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INVESTIGATIONS OF FACTORS TO IMPROVE TEXTURE AND COLOR OF FREEZE-DEHYDRATED AND SUBSEQUENTLY COMPRESSED RED TART PITTED CHERRIES

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Utah State University

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Freeze-dehydrated and compressed red tart pitted cherries, cultivar Montmorency, were stored at 21C and 38C for 12 and 6 months. Quality evaluations on color, firmness, acidity, alcohol extractable color substances, and ascorbic acid showed a greater degradation of overall quality at 38C than 21C as storage time was increased. Sensory evaluations were made on rehydrated cherries prepared as pies. Sulfited cherries retained better color but the high temperature (38C) seemed to offset the sulfiting effects. Calcium chloride treatment showed some firming effects. Lesser compression pressure (690×10^3 Pascal) gave better

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Storage			6		6	
Sulfiting			6		6	
Calcium Chlorides					6	
Color					7	
Stability					7	
Acidity					7	
Ascorbic Acid					7	
Quality					7	
Texture					7	

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texture after rehydration. Red food color incorporation to the freeze dehydrated RTP cherries improved the color; however, this was not successful on samples that had turned brown after storage at 38C.

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TECHNICAL REPORT
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INVESTIGATIONS OF FACTORS TO IMPROVE TEXTURE AND COLOR OF FREEZE-DEHYDRATED AND SUBSEQUENTLY COMPRESSED RED TART PITTED CHERRIES

by

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FOREWORD

Red tart cherries possess attractive red color and pleasant flavor and texture. They are, however, highly perishable. Most of the red tart cherries presently processed are canned or frozen. Armed forces consume a large quantity of red tart cherries in various forms of prepared products. Mobility is a very important factor for today's armed forces and the same with their food supplies. Food products that are light, compact, storage durable, and retain original characteristic flavor, color, and texture are constantly being sought. Studies on freeze dehydrated and compressed RTP cherries are therefore initiated in order to determine the product qualities.

This investigation was performed at the Utah State University, under Contract No. DAAG17-72-C-0187 during the period from June 1972 to June 1974, with funds provided under Project No. 1T762713A034, titled: Military Food Service and Subsistence Technology. Dr. D. K. Salunkhe served as the Principal Investigator. Dr. Abdul R. Rahman and Mr. Glenn Schafer served as Project Officer and Alternate Project Officer, respectively, for the U.S. Army Natick Laboratories.

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FREEZE DEHYDRATED AND COMPRESSED RED TART PITTED CHERRIES

INTRODUCTION

A total production of 140,000 tons of red tart cherries contributed nearly 30 million dollars to the economy of the United States in 1971 (USDA, 1972). Most of these cherries presently processed are canned or frozen. Preservation of attractive, fresh, red tart cherries beyond their normally short shelf-life by means other than canning and freezing should create additional utilization and marketability. High quality, low moisture, dehydrated red tart pitted (RTP) cherry products, reduced in weight and volume, that could be restored to their original characteristics by rehydration seem to be highly desirable and economically feasible.

Freeze-dehydration has been recognized in recent years as a significant breakthrough in dehydrating high moisture foods. This process retains many of the fresh food flavor components and significantly decreases the time required to reconstitute or add moisture to the dried foods. The main advantage of freeze-dehydration is that more than 95 percent of the moisture of a given frozen food can be removed by sublimation under vacuum and low temperature without inducing appreciable changes in its form, size and constituents. Thus, the product retains much of its original color, texture, and nutritive value. The resulting porous, sponge-like, dried substance reabsorbs water rapidly when being prepared for consumption. Nevertheless, freeze-dried products have the disadvantages of being brittle and susceptible to browning.

Because freeze-dried products retain their original size, the space saving advantage of conventional dehydration is lost. However, freeze-dried products can be compressed to reduce the bulkiness, and packaging costs are thereby lowered as the need for packaging materials is decreased. Compression can also alleviate the problems of brittleness and friableness during transportation.

In this paper, the process of freeze dehydration of RTP cherries has been utilized and the product qualities are examined as a way to increase their utilization, such as in pies, in confectionary, in mixing with cereal, and in bakery products.

MATERIALS AND METHODS

Processing

Preparation of fruits. Red tart cherries (*Prunus cerasus*), cultivar Montmorency, were mechanically harvested from a commercial orchard in Payson, Utah. They were immediately brought to the processing plant in water tanks where they were soaked in cold water (11.1C) for 4 to 8 hours to firm the texture. Cherries were selected by visual investigation for their uniformity of red color and freedom from bruises and scald. Fruits less than 9/16 inch in diameter were removed with a sizing screen. All pedicels were removed from the remaining cherries which were further chilled in a Freon-cooled water bath at 0C for 1 1/2 minutes and washed by water spray. Pits were removed with an automatic pitting machine.

Chemical treatments. Pitted cherries were treated with selected chemicals. Prior to freezing, the pitted cherries were dipped briefly in solutions of sodium bisulfite, sucrose, ascorbic acid, or calcium chloride. The concentration of solution used was 0.1% with pH adjusted to 3.5, except for calcium chloride which was 1%. The cherries, 5 pounds per batch, were dipped in 10 liters of one of the solutions for 3 minutes. Control samples were similarly treated with plain water.

Individual quick freezing. After the chemical treatments, single layers of pitted cherries were placed on stainless steel trays and blast frozen by cold air at -14C in 4 hours.

Freeze-dehydration. The individual quick-frozen cherries were freeze-dried in a freeze drying unit (Hull Corporation Model 651-F5, Hatboro, Pa.). A chamber pressure of less than 1 mm Hg (133.32 Pa) and a platen temperature of 57C were maintained for 14 hours to obtain a final product with a moisture content of 2% or less.

Conditioning. Freeze-dehydrated cherries are very brittle because of their low moisture content and will fragment when compressed, so the product must be conditioned before being compressed into a cohesive cake. One lot of cherries that had not been treated with a chemical was given a uniform spraying of 0.1% sodium bisulfite solution. However, their moisture content was kept under 3%. The sprayed and previously dipped cherries were then heated for 1 minute at 93C under an infrared lamp, which made them thermoplastic.

Compression. One hundred grams of conditioned, warm cherries were immediately placed in a cylindrical mold under a hydraulic press and compressed by applying a pressure of 690×10^3 to 2760×10^3 Pascal (100 to 400 Psi) for 0 to 10 seconds to form a disc of 8.2 cm (3 1/4 inches) in diameter and about 1.3 cm (1/2-inch) thick.

Packaging and storage. Three discs of compressed cherries per can were packed in No. 2 1/2 size tin cans with packages of desiccant (Calcium oxide) and sealed under a vacuum of 50.8 cm (20-inch) Hg and stored at 21 and 38C for 6 to 12 months for product stability studies.

Sensory evaluation. Rehydrated freeze-dried sour cherries in the form of pies and pie fillings were evaluated as to flavor, texture, and appearance by a trained taste panel consisting of 16 judges. A 9-point scale was employed in the sensory rating.

Quality evaluations

Rehydration. For evaluation, the freeze-dehydrated, compressed cherries (100 gm) were rehydrated by being placed in 300 ml of boiling distilled water in a 1 liter beaker for 3 minutes. They were then held for 30 more minutes at 49C. The cherries were kept submerged under the rehydration water throughout the process by using a smaller size beaker as a weight. After rehydration they were drained for 3 minutes to separate the unabsorbed water.

Cherry pie preparation. The cherry pies were baked uniformly in a rectangular aluminum pan-rack unit consisting of six 10.8 by 21.6 by 2.5 cm (4 1/4 by 8 1/2 by 1-inch) pans in an electric oven at 218C for 25 minutes followed by 177C for 20 minutes. All cherry pie fillings and crusts were based on the same recipes. One disc of freeze dehydrated and compressed RTP cherries (100 gm) were rehydrated and used in making a rectangular pie. Sucrose (52 gm), corn starch (4 gm), salt (3.2 gm), and water (155 ml) constituted the rest of the pie filling. The pie crust ingredients consisted of 61.5 gm all purpose flour, 2.5 gm salt, 11.5 gm shortening, and 67. 5 ml water.

Objective evaluation

Shear-press. Texture of the rehydrated fruit was measured by using a shear-press, and is reported in pounds of firmness.

Color. The color values of the rehydrated cherries were measured with a Hunter Color and Color-Difference Meter. An NBS color standard plate with Rd = 7.3, a = +61.5, and b = 20.6 was used for standardizing the meter.

pH and acidity. The pH of homogenous rehydrated fruit was read on a Beckman Model Expandomatic SS-J pH meter. The same sample was titrated with 0.1 N sodium hydroxide solution to pH of 8.1 and the acidity was calculated as percent malic acid.

Alcohol extractable color substances. Alcohol extractable color substances of the rehydrated cherries were determined photometrically and are expressed as absorbance at 525 nm (Nury et al., 1960).

Ascorbic acid. The ascorbic acid content of the homogenized rehydrated cherries was determined photometrically by using the method of Ruck (1963).

Moisture. The moisture of the freeze-dehydrated cherries was determined by using the method of the AOAC (1960).

Statistical analysis. The data were analyzed by analysis of variance wherever applicable.

RESULTS AND DISCUSSION

Sensory evaluation

The results of sensory evaluation of rehydrated samples by the trained panel indicated a decline in the overall quality as storage duration was extended (Tables 3 and 4). Flavor texture, and appearance of the products were acceptable after 6 months storage at 31C but appearance was unacceptable after 4 months storage at 38C. It was found that degradations of flavor, texture, and appearance were greater at 38C than at 21 C. The sulfiting treatment reduced such degradation.

Flavor. Significant differences occurred in flavor at different storage periods and temperatures (Tables 3 and 4). At 0 and 2 months storage, the judges gave the sulfited samples lower scores than the control samples because the sulfite treatment caused slight bitterness in the product. After 4 months storage at 21 C, the flavor was judged equal in control and sulfited samples. At 6 months, both were still acceptable. After 12 months the flavor of the sulfited sample was judged better than that of the control sample, which had become off-flavored. At 38C, both control and sulfited samples at 4 months exhibited a caramelized honey flavor.

Texture. The rehydrated cherries possessed a firm and plump texture. The degradation of texture in sulfite-treated and untreated samples after storage at 21C and 38C for 12 and 6 months was less dramatic than the color changes (Table 3 & 4). At the end of 12 months at 21C, the texture of both control and sulfited samples was rated slightly better than those at 38C for 6 months and were acceptable.

Appearance. Distinct changes were noticed in the color of stored samples. The freshly freeze dehydrated and rehydrated cherries retained an attractive red color with good shape. After storage at 38C for 2 months, anthocyanin degradation was apparent in unsulfited samples, which turned slightly brown. By the end of 4 months storage, both unsulfited and sulfited samples showed progressive browning and were not acceptable. Samples stored at 21C showed a slower rate of anthocyanin degradation. After 6 months storage, these samples could still be reconstituted to their original red color and shape, with the sulfited samples slightly superior to the unsulfited samples. The sulfited samples were slightly brown after 12 months, but were considered acceptable.

Objective evaluation

Color. Higher temperatures and longer storage duration accelerated the rate of browning and other degradation. The darkening of the red color of the samples was reflected in the decrease of Hunter "Rd" values as the storage time advanced (Table 1). Decreases in Hunter "a" values were slower at 21C than at 38C. This loss of red color coincided with the increased absorbance of alcohol extractable color substances, which consist of anthocyanin and its degradative products, at both storage temperatures for sulfited and unsulfited samples. A similar trend was observed in the decrease of Hunter "b" values at the higher storage temperature. The degradation of anthocyanin in freeze dehydrated, compressed cherries was more obvious at the higher storage temperature in this study. This is in agreement with the findings of Decareau et al. (1956) and Adams (1973).

Texture. The texture of freeze dehydrated cherries after rehydration was less firm than that of fresh fruit. Some physiological breakdown of the tissues may have taken place during the process of freezing, freeze-dehydration, and compression. The firmness of all samples decreased with time as measuredby shear-press (Table 1). The sulfited samples at 38C storage showed the least decrease in firmness, while the sulfited samples stored at 21C showed the largest decrease of firmness.

Acidity and pH. The pH values of all freeze-dried cherries ranged from 3.56 to 3.74 during storage at the two temperatures (Table 2). Total acidity increased more slowly in samples stored at 38C than those at 21C. Sulfited samples stored at 21C and 38C showed more acidity gains than did control samples after 12 and 6 months.

Ascorbic acid and alcohol extractable color substance. The ascorbic acid content progressively decreased as storage time increased. Ascorbic acid will be lost at storage temperatures over 27C even in the absence of air. The loss of ascorbic acid in sulfite-treated samples was less than in the control samples. Sulfite can protect ascorbic acid from oxidation during heat treatments (Mapson, 1970). The degradation trend of anthocyanin pigments paralleled the ascorbic acid loss. These findings agree with those of Charley (1970), who reported that the oxidation of ascorbic acid accelerated the degradation of anthocyanins. After 6 months storage at 38C, the control sample had lost all its ascorbic acid (Table 2), and the anthocyanins had deteriorated into reddish-brown substances. The browning reaction has been prevented more effectively when ascorbic acid and sulfur dioxide are both available in the product (Schroeter, 1966). However, sulfited samples stored at 38C showed more degradation of anthocyanins than did the control samples at 21C, even though more ascorbic acid was retained. Therefore, the high temperature induced more degradation of anthocyanins than the combined effect of ascorbic acid and sulfur dioxide could minimize. According to Adams (1973), glycosidic hydrolysis of the anthocyanin was the main cause of red color loss.

Individual quick freezing. If no Individual Quick Freezer is available, the simulation of individual quick frozen cherries of competitive quality could be done relatively simply and also economically with the use of Cold Air Blast Freezers or Deep Freezing Storage Rooms. By spreading a single layer of fruit on stainless steel trays with a bottom of wire mesh and placing them in the Blast Freezer or Deep Freezing Room under -36C to - 14C, the cherries could be frozen solid like marble within a few hours. They are then easily scraped off the tray and separate nicely into individual fruits. It is important to have just a single layer of cherries on the tray, otherwise a frozen mass of fruit will result which is extremely difficult to separate into individual frozen cherries.

Effects of chemical treatment on color. Protective actions on color of the freeze dehydrated cherries were observed with ascorbic acid, sugar, and sulfite treatment. Their effectiveness, as seen from the decrease in Hunter "a" values with increase in storage duration (Table 5), is in the order of sulfite, sugar, and then ascorbic acid.

Effects of calcium chloride treatment. A calcium chloride treatment of the cherries prior to freeze dehydration increased the firmness of the rehydrated cherries (Table 6). The effect was not striking at the concentration of calcium chloride solution (1%) employed in the study.

Effects of compression pressure on texture. The compression pressure of 2760 x 10^3 Pa (400 psi) without dwelling time yielded a tight disc of freeze-dehydrated RTP cherries. With 690 x 10^3 Pa (100 psi) compression, the cherry discs obtained were thicker and not as tight as the 2760 x 10^3 Pa (400 psi) compressed ones (Fig. 1). Consequently, they separated into individual cherries in less time when rehydrated in boiling water--9 minutes against 12 minutes. The 690 x 10^3 Pa (100 psi) cherries were also firmer in texture as judged by the panel members. Shear-press values of the rehydrated cherries compressed with different magnitudes of force are presented in Table 7.

Rectangular cherry pie. In evaluating the quality of rehydrated compressed freeze-dehydrated RTP cherries prepared as pies, a rectangular aluminum pie pan and rack unit was used in baking. When a rectangular-shaped pie is cut up for evaluation it has advantages over the conventional round-shaped ones of the same size, because each piece contains more of the whole cherries than would a wedge-shaped piece from a round pie.

Food color incorporation. An attempt to enrich the red color of the freeze-dehydrated RTP cherries was carried out by dipping in 1/10 strength of Red Food Color solution (manufactured by McCormick & Co., Inc.) for 1 sec. and drying in a chamber under 0.6 mm vacuum for 3 hours. The product appeared to have a more intense and uniform red color than the untreated ones. This technique, however, did not improve the redness of freeze-dehydrated cherries stored at 38C, which turned brown.

SUMMARY AND CONCLUSIONS

RTP cherries, cultivar Montmorency, were freeze-dehydrated, vacuum packaged, and stored at 21C and 38C for 12 and 6 months, respectively. Every 2 months the samples were analyzed for color, firmness, acidity, alcohol extractable color substances, and ascorbic acid. Subjective evaluations were made of texture, flavor, and appearance of the rehydrated cherries prepared as pies.

Sensory evaluations indicated that samples stored at 21C retained a good quality after 12 months storage, and that sulfited samples were more acceptable than the others. At 38C storage temperature, both the sulfited and control samples showed lower quality than those stored at 21C, and were unacceptable in flavor and appearance after 6 months storage. The appearance was significantly affected after 2 months storage at 38C.

Overall quality declined as storage duration increased--with degradation greater at 38C than at 21C. The sulfite conditioning treatment reduced the degradation of quality.

When rehydrated, the freeze-dehydrated products reabsorbed only about one-fifth the moisture content of the fresh fruits. This may be due to the physiological breakdown of the tissues during freezing, freeze-dehydration, and compression.

Color values measured by the Hunter Color and Color-Difference Meter showed progressive degradation of pigments occurred during storage. The sulfited samples of freeze-dehydrated cherries, when stored at 21C, had the best retention of color. Unsulfited control samples stored at 38C retained the least red pigment. The results indicated that the sulfiting enhanced the retention of color, but the 38C temperature more than offset the sulfiting effects.

The firmness as measured by shear press values indicated a decline during storage. The sulfited samples stored at 38C showed the least decrease in firmness and the sulfited samples stored at 21C showed the most decrease in firmness. Sulfiting did not minimize the degradation of texture. Duration of storage was the determining factor in degree of degradation of firmness.

Acidity of the freeze-dehydrated cherries stored at 21C was greater than in those stored at 38C. Sulfiting did affect the acidity increment in freeze-dehydrated cherries.

Anthocyanins underwent very slow degradation at 21C, with the best retention of anthocyanins being in the sulfited samples of that temperature. Anthocyanins showed a very fast degradation in samples at 38C, and the unsulfited control samples had the most degradation. Sulfiting thus inhibited degradation of anthocyanins, and 21C storage temperature favored retention of anthocyanins. The degradation of ascorbic acid was inhibited by the sulfite treatment and the 21C storage temperature enhanced the effect of sulfiting in retention of ascorbic acid.

Table 1. Effect on physical characteristics of freeze-dehydrated RTP cherries after storage at 21C and 38C

		Control				Sulfite			
Temperature (C)	Storage time (months)	Reflectance (Rd)	Redness (a)	Yellowness (b)	Shear values lb/sq in/50 g	Reflectance (Rd)	Redness (a)	Yellowness (b)	Shear values lb/sq in/50 g
21	0	3.8	30.2	12.0	120.0	4.7	31.4	12.2	136.7
	2	3.6	28.4	10.8	118.6	4.3	31.0	11.5	115.0
	4	3.5	24.8	10.4	73.3	3.8	28.0	10.9	68.0
	6	3.5	20.0	10.0	60.0	3.6	24.0	10.4	53.0
	8	3.5	19.8	9.8	56.5	3.6	21.8	10.0	51.0
	10	3.4	18.5	9.4	51.0	3.5	19.0	9.6	48.2
	12	3.4	15.4	9.0	50.1	3.5	18.3	9.3	45.5
38	0	3.8	30.2	12.0	120.0	4.7	31.2	12.2	136.7
	2	3.2	16.4	10.4	112.0	4.2	19.6	11.4	126.3
	4	3.0	11.0	10.0	70.0	3.4	13.0	10.4	98.0
	6	2.3	8.0	8.8	66.0	2.5	9.6	9.4	90.0
LSD:									
at 0.05 level		0.2	0.7	0.4	7.0	0.2	0.7	0.4	7.0
at 0.01 level		0.3	1.0	0.5	9.4	0.3	1.0	0.5	9.4

Table 2. Effect on chemical characteristics of freeze-dehydrated RTP cherries after storage at 21C and 38C

Temperature (C)	Storage time (months)	Control: Alcohol extractable color substances (absorbance)	Control: Ascorbic acid (mg/100 g)	Control: Acidity as % malic acid	Control: pH	Sulfite: Alcohol extractable color substances (absorbance)	Sulfite: Ascorbic acid (mg/100 g)	Sulfite: Acidity as % malic acid	Sulfite: pH
21	0	0.62	0.89	2.81	3.58	0.56	0.89	2.82	3.62
	2	0.62	0.46	2.96	3.56	0.60	0.60	3.00	3.57
	4	0.62	0.30	3.06	3.59	0.61	0.50	3.14	3.63
	6	0.65	0.09	3.08	3.65	0.63	0.43	3.24	3.64
	8	0.65	0.00	3.10	3.60	0.62	0.31	3.19	3.64
	10	0.67	0.00	3.16	3.58	0.62	0.24	3.24	3.51
	12	0.67	0.00	3.14	3.58	0.64	0.10	3.29	3.60
38	0	0.62	0.89	2.81	3.58	0.56	0.89	2.82	3.62
	2	0.63	0.44	2.83	3.63	0.61	0.54	2.84	3.65
	4	0.72	0.24	2.85	3.69	0.74	0.37	2.86	3.74
	6	1.10	0.00	2.89	3.65	0.84	0.30	2.87	3.66
LSD:									
at 0.05 level		0.01	0.05	0.03	0.06	0.01	0.05	0.03	0.06
at 0.01 level		0.06	0.07	0.04	0.08	0.06	0.07	0.04	0.08

Table 3. Effect on quality acceptance scores of freeze-dehydrated RTP cherries after storage at 21C and 38C prepared as pies

Temperature (C)	Storage time (months)	Control			Sulfite			Remarks					
								Control			Sulfite		
		Flavor	Texture	Appearance	Flavor	Texture	Appearance	Flavor	Texture	Appearance	Flavor	Texture	Appearance
21	0	7.2	6.7	6.7	7.1	6.3	6.8	Sour	Firm	Good shape, good color	Sour, sl. bitter	Firm	Good shape, good color
	2	6.8	6.3	6.4	6.4	6.2	6.4	Sour	Firm	Good shape, good color	Sour	Firm	Good shape, good color
	4	6.1	6.3	5.9	6.1	6.4	6.2	Sour	Little soft	Good shape, sl. brown	Sour	Little soft, plump	Good shape, good color
	6	5.6	6.4	5.5	6.1	6.0	6.0	Sour, sl. off flavor	Soft	Good shape, sl. brown	Sour	Soft, plump	Good shape, sl. brown
	8	5.4	5.9	5.5	6.1	6.0	6.0	Sour	Soft	Good Shape, sl. brown	Sour	Soft	Good shape, sl. brown
	10	5.0	5.7	5.2	6.0	5.8	5.9	Sour, sl. off flavor	Soft	Good shape, brown	Sour	Soft	Good shape, sl. brown
	12	4.5	5.7	5.0	6.0	5.8	5.9	Sour, off flavor	Soft	Good shape, brown	Sour, sl. off flavor	Soft	Good shape, sl. brown
38	0	7.0	6.5	7.1	6.8	6.3	7.1	Sour	Firm	Good shape, good color	Sour	Firm	Good shape, good color
	2	6.6	6.7	4.4	6.3	6.0	4.5	Sour	Little soft	Good shape, sl. brown	Sour	Tough	Good shape, sl. brown
	4	4.8	5.8	3.4	5.0	5.9	3.6	Sour, off flavor	Soft	Good shape, brown	Sour, off flavor	Little soft	Good shape, sl. brown
	5	3.8	5.6	2.7	4.4	5.5	3.2	Sour, off flavor	Soft, plump	Good shape, very brown	Sour, off flavor	Little soft	Good shape, brown
LSD:													
at 0.05 level		0.5	0.3	0.6	0.5	0.3	0.6						
at 0.01 level		0.6	0.4	0.9	0.6	0.4	0.9						

Table 4. Effect on quality acceptance scores of rehydrated RTP cherries after storage at 21C and 38C

Temperature (C)	Storage time (months)	Control			Sulfite		
		Flavor	Texture	Appearance	Flavor	Texture	Appearance
21	0	7.5	7.0	6.9	7.2	6.8	6.9
	2	7.0	6.4	6.5	6.7	6.5	6.6
	4	6.2	6.4	6.0	6.3	6.5	5.3
	6	5.7	6.5	5.8	6.2	6.1	6.2
	8	5.5	6.2	5.6	6.2	6.1	6.2
	10	5.0	6.0	5.3	6.0	5.9	6.1
	12	4.7	6.1	5.1	6.0	5.9	6.1
38	0	7.1	6.7	7.1	6 9	6.5	7.2
	2	6.8	6.6	4.5	6.5	6.1	4.7
	4	4.9	6.0	3.6	5.0	6.0	3.8
	6	3.8	5.8	3.0	4.5	6.0	3.2
LSD:							
at 0.05 level		0.4	0.1	0.6	0.4	0.1	0.6
at 0.01 level		0.5	0.2	0.8	0.5	0.2	0.8

Table 5. Effects of sugar, ascorbic acid, and sulfite on color retention of freeze-dehydrated RTP cherries as measured by Hunter "a" values

Storage months	Control	Ascorbic acid	Sugar	Sulfite
0	27.2	27.2	27.2	27.0
2	25.6	26.6	26.8	26.4
4	20.2	21.6	24.5	25.0
6	16.1	19.0	21.3	21.5
8	15.0	18.4	20.1	20.[illegible]
10	14.2	16.3	17.9	18.4
12	13.0	14.0	16.2	17.0

LSD at 0.05 level: 0.5

Table 6. Effects of calcium chloride treatment on texture of rehydrated cherries expressed in shear press values (x 6.89 x 10^3 Pascal)

Storage (months)	Control	$CaCl_2$ treated
0	772.8	828.0
2	772.8	834.9
4	765.9	821.1
6	752.1	793.5
8	731.4	793.5
10	724.5	759.0
12	696.9	765.9

LSD at 0.05 level: 1.9

Table 7. Effects of compression pressure on texture of rehydrated cherries expressed in shear press values (x 10^3 Pascal)

Compression pressure	Shear press	Remarks by taste panel
690	834.9	Firmer
1380	800.4	Firm
2070	786.6	Soft
2760	738.3	Slightly mushy

LSD at 0.05 level: 2.7

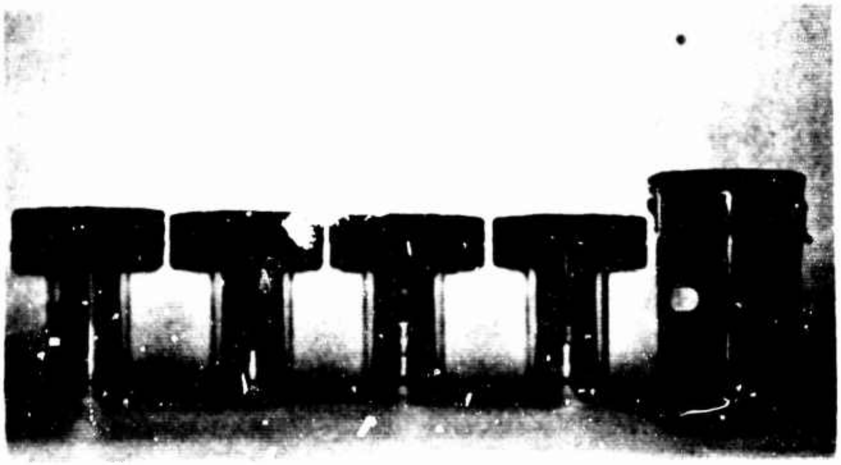

Figure 1. Freeze-dehydrated RTP cherries, before and after compression. 1 = 690 x 10^3, 2 = 1380 x 10^3, 3 = 2070 x 10^3, 4 = 2760 x 10^3 Pascal. (1 = 100, 2 = 200, 3 = 300, 4 = 400 psi respectively)

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