because of its soft spongy texture. The sample was then kept in the oven at atmospheric pressure for about 15 to 45 minutes at about 100 to 150°F (37° to 47°C) to enable the pectinase to be most effective. Since a primary binding component of the albedo is pectin and the albedo is the principal material holding the flavedo or outer skin onto the fruit, the action of the enzyme caused the peel to be greatly loosened and segments to be separated easily. Thus after this treatment, the skin came off the fruit with little or no effort and the segments separated very cleanly.

We tested several types of commercially available enzymes for effectiveness, and some of the most effective, for information, are listed in Table 1, with an indication of their relative effectiveness in removing peel aud separating grapefruit sections. Samples were graded on a scale of 1 to 4 by three independent invertigators, for 1) ease of peel removal, 2) lack of adhering albedo, 3) ease in separating and removing fruit segments, and 4) general appearance. 1 = poor, 2 = fair, 3 = good, and 4 = excellent. Values shown are average judgements by three testers.

When the enzymes were assayed for individual specific enzyme activities, we fouud nearly all of them exhibited not only pectinase activity (as measnred by lowering of viscosity of standard pectin solutions under standard conditions) but also exhibited activities for polygalacturonase, pectinesterase and cellulase (as measured by standard methods). Relative amounts of these enzyme activities in the commercial pectinases tested, are shown in Table 2.

From these values it is apparent that the two most effective commercial pectinase preparations were relatively higher in polygalacturonase activities than any of the others tested. Other subsequent results in our studies have tended to verify this observation.

Citrus sections prepared in this manner can be canned, bottled or sealed in plastic bags in a relatively "dry" pack. They can be heat treated after packaging, to about 160°F (52°C) or they can be "cold-packed" using a chemical sterilant such as a dip or vacuum infusion in 0.3% potassium sorbate, and/or 0.2% sodium benzoate or 1% sodium hypochlorite, followed by a rinse in sterilled water. All three treatments prevented growth of microbial colonies up to 18 weeks at 35°F (2°C).

Ripening and storage of mango slices

Mangos also afford an opportunity for a potentially desirable consumer product. They are difficult to prepare in the home because of their unusual and irregular shapes, clinging peel and large, fibrous clinging seed. We conducted studies to determine whether the appearance and flavor of mango slices could be preserved in storage. We also studied the prospects of preparing slightly underripe slices and enhancing the continuation of ripening during storage and transportation to market so that the product would reach the market place in an optimum stage of ripeness.

Mature size green mangos or those that were partially ripened (yellow or yellow orange) were peeled by hand and slices of about one-third of a fruit each were used for tests. They were placed in plastic bags of either oxygen permeable or oxygen impermeable material, and flushed with one of the gases or gaseous mixtures shown in Table 3 below. They were flushed in the desired gas atmosphere then sealed in the gas aud stored at 80°F (27°C) until their general appearance, color, sheen and softness indicated they were ripe. Time required to ripen the experimental samples in the various atmospheres varied depending on the initial stage and degree of ripeness, but as indicated in Table 3, all samples improved in Brix-Acid ratio and color after 14 to 21 days of storage. Samples flushed and stored in CO or O_2 required less time to reach the orange color stage of ripeness and those stored in CO, C_2H_4 or CO_2 were among the greatest increases in solids/acid ratio. Those stored in oxygen however exhibited some browning of the flesh and showed the slightest increases in solids/acid ratio.

In storage experiments using similar gaseous atmospheres we found that 6 to 8 weeks storage at 35°F (2°C) resulted in bland flavor and little color change except for those samples stored iu nitrous oxide, all of which developed undesirable off-flavors. Only those stored in oxygen or ethylene developed characteristic mango flavors. Also noue of the mango slices stored in low oxygen transmissibility bags developed desirable mango flavor while all samples which developed desirable flavors, in auy atmosphere, were packaged in bags made of high oxygen transmissibility plastics.

Thus we concluded thar ripening of mango slices prepared for this type of product is affected by the initial stage of maturity of the fruit. With packaging in the right atmospheres, slightly mature fruit could be satisfactorily ripened better than completely green fruit which didn't change much in any atmosphere. Carbon dioxide, monoxide or ethylene were the best atmospheres for promoting ripening in the package. High oxygen trausmission materials are recommended for packaging during transport and marketing of these products. Oxygen or ethylene appear the most promising atmospheres for promoting development of mango flavor during marketing. Perhaps a combination of these gases would be even more advantageous. This possibility has yet to be tested.

Table 1. Ratings of pectinases for grapefruit peeling and sectioning.

Enzyme	Peeling	Sectioning
SPARK L HPG	4.0	4.0
PECTINEX 3XL	3.8	3.8
EXTRACT L5X	4.0	2.8
CLAREX L	3.8	3.4
ROHAPEC C	3.0	3.0
ULTRA SPL	3.0	2.5
ROHAPECT B1L	2.5	3.0
PEC. 10000	1.8	2.0

Table 2. Relative enzyme activities of several commercial pectinases.

Enzyme	PECT	PGA	PEU	CELL
SPARK L HPG	154	1165	82.9	-
PECTINEX 3XL	287	1418	40.5	58
EXTRACT L5X	46	39	38.6	20
CLAREX L	193	23	10.1	15
ROHAPECT C	30	12	312.3	13
ULTRA SPL	205	218	22.2	80
ROHAPECT B1L	98	151	6.1	47
PEC. 10000	-	-	-	29

PEC = Pectinase, PGA = Polygalacturonase, PEU = Pectinesterase, CELL = Cellulase.

Table 3. Ripening mango slices in oxygen barrier bags.

Atmosphere	Before		After	
	Color	Brix/Acid	Color	Brix/Acid
CO_2	Y-O	14.8	L-O	24.2
2.5%CO_2 + 2.5%O_2	Y	12.0	D-O	20.0
5%CO_2 + 2.5%O_2	Y-O	14.5	D-O	22.7
CO	L-O	18.8	D-O	24.7
N_2O	Y-O	16.1	L-O	20.7
O_2	Y-O	11.3	D-O	15.7
C^2H_4	Y-O	10.6	D-O	24.6

L = light, D = dark, Y = yellow, O = orange

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