A REVIEW OF CURRENT RESEARCH ON DRIED FRUITS AND TREE NUTS AT WESTERN REGIONAL RESEARCH LABORATORY

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PRUNES

For many years dried fruits have been marketed at low moisture levels. However, the trend in recent years has been toward higher moisture content, making the fruits more appealing in texture and flavor. As the moisture content of dried fruits is increased they become more susceptible to microbial spoilage; consequently, they must be subjected to some type of treatment to prevent this type of growth.

An effective treatment for prunes with moisture as high as 35% has been described by Nury et al. (3) and by Balatsouras and Polymenacos (1), in which the prunes were dipped in potassium sorbate solutions. McBean and Pitt (2) have described the use of heat for killing microbial spores in packaged dried fruit. However, all of the studies to date have dealt with prunes at 35% or less moisture. If the present trend continues for marketing dried fruits at high moisture contents, it would be worthwhile to know how effective some of the antimicrobial agents are at moisture levels well above 35%. The present study was undertaken to ascertain the protection provided by various concentrations of potassium sorbate and diethylpyrocarbonate, as well as heat, on prunes packed at various high moisture levels.

Materials and Methods

Fresh French prunes obtained from the Colusa area of California were mixed well and divided into four lots. These lots were put into a dehydrator set at 165°F and dried to 69%, 57%, 43% and 34% moisture respectively. After drying, each lot then was divided into seven sublots each containing 1-1/4 pounds of prunes. Four of the sublots were dipped in potassium sorbate solutions (0.5, 2.0, 5.0, and 10%) for 1 minute. All the prunes were then spread on stainless steel trays and sprayed with a water suspension of *Aspergillus glaucus* and *Saccharomyces rouxii*, the predominant mold and yeast spoilage organisms of prunes. The inoculated prunes next were put into pouches made of Rilsan's Nylon 11, each pouch containing 7 oz. of prunes. All bags were sealed except for one sublot of three bags in each of the groups. Diethylpyrocarbonate (DEPC) was added to these bags, 0.01 ml. to two bags and 0.10 ml. to one bag, after which the bags were quickly sealed. Of the two remaining sublots, one was kept as a control and the other was heat treated by putting each of the three sealed bags between five infrared bulbs for 10 minutes. All the packaged prunes were stored in a cabinet at 79°F and 80% relative humidity.

The samples were removed periodically for examination - mold growth was determined visually. Yeast fermentation was detected by measuring the change in bag volume by displacement in water. Moisture was determined by modification of the AOAC method where the sample was heated at 140°F for 30 hours.

With 34% moisture prunes, (figure 1), complete protection was realized with the 2%, 5%, and 10% potassium sorbate dips, infrared heating, and the 550 ppm DEPC treatment. Even the low concentration of 50 ppm DEPC protected the prunes for about a month. The prunes which lasted throughout 90 days of storage had a good flavor, odor, and appearance. The skin was slightly dark, but not brown, and the flesh was bright yellow.

At 43% moisture, (figure 2), complete preservation was provided by the 5% and 10% potassium sorbate dips and by infrared heating. At this moisture level the 550 ppm DEPC offered some protection, indicating that possibly complete preservation could be obtained by adding an increased amount of DEPC. The prunes which lasted through this study had good flavor and aroma.

The 57% moisture prunes, (figure 3), had all spoiled because of yeast and mold growth by the 90th day except those heated by infrared lamps. However, the storage life of those samples treated with potassium sorbate was extended in direct proportion to the increasing concentration of the dipping solutions. The 0.5% and 2% dipped prunes lasted only a few days, but the 5% dipped samples didn't start to spoil until after 20 days and the 10% dipped ones after 40-50 days. The 10% potassium sorbate dipped prunes never did have any mold growth present and showed only slight fermentation. Visually the infrared heated prunes at the end of the study were brownish, but they didn't have an unpleasant odor. The characteristic prune flavor was lacking, but also there wasn't any objectionable off-flavor.

All of the 69% moisture prunes had noticeable yeast growth by the third day, except for the sample which had been heat treated. These heat-treated prunes remained sound throughout the entire storage period even though their skin did turn to a chocolate brown color and an objectionable odor developed. Their texture was firm, but there was a small amount of juice in the bag.

These studies point out the effectiveness of different concentrations of potassium sorbate in preventing microbial growth on dried prunes of various moisture levels. It should be pointed out that if the prunes were heavily contaminated, they would probably require a stronger treatment. However, prunes are usually packaged almost immediately after being processed in boiling water, so, by the time they have been sealed in the package, there should be very few spores present. Also, this study has pointed out that DEPC could possibly have application as an antimicrobial agent for dried fruits. It is effective in small concentrations and also it breaks down in the package to ethanol and carbon dioxide, thus leaving no questionable residue. And finally, the effectiveness of heat in killing microbial spores has been exemplified.

PRUNE JUICE

A large tonnage of prunes annually goes into the production of juice. The major prune juice on the market today is a water extract of dried prunes. In the past few years, a new type of prune juice has been produced. This juice is prepared by expressing the liquid from fresh prunes and then clarifying and bottling it. Juice prepared by this procedure is bright, clear, and has a distinctive fruit flavor. However, some of the juices prepared by this method darken noticeably overnight after opening, even if held in a refrigerator. This darkening needs to be prevented if this type of juice is to find a wide acceptance.

For this investigation, fresh prune juice was obtained from a local manufacturer. A light absorption curve was run on a sample of darkened juice using a spectrophotometer. An absorption peak was found at a wavelength of 505 mμ. Darkening of the juice after opening was followed by determining periodically its absorbance at this wavelength.

Inhibition of darkening: One treatment that inhibited darkening consisted of incorporating sulfur dioxide into the juice. The effectiveness of this treatment was determined by adding various amounts of sodium bisulfite to 16 oz. bottles of juice to give 0, 100, 200, and 300 ppm sulfur dioxide equivalency. This series of treatments, (figure 4), indicated that when enough sodium bisulfite was added to give 100 ppm SO_2 in the juice, it wouldn't darken noticeably for at least two weeks when held at 45°F. In contrast, the untreated juice initially darkened quickly, and thereafter at a slower rate.

Juice with a light, stable color was also obtained by means of adding a high molecular weight water-insoluble polymer, polyvinylpyrrolidone (PVP), to the juice. This material specifically absorbs polyphenols which oxidize to dark colored pigments. The fresh prune juice was treated by adding 0, 0.1, 0.2, 0.4 and 1.0% PVP to the juice, stirring for 10 minutes, and then filtering. This juice was stored at 45°F. One hundred ml samples of the juice were removed periodically for absorbance measurements, (figure 5). Untreated juice and juice to which 0.1% PVP had been added darkened overnight. However, 0.2% PVP addition did inhibit juice browning. When greater amounts of PVP were used, the juice became increasingly lighter because of the added absorption of the natural anthocyanin pigments by this material.

Flavor unchanged: A triangle taste panel consisting of twelve judges making a total of twenty-four judgments was used to determine if any flavor difference was imparted to the juice by the 100 ppm, SO_2 or 0.2% PVP treatments. Out of 24 judgments only 29% indicated a difference between the juice containing 100 ppm, SO_2 and the untreated juice. A 29% level is not considered significant. When the panel compared untreated juice to that treated with 0.2% PVP, 46% of the judgments showed a difference. This percentage is also not significant. Therefore, the taste panel results indicate that there seems to be no noticeable flavor change imparted by treating the fresh prune juice with either 100 ppm sulfur dioxide equivalency or 0.2% PVP.

From these studies it can be concluded that oxidative browning of fresh prune juice can be retarded either by the incorporation of about 100 ppm sulfur dioxide or by using a treatment with 0.2% polyvinylpyrrolidone.

FIGS

Figs have been an important and enjoyable food of mankind for thousands of years. A little over 100 years ago they were introduced on a small scale into California production. During the early years, figs were all marketed whole. However, today this marketing form has shifted to the point where in the U.S. approximately two-thirds of all the dried figs produced are utilized in the ground form. This paste is purchased by commercial bakers and institutions for use in their formulations.

In some countries a dark paste is desirable, but in this country the consumer demands a light colored product. Therefore, any information that could be obtained on processing methods that would result in a lighter colored product should prove useful. In this study we sought to determine the effectiveness of cooling figs before or during grinding on the lightness of the final product. No tests were conducted on bleaching figs chemically.

Natural Calimyrna figs were obtained from a commercial processor and were hydrated in hot water to about 23% moisture. These figs were then mixed well and separated into four lots consisting of about 5 pounds per lot. The lots then were stored at four different temperatures, -10, 34°, 70° and 90°F for two days, after which each was ground through an electric food grinder. The final temperatures of the ground pastes were 28, 50, 77 and 86°F. The figs that were ground colder were noticeably lighter in color than those ground at higher temperatures, (figure 6). The relative color intensities of these pastes were compared and followed during storage by measuring their lightness with a color difference meter. All pastes darkened when stored at 70°F as shown in figure 7. It was interesting to note that even though a color difference could be noted on the paste packed inside the transparent cups, no difference could be observed where the pastes were exposed to the air.

ALMOND-FRUIT BLENDS

In addition to figs, another product that is utilized to some degree in the paste form is almonds. This product is milled into a smooth, flavorful paste that is used by confectioners and bakers. An increased utilization of almonds as well as dried fruits should be realized by the production of almond-dried fruit pastes.

At WRRL we have produced several of these paste blends using conventional dried fruits. They were prepared by grinding the dried fruit together with pulverized almonds, sugar, and water, after which the blend was tempered for about 3 hours and then milled twice between two steel rollers (0.002-0.005 inches apart), rotating in the same direction but at different speeds. Specific formulations were similar for all dried fruits used with one exception, (figure 8). In the prune and raisin formulations the quantity of sugar was increased because oil separation occurred during storage if less was used. However, in all the above formulations there was no oil separation and the paste had a smooth, velvety texture.

The different flavors can be intensified by varying the almond to dried fruit ratio. Also, oil of bitter almond can be added, if desired, to enhance the almond flavor. However, when we added even a small amount of an emulsion of bitter almond oil, the fruit flavor seemed to be completely masked.

In all our blends thus far we have used regular moisture dried fruits. However, for commercial application it might be more convenient to use dried fruit powders. These powders could be mixed easily into a blend with the other ingredients.

REFERENCES

(1) Balatsouras, Georges D. and Polymenacos, Nic. G. 1963. J. Food Sci. 28, 267-275

(2) McBean, D. McG. and Pitt, J.I. 1965. Preservation of high-moisture prunes in plastic pouches. Food Preserv. Quart. 25 (2): 27-32

(3) Nury, F.S., Miller, M.W. and Brekke, J.E. 1960. Preservative effect of some antimicrobial agents on high-moisture dried fruits. Food Technol. 14 (2): 113-115.

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SPOILAGE OF HIGH-MOISTURE PRUNES BY MOLD AND YEAST GROWTH DURING STORAGE*

Moisture, 34%

Treatment	Storage (days) 3	6	15	40	65	90
None	-	++	+++			
Potassium sorbate						
0.5%	-	-	+	+++		
2.0	-	-	-	-	-	-
5.0	-	-	-	-	-	-
10.0	-	-	-	-	-	-
IR heated	-	-	-	-	-	-
DEPC						
50 ppm	-	-	-	++	+++	
550 ppm	-	-	-	-	-	-

*- Equals no spoilage, +, ++, +++ = 1/4, 1/2, and all prunes have spoiled respectively.

Figure 1 - Spoilage of high-moisture prunes by mold and yeast at 34% moisture.

SPOILAGE OF HIGH-MOISTURE PRUNES BY MOLD AND YEAST GROWTH DURING STORAGE*

Moisture, 43%

Treatment	Storage (days) 3	6	15	40	65	90
None	-	+++				
Potassium sorbate						
0.5%	-	-	+++			
2.0	-	-	+	+++		
5.0	-	-	-	-	-	-
10.0	-	-	-	-	-	-
IR heated	-	-	-	-	-	-
DEPC						
50 ppm	-	+	+++			
550 ppm	-	-	-	++	+++	

* - Equals no spoilage, +, ++, +++ = 1/4, 1/2, and all prunes have spoiled respectively.

Figure 2 - Spoilage of high-moisture prunes by mold and yeast at 43% moisture.

SPOILAGE OF HIGH-MOISTURE PRUNES BY MOLD AND YEAST GROWTH DURING STORAGE*

Moisture, 57%

	Storage (days)					
Treatment	3	6	15	40	65	90
None	-	+++				
Potassium sorbate						
0.5%	-	+++				
2.0	-	-	+++			
5.0	-	-	-	++	+++	
10.0	-	-	-	-	-	-
IR heated	-	-	-	-	-	-
DEPC						
50 ppm	-	++	+++			
550 ppm	-	-	++	+++		

*- Equals no spoilage, +, ++, +++ = 1/4, 1/2, and all prunes have spoiled respectively.

Figure 3 - Spoilage of high-moisture prunes by mold and yeast at 57% moisture.

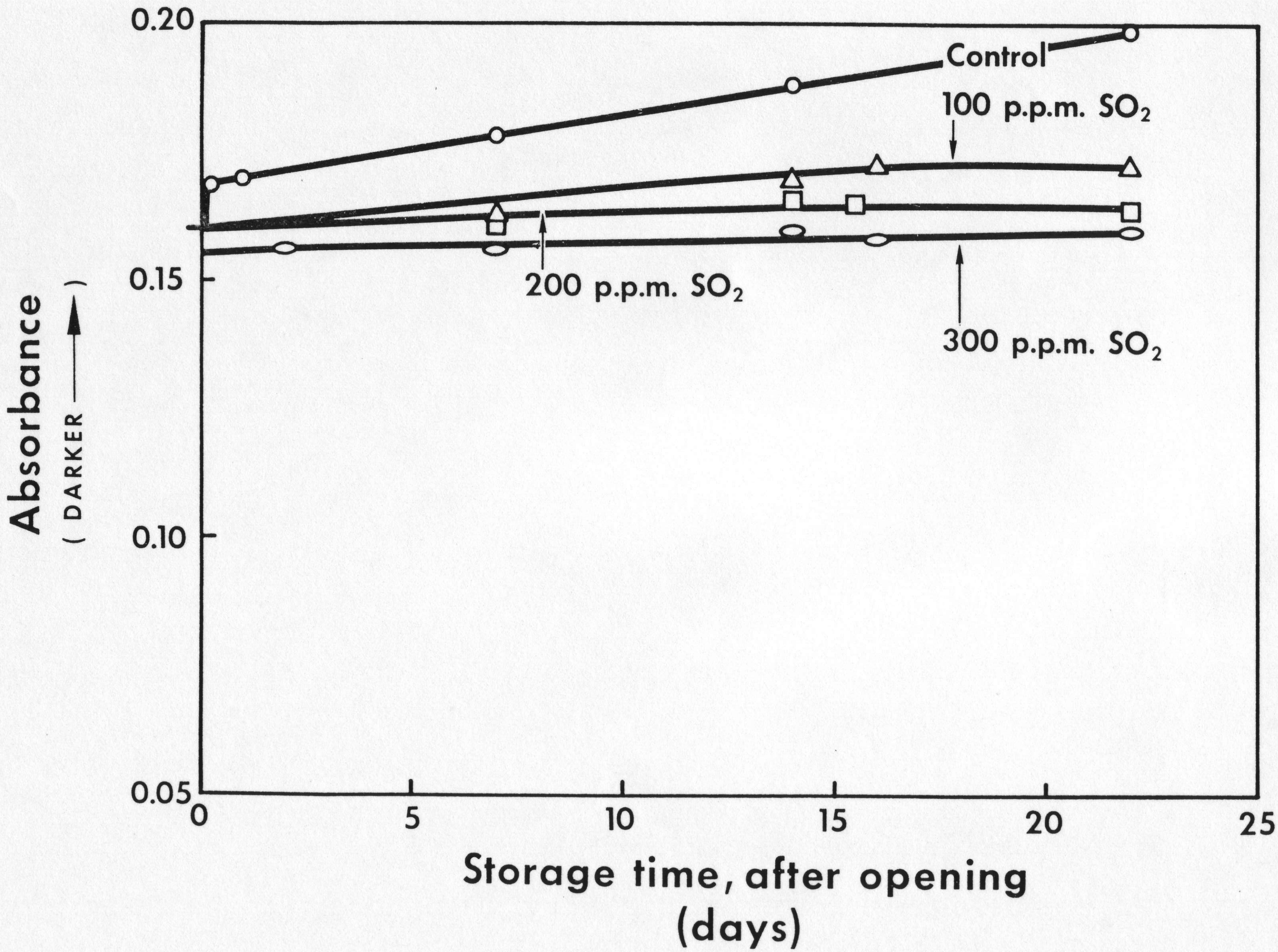

Figure 4 - Prevention of darkening of bottled fresh plum juice by sulfur dioxide.

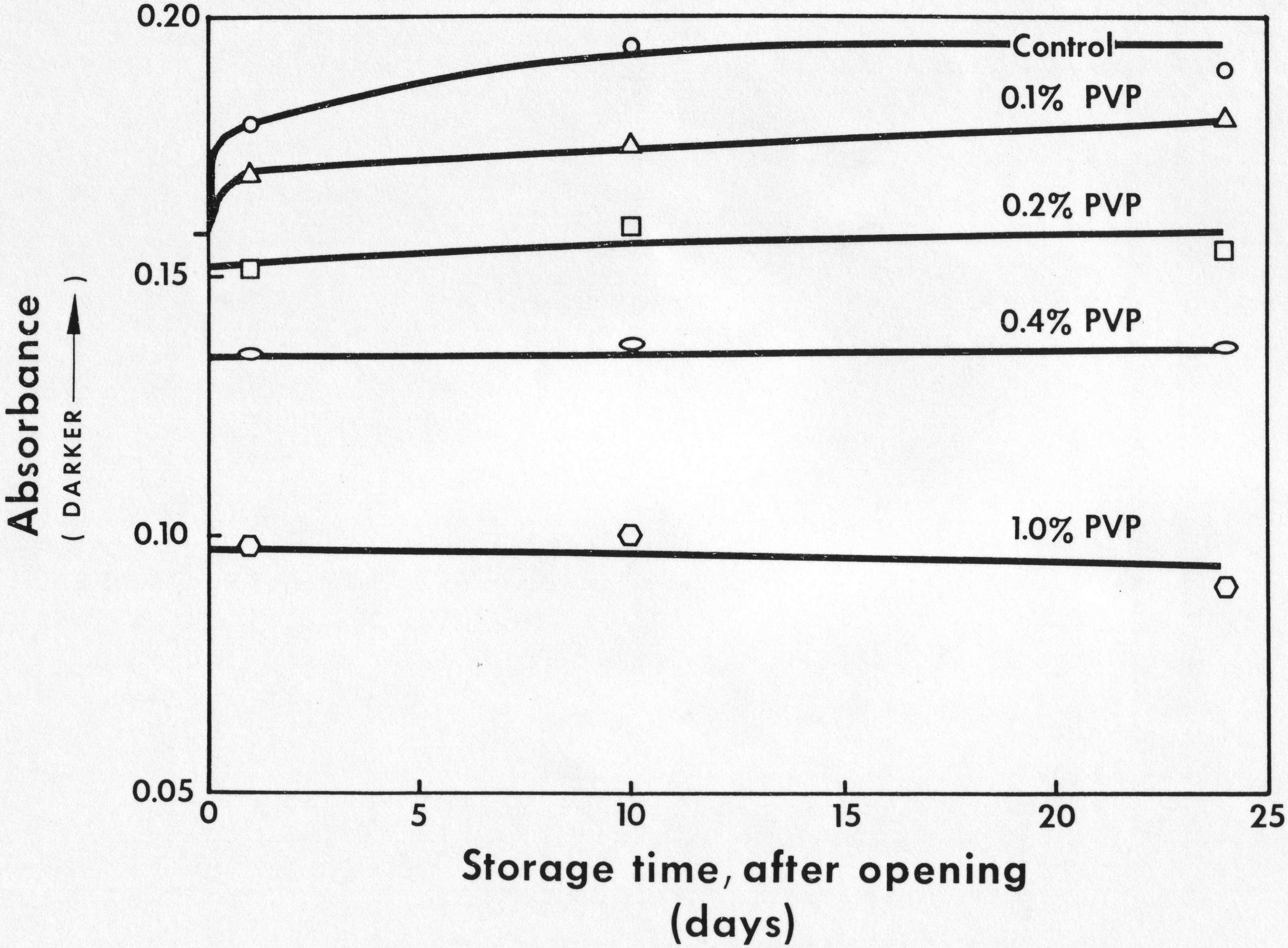

Figure 5 - Prevention of darkening of bottled fresh plum juice by polyvinylpyrrolidone (PVP).

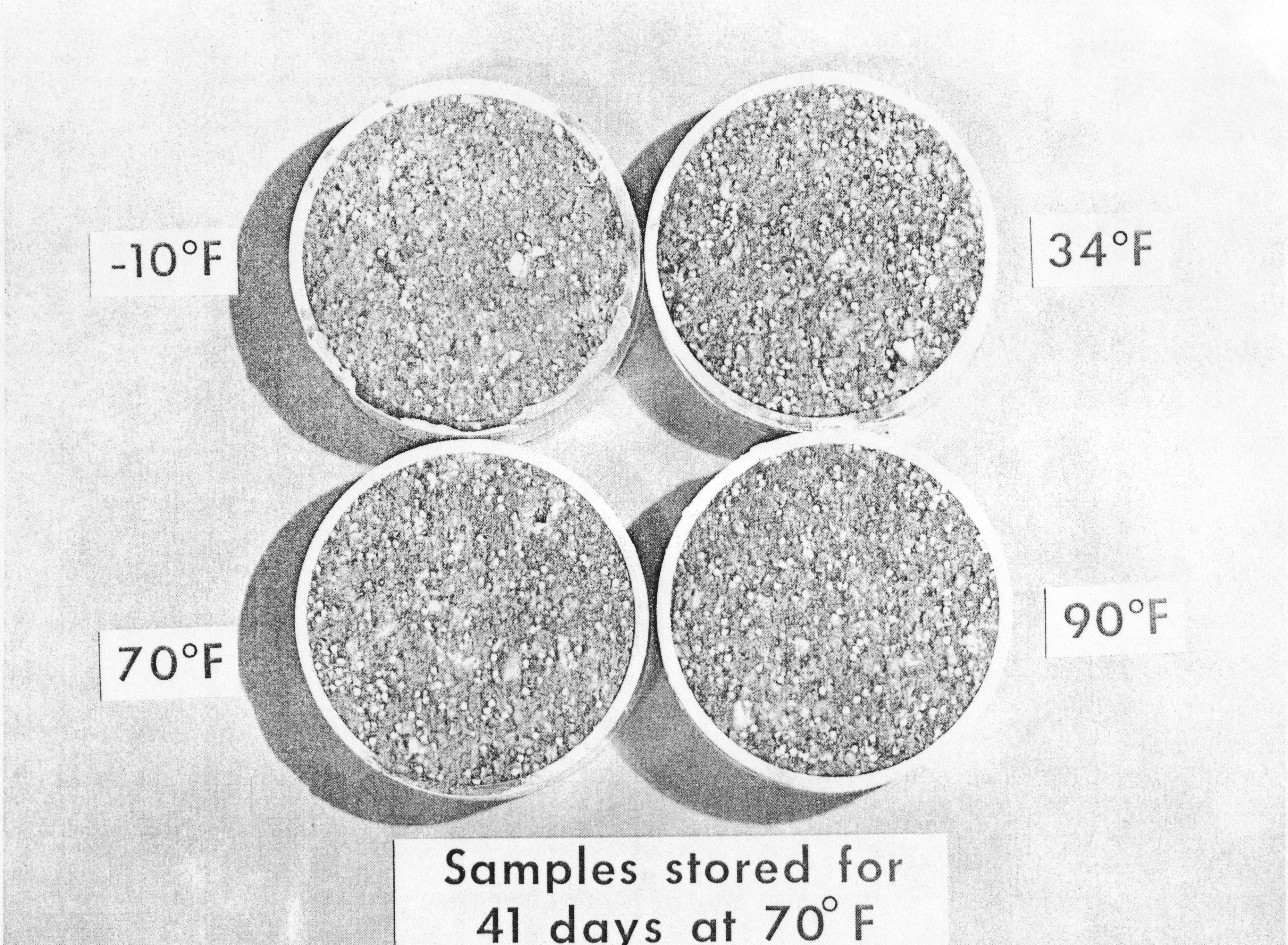

Figure 6 - Color of Calimyrna fig paste ground at four different temperatures.

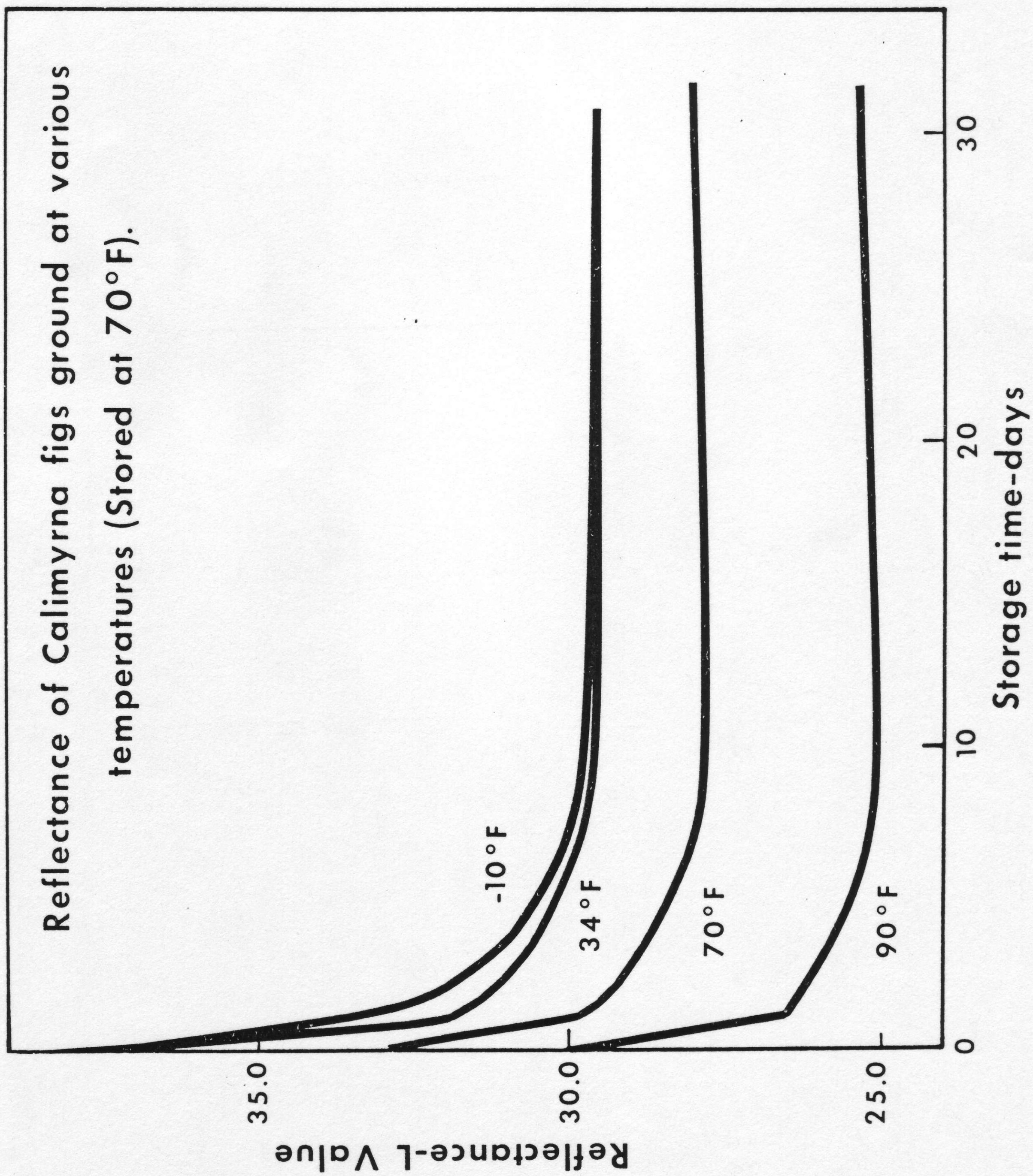

Figure 7 - Reflectance of Calimyrna fig paste ground at four different temperatures.

ALMOND-DRIED FRUIT PASTE FORMULATIONS

	Prune	Raisin	Fig	Apricot
Dried fruit	150 gm	150 gm	150 gm	150 gm
Pulverized almonds	300	300	300	300
Sugar	150	150	83	83
Water	17	28	25	25
Final moisture level	11%	10%	14%	14%

Figure 8 - Formulations for almond paste-dried fruit blends.