THE EFFECT OF BLANCHING ON THE STABILITY OF ANTHOCYANINS IN FROZEN TART CHERRIES

Thesis for the Degree of M. S.
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ALVIN SIEGEL
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ABSTRACT

THE EFFECT OF BLANCHING ON THE STABILITY OF ANTHOCYANINS IN FROZEN TART CHERRIES

By

Alvin Siegel

The effect of blanching on the stability of anthocyanins in individually quick frozen (IQF) red tart cherries (Prunus cerasus L. var. Montmorency) was studied during frozen storage (0 to -5°F) for three months and ten months, in two different experiments. Cherries used in this study were blanched in steam (212°F) for 0, 30, 45, and 60 seconds and their anthocyanin content was determined periodically during storage.

When the control (unblanched) and blanched cherries were not allowed to thaw before they were analyzed, no color loss due to anthocyanin destruction was observed after any period of frozen storage. When they were let to stand at room temperature (70°F), as a single layer of cherries, for two or four hours, the control frozen cherries lost 15% and 25% of their anthocyanin color, respectively; the frozen cherries which had been blanched even for 30 seconds showed no significant color loss.

A test in which the frozen cherries were mixed in a Waring blendor for periods up to 30 minutes, under air, pure oxygen, or pure nitrogen showed that unblanched cherries lost considerable color (70% after 30 minutes under oxygen), whereas those blanched for 45 or 60 seconds suffered no color loss. Some color loss was observed when the 30-second blanch was applied. Pure oxygen was more deleterious to the color than air; pure nitrogen minimized the color loss but did not eliminate it.

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Alvin Siegel

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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INTRODUCTION

The color of food is used as an important quality indicator by the consumer. Color preferences are established which greatly effect the acceptance of the product. Many types of deteriorative changes that food undergoes are reflected by its appearance and color.

The red tart cherry undergoes a detrimental loss of color. Anthocyanins, the red color pigments in the cherry, are degraded with a concurrent formation of brown pigment. Enzymes (Huang, 1955; Van Buren et al., 1959; Peng and Markakis, 1963; Grommeck and Markakis, 1965) are known to contribute to the destruction of anthocyanins. A process which inhibits enzymatic activity or inactivates these enzymes, therefore, would be very effective in minimizing destruction of the anthocyanin pigment in the fruit.

Blanching with steam has been known for a long time as a pretreatment procedure used for frozen vegetables. This process prevented the enzymatic development of off-flavors and off-odors in the product. Blanching of fruit for freezing was less used because this procedure caused a softening of the fruit texture with the consequent leaching of soluble solids. Subjecting fruit to

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steam blanching for a very short time followed by immediate freezing appeared to be a method for stabilizing anthocyanins in cherries while eliminating leaching losses in the fruit (Bedford and Smith, 1967). An advantage of blanching is that fruit does not require the addition of foreign chemical substances to prevent color loss (Joslyn and Hohl, 1948).

This study was undertaken to determine the effect of a pretreatment blanch on the stability of anthocyanins in individual quick frozen cherries, and to study the color retention under accelerated defrosting and ordinary thawing conditions.

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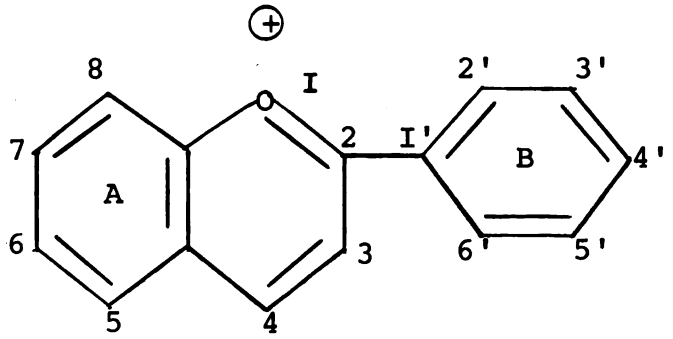
LITERATURE REVIEW

Anthocyanins: Their Occurrence, Structure, and Properties

Anthocyanins are responsible for the attractive color in red tart cherries. The appearance of this fruit, therefore, is greatly affected by any change or loss of these pigments. Marquart in 1835 used the term 'anthocyanin' to designate red, violet, and blue (Gr. cyanin) flower (Gr. antho) pigments (Onslow, 1925). The importance of these pigments became recognized and numerous investigations were undertaken to determine their occurrence, structure, properties, identification, and the changes to which they may be subjected.

The red and blue colors of flowers, fruits, and blossoms are due to the presence of these plant pigments (Robinson and Robinson, 1932). The color of anthocyanins is due to the presence of an extensive conjugated double bond system (chromophore) in the molecule. The chromophore creates a condition in the molecule which allows specific wavelengths in the visible region of the spectrum to be absorbed; the remaining wavelengths result in the perception of color (Goodwin, 1965).

All anthocyanins exist in nature as glycosides which, when hydrolyzed, result in a sugar (pentose, hexose) and an aglycone, called anthocyanidin. The anthocyanidins consist of a benzopyrylium nucleus (A) and a phenol ring (B) forming a compound called flavylium (I). This is an oxonium compound, the oxygen being four-valent. The sugar moiety in anthocyanins is usually attached to the hydroxyl at position 3 (Braverman, 1963).



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These plant pigments are soluble in water and alcohol but are insoluble in benzene, chloroform, and ether. A unique property of anthocyanins is their ability to act as pH indicators because they change color according to changes in pH. They are red in acid solutions, blue in alkaline solutions, and they fade at neutrality (II).

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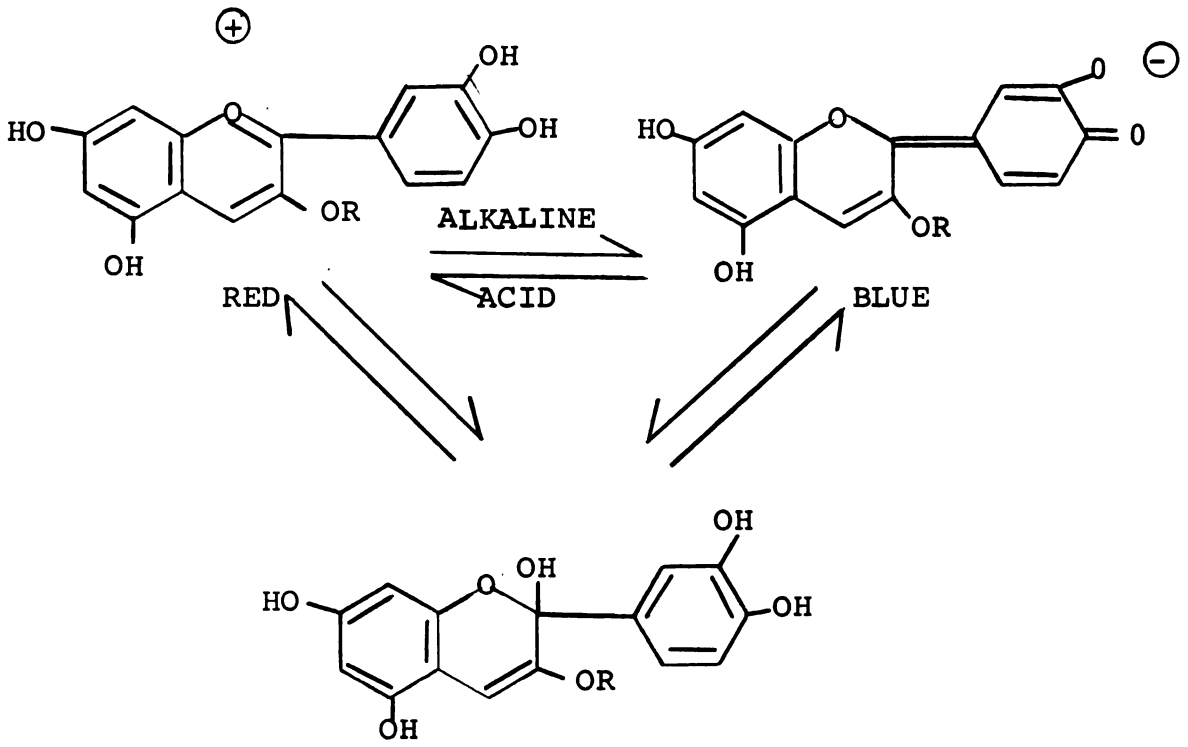

COLORLESS

II

Isolation and Identification of Anthocyanins

Anthocyanins have been identified in various fruits using different methods of isolation and purification. Li and Wagenknecht (1965) identified two anthocyanins in red tart cherries: cyanidin-3-rhamnoglucoside and cyanidin -3-gentiobioside. Schaller and von Elbe (1968) identified a third minor pigment in the tart cherry as being cyanidin-3-monoglucoside.

Various methods for investigating anthocyanin pigments have been developed. Colorimetric determinations in strawberries were developed by Sondheimer and Kertesz

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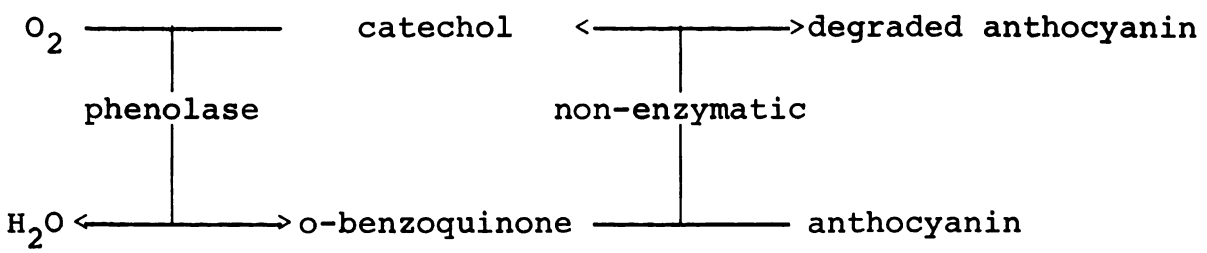
(1948) which involved a method of taking the optical densities of the pigment at two pH levels and then using the difference as the true optical density reading. Markakis (1960) used zone electrophoresis as a separation method for tart cherry anthocyanins. Fuleki and Francis (1968) found ion exchange resin chromatography to be a desirable method for purifying cranberry anthocyanins.

Enzymatic Degradation of Anthocyanins

Degradation of the anthocyanin pigment with the concurrent development of brown pigments in fruit is a problem which has been the topic of much research. Robinson and McCance (1925) showed that in the aerobic oxidation of catechol using a mushroom enzyme, two atoms of oxygen were consumed per mole of substrate. Since only one atom of oxygen is needed for this reaction, further investigations were needed. Dawson and Nelson (1938) concluded that the enzymatic oxidation of catechol resulted in the initial production of o-benzoquinone and unoxidized catechol. Joslyn and Ponting (1951) reported that the formation of dark brown color pigments in fruit was initially caused by the oxidation of catechol by a polyphenol oxidase. Phenolase activity has been reported in cherries (Bedford, 1968).

Peng and Markakis (1963) proposed the probable mechanism of the phenolase-catechol-anthocyanin reaction as follows:



It is generally accepted that the o-benzoquinone polymerizes to form simple melanins (brown pigments). Goodman and Markakis (1965) found that sulfur dioxide inhibited degradation of the tart cherry anthocyanin by tyrosinase. Peroxidase has been shown to cause a degradation of anthocyanin pigments (Grommeck and Markakis, 1964).

Enzymatic Inactivation by Blanching

Steam-blanching of fruit has the effect of inactivating enzymes present in the skin and tissue of the product. Inactivation by heat is due to denaturation of the enzyme protein (Dixon, 1958). Proper blanching involves sufficient inactivation of the enzymes in the least amount of time necessary to accomplish this.

Food Preservation by Freezing

The first freezing of cherries was done by the pie bakers at market centers in the original fresh fruit crate (Rogers, 1940). The proper freezing of fruit involves an understanding of the mechanics of the freezing process.

Briefly, freezing involves the removal of pure water from solution and its isolation into biologically inert, foreign bodies, ice crystals (Meryman, 1956). Ice crystal nucleation and growth interact to determine crystal size. Efficient removal of heat is important for obtaining a product which will be in as natural a state as possible after frozen storage.

Birdseye (1931) found that slow freezing of fruits and vegetables resulted in very large ice crystals, whereas, extremely quick freezing resulted in small crystals uniformly distributed throughout the material. Rapid freezing also resulted in less tissue damage.

Cherries readily lend themselves to the process of individual quick freezing. This quick frozen product can be easily handled by the processor for use in various products. Storage of individually quick frozen (IQF) tart charries at 0°F or below should be applied without any damaging fluctuations in temperature. Woodroof (1944) stated that such fluctuations can cause desiccation, and losses of color, flavor, and aroma.

METHODS AND MATERIALS

The cherries (Prunus cerasus L. var. Montmorency) were obtained from Western Michigan in 1968 and 1969, through the Department of Food Science at Michigan State University. Two different lots of cherries were used for the studies which included both a preliminary 300-day storage test and a second 100-day storage test. Upon arrival at the Laboratory the fruit was soaked for several hours in cold running water at 45 to 50°F to remove dirt and firm the cherries. After soaking, the fruit was sorted and sound fruit was placed in a single layer on perforated blancher trays. After steam-blanching for 0 (control), 30, 45, and 60 seconds, the cherries were frozen immediately in the -5°F freezing room. The cherries were later transferred to 30 lb cans and stored at 0°F to -5°F. Mayak (1965) found that cherries stored in 30 lb cans experienced less red color loss than those stored in polyethylene bags. The identical treatments for both lots were as follows:

(1) Control: unpitted cherries were individually quick frozen.

(2) Blanched samples: representative amounts of unpitted cherries were steam blanched for 30, 45,

and 60 seconds and individually quick frozen.

The total anthocyanin content in the cherries was determined using a modified procedure originally developed by Fuleki and Francis (1968) for cranberries.

Solvents

The following solvents were used:

Extracting solvent: 95% ethanol-1.5N HCl (85:15)

pH 1.0 buffer: 0.2N KCl-0.2N HCl (25:67)

pH 4.5 buffer: N Sodium Acetate-1N HCl-water (100:60:90)

Color Determination

a. 300-day storage (1968 crop)

Representative samples of the frozen blanched cherries and the control were pitted by hand to obtain a final weight of 50 g. Each 50-gram sample was blended with 50 ml of extracting solvent in a Waring blendor at high speed for two minutes. After blending, another 50 ml of extracting solvent was used for washing the blendor jar and it was then added to the cherry mixture. The mixture was transferred to a beaker, covered with parafilm, and stored overnight at 35°F. The mixture was filtered under vacuum on S and S Sharkskin paper through a Buchner funnel and the extract was analyzed to determine total anthocyanin content.

b. 100-day storage (1969 crop)

Representative samples of the frozen blanched fruit and the control were pitted by hand to obtain a final weight of 50 g. Each 50-gram sample was added to 100 ml of extracting solvent and boiled for one minute. The samples were then blended in a Waring blendor at high speed for two minutes. Preliminary tests indicated that boiling the cherries in extracting solvent prior to blending allowed for a better extraction of the anthocyanin pigment. After washing the blendor jar with an additional 25 ml of extracting solvent, the mixture was transferred quantitatively to a 250 ml beaker. The beaker was covered with parafilm and stored overnight at 35°F. The samples were filtered under vacuum on S and S Sharkskin paper through a Buchner funnel using approximately 50 ml of extracting solvent for washing the cherry residue on the filter paper. The extract was transferred quantitatively to a 250 ml volumetric flask and made up to volume with extracting solvent. The extract was analyzed for total anthocyanin content.

Analysis of Cherry Extracts

Three 1-ml aliquots of the above extract were diluted each with 9 ml of buffer pH 1.0. Similarly another three 1-ml aliquots were diluted with 4 ml of buffer pH 4.5. The diluted samples were allowed to

equilibrate in the dark at room temperature for one hour. The wavelength to be used for comparing the absorbance of the extracts was determined by means of a Spectronic 505 recording spectrophotometer for a pH 1.0 cherry extract (Fig. 1). The absorption maximum for this extract was found to be 518 nm. Total anthocyanin content was determined for the two buffered solutions at this wavelength on a Beckman DU Spectrophotometer using distilled water as blank. The absorbance difference was obtained by subtracting the total absorbance at pH 4.5 from the total absorbance at pH 1.0.

Rapid Oxidation

Rapid oxidation tests were conducted using 100-g samples of frozen blanched fruit and the control to determine rate of color loss. Each sample was blended with 100 ml of distilled water in a Waring blendor at high speed for two minutes and at low speed for three additional minutes. After this initial five minute mixing period, blending continued at low speed. Representative 20-gram aliquots were removed at 5, 10, 15, 20, and 30 minute intervals, and 20 ml of extracting solvent was added to them. Mayak (1965) found that the alcoholic extracting solution prevented further degradation of the anthocyanin pigment. The solutions were stored overnight at 35°F. Each sample was filtered under vacuum on S and

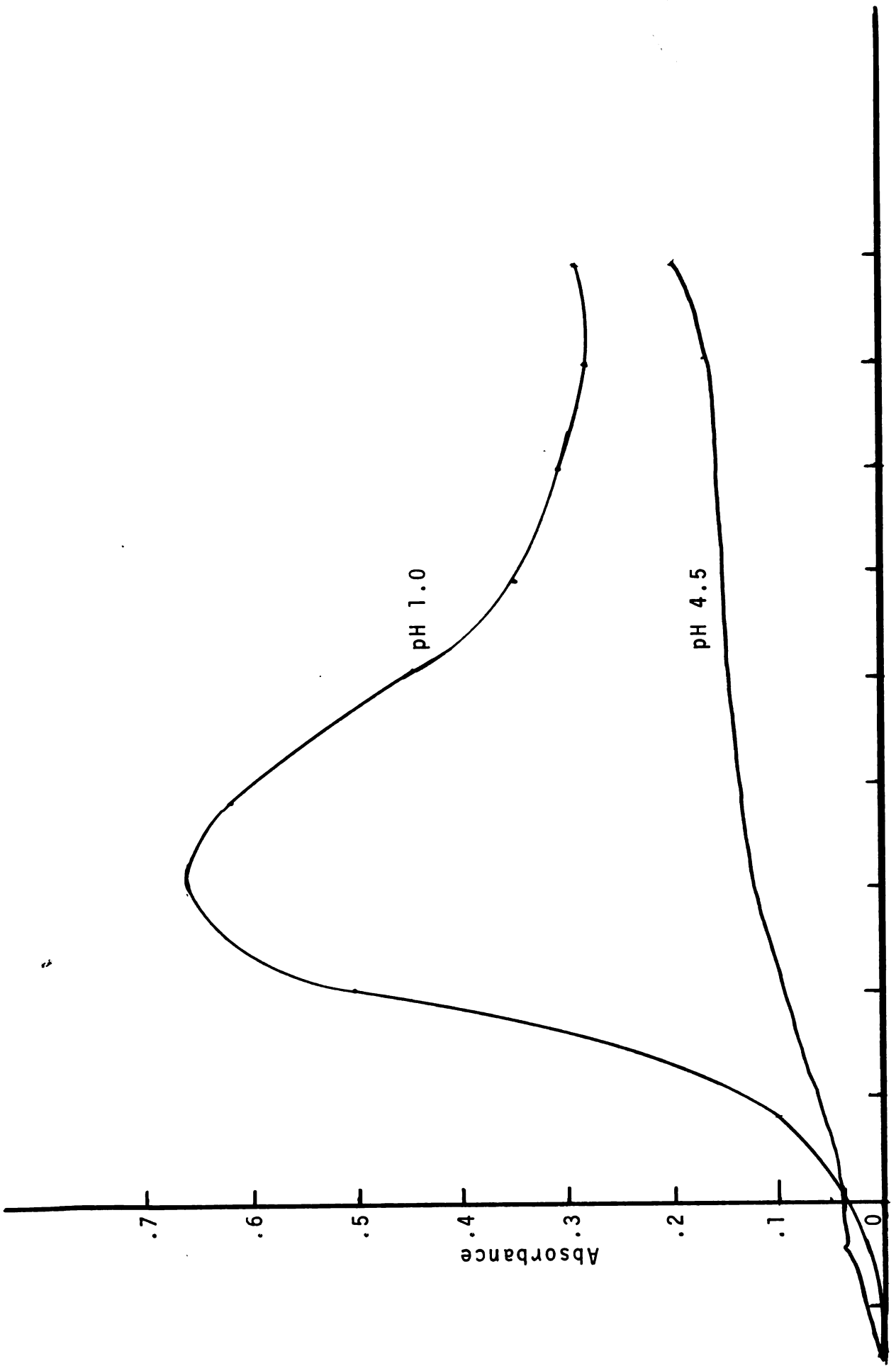


Figure 1.--Absorption spectra of a cherry anthocyanin extract at pH 1.0 and pH 4.5

S Sharkskin paper through a Buchner funnel. Each extract was transferred to a 100 ml volumetric flask and made up to volume with extracting solvent. The solutions were analyzed for total anthocyanin content using the previously described method.

The rates of anthocyanin degradation and color loss under conditions of rapid oxidation and accelerated defrosting were determined under atmospheres of oxygen and nitrogen, as well as air. For these tests, air, oxygen, or nitrogen were bubbled into the churning mixture of fruit and distilled water during the entire 30 minute mixing time. Identical methods of collecting aliquots, diluting, extracting, and final analyzing were used for these rapid oxidation tests under all three atmospheres.

Thawing

50-gram samples of pitted frozen fruit and control were used for this study. These samples were thawed at room temperature for 0, 2, and 4 hour periods. The samples were blended with extracting solvent, stored, extracted, diluted with buffers, and analyzed in the usual manner. For zero thawing time the frozen samples were dropped in the boiling extraction liquid.

RESULTS AND DISCUSSION

Color Changes During Frozen Storage

a. 300-day storage (1968 crop)

All frozen cherry samples, blanched and control, exhibited no visible color loss throughout the 300-day period of frozen storage at 0 to -5°F. Discoloration of the fruit as shown by browning of the flesh or scald was not evident. Guadagni and Nimmo (1958) reported that cherries which were stored at 0°F for a period of two years had little or no color change.

Spectrophotometric analysis of the cherry extracts from the treated and untreated samples illustrated that there was no significant color loss throughout the storage time. The absorbances of these extracts obtained at 15, 30, and 60 day intervals varied within a certain average range. Table 1 summarizes the data of the 300-day experiment. The differential absorbance ($A_{518,\ 1.0} - A_{518,\ 4.5}$) of the extract is taken as a measure of the anthocyanin content of the cherries. Sondheimer and Kertesz (1948) observed that secondary brown pigments developed in strawberries at a temperature above 0°F along with a loss of red anthocyanin color. Since the

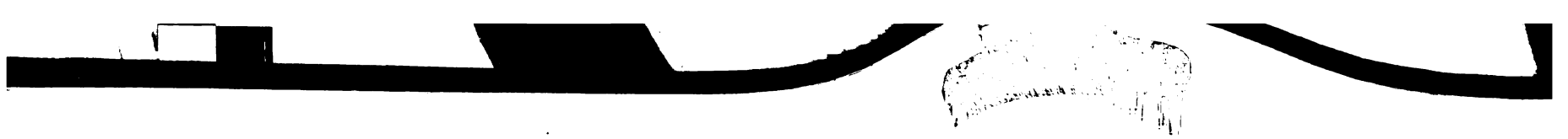


Table 1.--Differential absorbance values, $\Delta A = {}^{*}A_{518,\ 1.0} - A_{518,\ 4.5}$, of cherries steam blanched for 4 different periods and periodically analyzed during 300 days of frozen storage. (Average of triplicate readings.)

Days	**ΔA 0 Sec. (Control)	ΔA 30 Sec. Blanch	ΔA 45 Sec. Blanch	ΔA 60 Sec. Blanch
0	0.293	0.306	0.330	0.300
15	0.323	0.305	0.312	0.333
30	0.275	0.319	0.333	0.316
45	0.292	0.305	0.298	0.295
60	0.297	0.306	0.311	0.313
75	0.314	0.304	0.318	0.307
135	0.283	0.303	0.323	0.323
150	0.318	0.300	0.315	0.327
180	0.276	0.316	0.293	0.335
240	0.303	0.309	0.318	0.310
300	0.295	0.317	0.335	0.335
Average	0.297	0.308	0.317	0.318

*$A_{518,\ 1.0}$ denotes absorbance at 518 nm of an extract adjusted to pH 1.0.

**These values represent anthocyanin concentrations 2500 times lower than those actually present in the fruit flesh.

browning does not change within the pH ranges for 1.0 to 4.5, measuring the absorbances of the extracts at two pH levels and subtracting them from each other prevents the brown pigments from contributing to the absorbance giving a truer anthocyanin content.

b. 100-day storage (1969 crop)

Individually quick frozen blanched and unblanched cherries were in frozen storage for 100 days (0 to -5°F). All fruit samples showed no visible color loss. Absorbances were determined at 15-day and 30-day intervals, the results indicating that no significant loss of red anthocyanin pigment had occurred (Fig. 2). Tables 2, 3, 4, and 5 show the A_{518} values at pH 1.0 and pH 4.5, and their differences for the samples tested during the 100-day storage period.

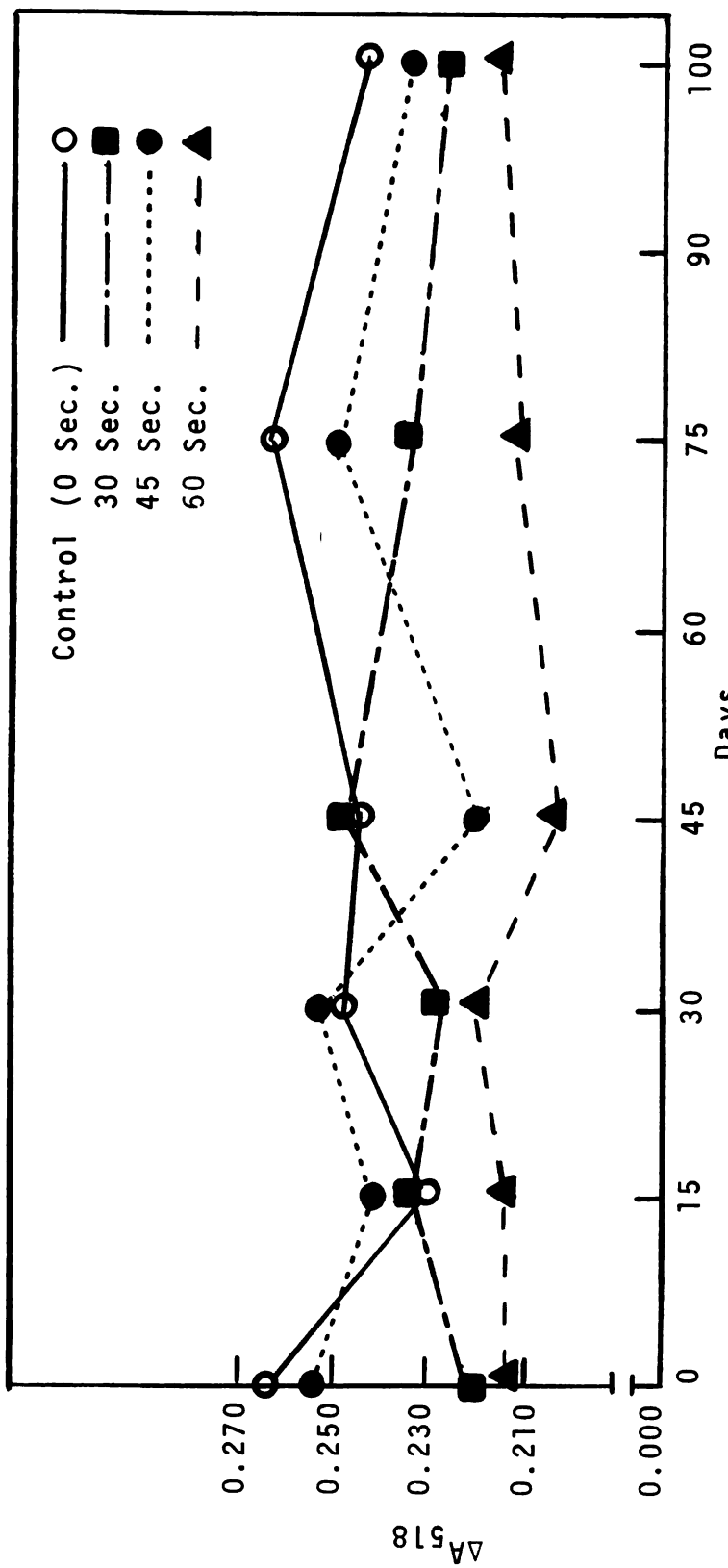


Figure 2.--Effect of blanching on red color retention during frozen storage.

Table 2.--Absorbance values of unblanched cherries stored frozen for 100 days.

Days	$A_{518, 1.0}$	$A_{518, 4.5}$	$^{*}A_{518, 1.0} - A_{518, 4.5}$
0	0.384	0.123	0.261
	0.385	0.122	0.263
	0.382	0.123	0.259
15	0.342	0.112	0.230
	0.342	0.115	0.227
	0.342	0.111	0.231
30	0.358	0.116	0.242
	0.368	0.119	0.249
	0.364	0.114	0.250
45	0.360	0.113	0.247
	0.354	0.114	0.240
	0.359	0.116	0.243
75	0.388	0.125	0.263
	0.385	0.120	0.265
	0.382	0.123	0.259
100	0.370	0.123	0.247
	0.361	0.123	0.238
	0.365	0.122	0.243

*These values represent anthocyanin concentrations 2500 times lower than those actually present in the fruit flesh.

Table 3.--Absorbance values of cherries steam-blanched for 30 seconds and then stored frozen for 100 days.

Days	$A_{518, 1.0}$	$A_{518, 4.5}$	$^{*}A_{518, 1.0} - A_{518, 4.5}$
0	0.361	0.135	0.226
	0.353	0.134	0.219
	0.353	0.133	0.220
15	0.352	0.118	0.234
	0.350	0.120	0.230
	0.352	0.117	0.235
30	0.345	0.113	0.232
	0.337	0.111	0.226
	0.335	0.113	0.222
45	0.370	0.123	0.247
	0.372	0.125	0.247
	0.373	0.126	0.247
75	0.348	0.118	0.230
	0.358	0.119	0.239
	0.354	0.120	0.234
100	0.343	0.120	0.223
	0.345	0.118	0.227
	0.343	0.117	0.226

*These values represent anthocyanin concentrations 2500 times lower than those actually present in the fruit flesh.

Table 4.--Absorbance values of cherries steam-blanched for 45 seconds and then stored frozen for 100 days.

Days	$A_{518,\ 1.0}$	$A_{518,\ 4.5}$	$^{*}A_{518,\ 1.0} - A_{518,\ 4.5}$
0	0.381	0.130	0.251
	0.385	0.130	0.255
	0.386	0.130	0.256
15	0.361	0.121	0.240
	0.365	0.118	0.247
	0.361	0.121	0.240
30	0.385	0.128	0.257
	0.372	0.122	0.250
	0.370	0.122	0.248
45	0.325	0.106	0.219
	0.326	0.108	0.218
	0.331	0.110	0.221
75	0.360	0.118	0.242
	0.370	0.119	0.251
	0.368	0.117	0.251
100	0.366	0.135	0.231
	0.360	0.128	0.232
	0.361	0.129	0.232

*These values represent anthocyanin concentrations 2500 times lower than those actually present in the fruit flesh.

Table 5.--Absorbance values of cherries steam-blanched for 60 seconds and then stored frozen for 100 days.

Days	$A_{518, 1.0}$	$A_{518, 4.5}$	$^{*}A_{518, 1.0} - A_{518, 4.5}$
0	0.338	0.125	0.213
	0.337	0.127	0.210
	0.337	0.121	0.216
15	0.333	0.117	0.216
	0.339	0.124	0.215
	0.333	0.122	0.211
30	0.340	0.118	0.222
	0.340	0.119	0.221
	0.335	0.116	0.219
45	0.305	0.110	0.195
	0.303	0.105	0.198
	0.325	0.110	0.215
75	0.335	0.118	0.217
	0.330	0.120	0.210
	0.325	0.119	0.206
100	0.331	0.119	0.212
	0.337	0.123	0.214
	0.332	0.116	0.216

*These values represent anthocyanin concentrations 2500 times lower than those actually present in the fruit flesh.

Color Changes During Rapid Oxidation

Rapid oxidation tests were conducted on frozen fruit samples after the initial storage of the cherries, during the middle part of storage, and towards the end of the storage period. Absorbances determined from these oxidation tests were calculated as percent loss of color as related to the initial anthocyanin content of the frozen cherries. The results are illustrated in Figures 3, 4, and 5, as the average of three percents.

Unblanched cherries which were subjected to rapid oxidation and accelerated defrosting conditions in an oxygen atmosphere experienced the greatest final loss of color. The average percent color loss after blending for 5, 10, 15, 20, and 30 minutes was 12, 22, 34, 53, and 69, respectively. Peng and Markakis (1963) found that tart cherry anthocyanins are destroyed by the oxidative enzymatic reaction of phenolase in the presence of catechol, a polyphenolic compound. Horseradish peroxidase has also been shown to cause a decrease in cherry anthocyanin content (Grommeck and Markakis, 1964).

All unblanched fruit which underwent rapid oxidation tests in air, oxygen, and nitrogen atmospheres displayed significant anthocyanin degradation with final percent losses being 66, 69, and 53 for the air, oxygen, and nitrogen environments, respectively.

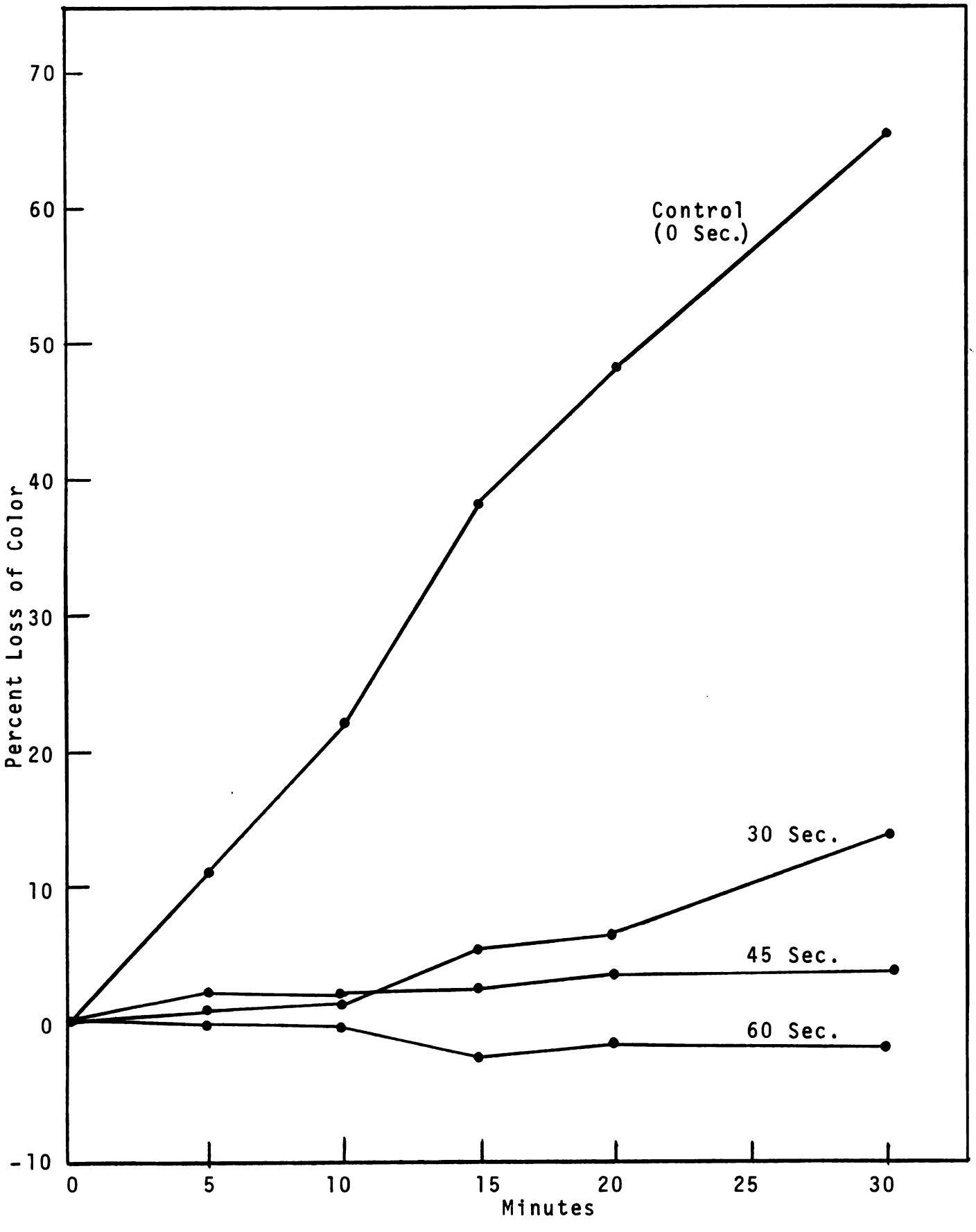


Figure 3.--Effect of blanching on the rate of red color loss during accelerated oxidative defrosting in air.

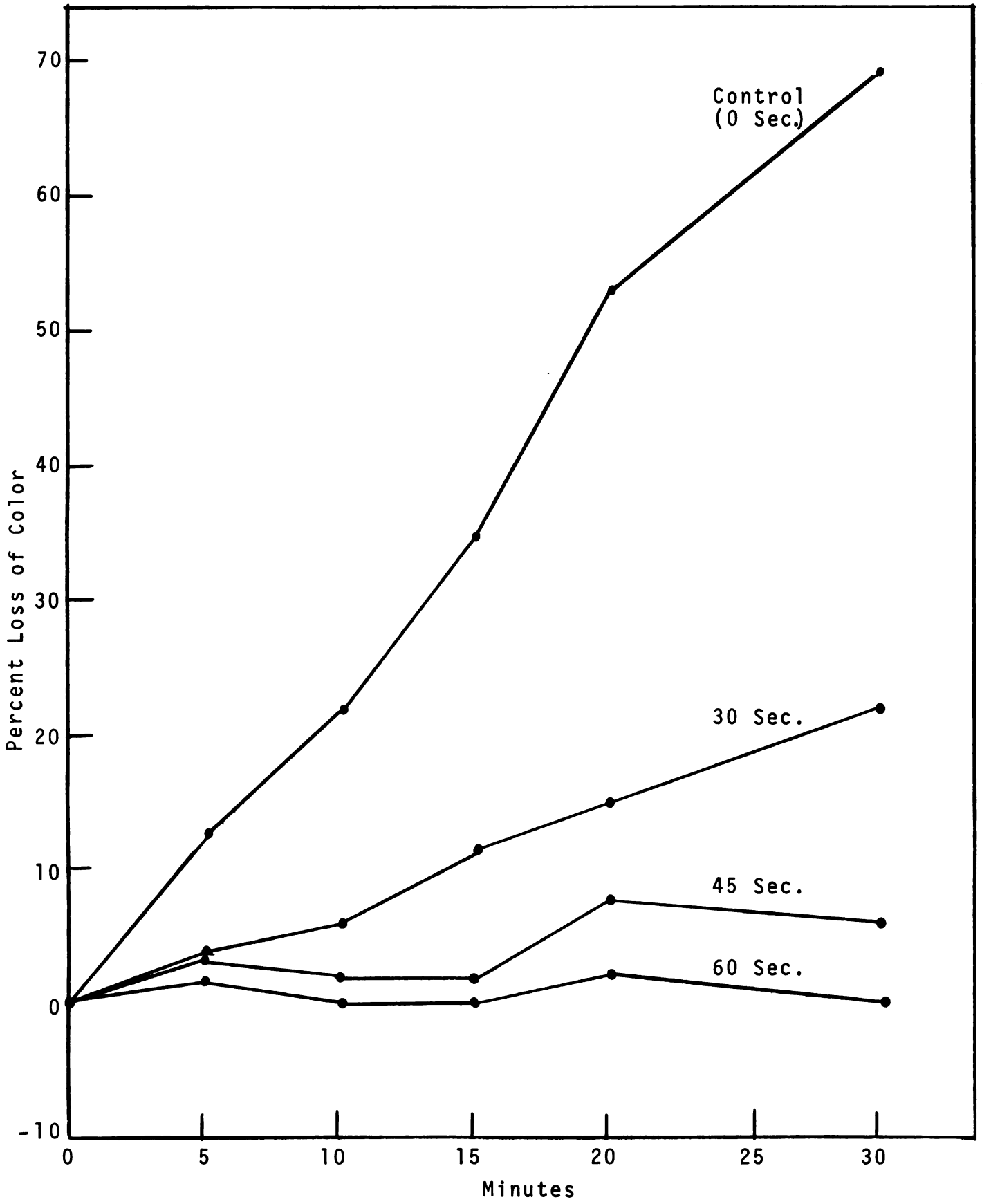


Figure 4.--Effect of blanching on the rate of red color loss during accelerated oxidative defrosting in oxygen.

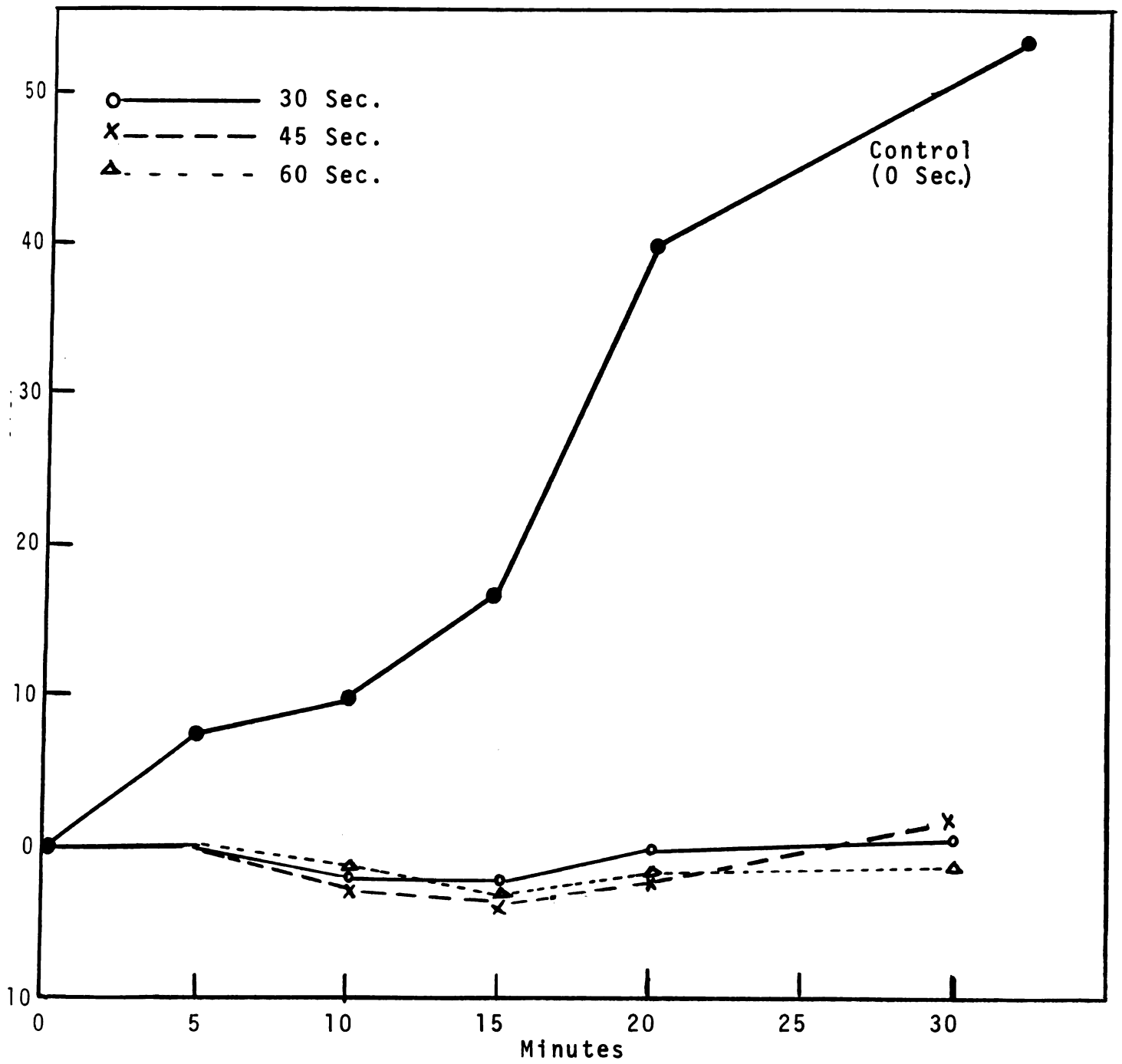


Figure 5.--Effect of blanching on the rate of red color loss during accelerated oxidative defrosting in nitrogen.

Results of oxidation tests conducted in air are illustrated in Figure 3. They indicate that blanched cherries experienced color loss in a range from moderate to no loss at all. The 30-second blanched fruit reached a final color loss of 14%, whereas, the 45-second blanched cherries had a final color loss of 4%, and the 60-second blanched samples had no color loss throughout the entire aeration period.

Figure 4 depicts the results for oxidation tests under oxygen. The 30-second blanched sample had a greater color loss than all other blanched samples under any atmosphere. This illustrated that a 30-second steam blanch treatment was insufficient in inactivating the oxidative enzymes in the fruit. On the other hand, the 45-second blanched fruit had a low percent color loss and the 60-second blanched fruit had no color loss indicating sufficient enzyme inactivation for this amount of time. Wiegard (1946) found that steam blanching reduced enzymatic oxidation, and, thus, preserved the color of peaches.

A nitrogen atmosphere had the effect of inhibiting anthocyanin degradation and red color loss (Fig. 5). Under nitrogen, the unblanched cherries had the lowest color loss (53%) among all unblanched samples. All blanched fruit showed no color loss under nitrogen

blending. Markakis et al. (1957) reported that replacing air with nitrogen resulted in a higher anthocyanin pigment retention for strawberries.

Color Changes During Thawing

Absorbance values were determined for fruit which underwent room temperature thawing as a single layer of cherries, over a given period of time. As shown in Figure 6 and in Tables 6, 7, and 8, after thawing for two-hour and four-hour periods, the unblanched fruit had an approximate color loss of 15% and 25%, respectively. This color loss was readily visible. The blanched samples had no overall color loss during the thawing time. The thawing test illustrated that frozen cherries which are allowed to thaw at room temperature will experience anthocyanin pigment loss even though no loss occurred during long frozen storage. Stein and Weckel (1954) observed that browning in frozen cherries occurred when they were exposed to oxygen on thawing. Joslyn (1941) reported that rapid browning occurred in fruit tissue which was exposed to free oxygen.

Commercially, cherry processors must minimize the thawing period of the (unblanched) frozen product in order to save the color of the fruit. The handling of frozen cherries must also be considered in relation to the discoloration of fruit tissue. La Belle et al. (1958) and Pollack et al. (1958) concluded that poor handling of red tart cherries caused bruising of fruit tissue allowing for oxidation and consequent browning in the fruit.

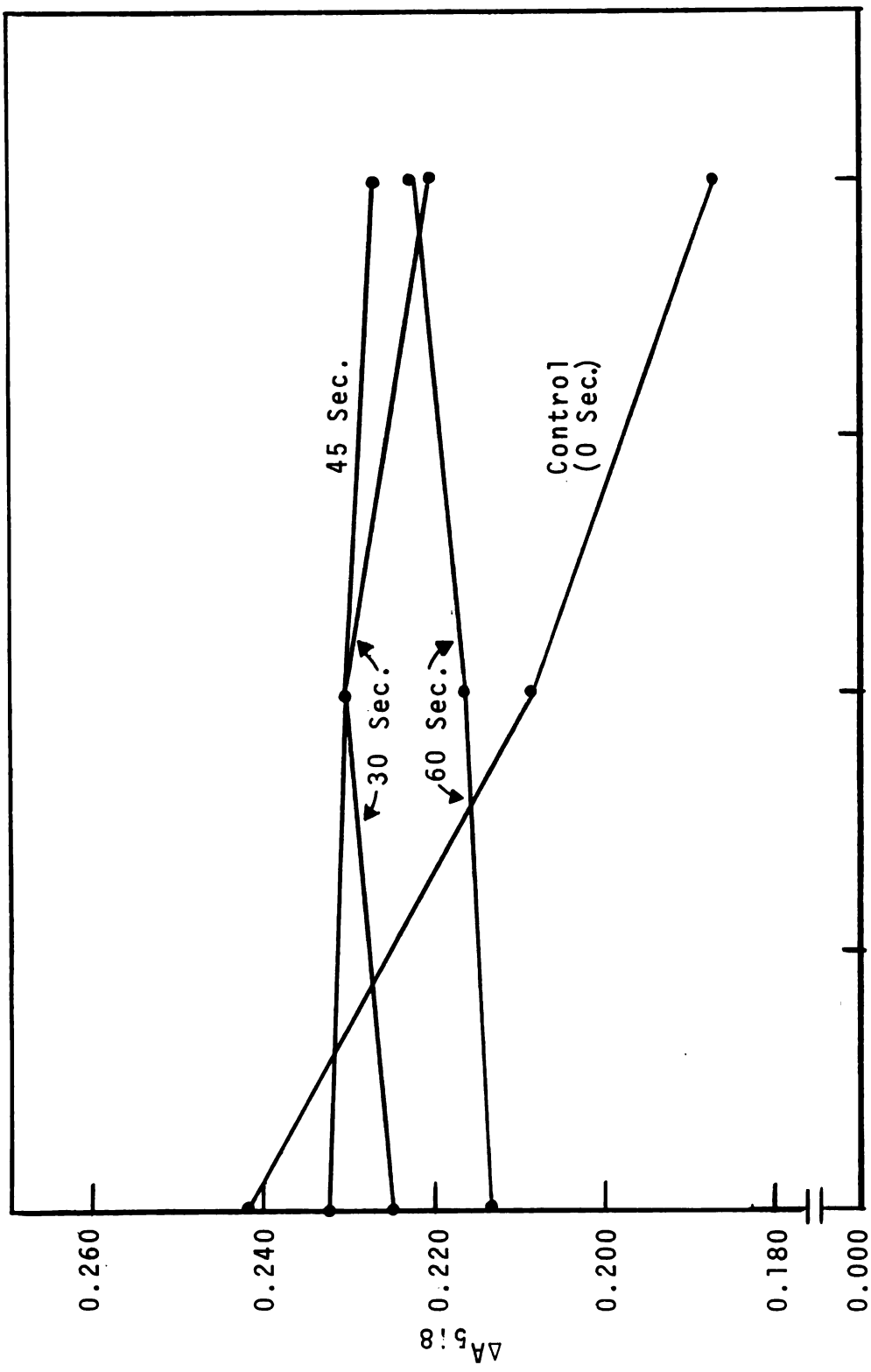


Figure 6.--Effect of blanching on red color retention during thawing.

Table 6.--Absorbance values of cherries steam-blanched for 4 different periods and analyzed without thawing (frozen sample dropped in boiling extraction solvent).

Blanch	$A_{518, 1.0}$	$A_{518, 4.5}$	$^{*}A_{518, 1.0} - A_{518, 4.5}$
Control (0 sec.)	0.360	0.113	0.247
	0.355	0.118	0.237
	0.355	0.113	0.242
30 sec.	0.340	0.117	0.223
	0.344	0.118	0.226
	0.340	0.114	0.226
45 sec.	0.355	0.124	0.231
	0.355	0.123	0.232
	0.353	0.120	0.233
60 sec.	0.325	0.114	0.211
	0.325	0.112	0.213
	0.323	0.108	0.215

*These values represent anthocyanin concentrations 2500 times lower than those actually present in the fruit flesh.

Table 7.--Absorbance values of cherries steam-blanched for 4 different periods and analyzed after 2 hours of thawing as single layer at room temperature.

Blanch	$A_{518, 1.0}$	$A_{518, 4.5}$	$^{*}A_{518, 1.0} - A_{518, 4.5}$
Control (0 sec.)	0.320	0.114	0.206
	0.320	0.113	0.207
	0.320	0.110	0.210
30 sec.	0.346	0.118	0.228
	0.350	0.120	0.230
	0.349	0.117	0.232
45 sec.	0.350	0.118	0.232
	0.350	0.118	0.232
	0.345	0.120	0.225
60 sec.	0.335	0.118	0.217
	0.335	0.120	0.215
	0.335	0.118	0.217

*These values represent anthocyanin concentrations 2500 times lower than those actually present in the fruit flesh.

Table 8.--Absorbance values of cherries steam-blanched for 4 different periods and analyzed after 4 hours of thawing as single layer at room temperature.

Blanch	$A_{518, 1.0}$	$A_{518, 4.5}$	$^{*}A_{518, 1.0} - A_{518, 4.5}$
Control (0 sec.)	0.310	0.124	0.186
	0.312	0.124	0.188
	0.310	0.124	0.186
30 sec.	0.338	0.119	0.219
	0.343	0.120	0.223
	0.339	0.122	0.217
45 sec.	0.345	0.118	0.227
	0.345	0.118	0.227
	0.343	0.119	0.224
60 sec.	0.348	0.127	0.221
	0.348	0.127	0.221
	0.342	0.122	0.220

*These values represent anthocyanin concentrations 2500 times lower than those actually present in the fruit flesh.

SUMMARY AND CONCLUSIONS

1. The effect of blanching on the stability of anthocyanins and the prevention of red color loss in individually quick frozen red tart cherries was studied.

2. Blanched and unblanched cherries showed no color loss during frozen storage for 300 days and 100 days in two consecutive years. Absorbance values of the samples were determined at two pH levels which eliminated the interference of any concurrent browning.

3. Rapid oxidation tests were conducted under atmospheres of air, oxygen, and nitrogen. All unblanched fruit showed a high color loss under these accelerated oxidative defrosting conditions; 69, 66, and 53 percent for oxygen, air, and nitrogen, respectively.

Blanched fruit showed a significantly lower percent color loss during oxidation tests than the unblanched fruit. Using oxygen, the 30-second blanched fruit showed the highest color loss (22%) of all blanched samples; red color loss was very low (6%) for 45-second blanched fruit and no color loss occurred in the 60-second blanched fruit. Also, among the blanched samples, those blended under nitrogen suffered the smallest loss of color.

4. Unblanched cherries showed a significant color loss on thawing at room temperature for two and four hour periods; blanched fruit showed no significant color loss.

5. In conclusion, cherries which remained frozen at 0 to -5°F had no red color loss over a relatively long period of time. Fruit which thawed was subjected to anthocyanin degradation. A 60-second steam blanch treatment before freezing was effective in eliminating this oxidative enzymatic color loss in the thawed fruit. Steam blanching may supplement good handling and proper storing in preserving the red color of frozen cherries.

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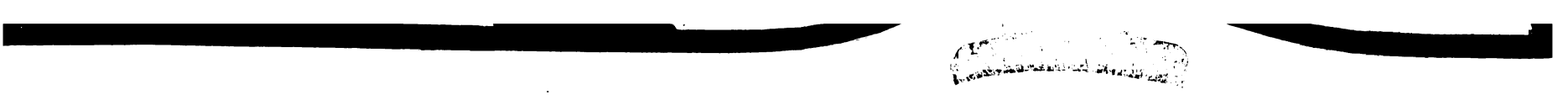

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