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Effects of Calcium, Daminozide, and Fruit Maturity on Canned 'Bing' Sweet Cherry Quality

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Additional index words. *Prunus avium*, pitted vs. nonpitted

Abstract. **Cherries pitted prior to canning or treated with daminozide had lower drained weights, more total anthocyanin, more turbid syrup, darker Agtron red values, and were softer than nonpitted or nontreated cherries. USDA color grade was higher, but USDA character grade was reduced when cherries were pitted or treated with daminozide. $CaCl_2$ applied as either a 3% dip prior to pitting or as a 1% addition to the syrup increased the firmness, decreased the turbidity of the syrup of pitted and nonpitted cherries, and reduced the number of split fruit in nonpitted cherries. $CaCl_2$ improved the USDA character grade of pitted and nonpitted cherries, and daminozide-treated cherries. Delaying harvest by 8 days reduced drained weight losses, increased total anthocyanin content, pH and soluble solids, and resulted in a darker red canned cherry as measured by the Agtron. $CaCl_2$ compensated for the reduced USDA scores for character caused by pitting or daminozide, increasing character to equal that of nonpitted or nontreated, respectively. Chemical names used: butanedioic acid mono(2,2-dimethylhydrazide) (Daminozide).**

Traditionally, sweet cherries have been canned with the stony endocarp (pit) intact. Presently the trend in sweet cherry canning is to remove the pit. Sweet cherry pit removal leads to extensive mechanical damage to the cherry with possible losses in quality. Other problems associated with pitting can vary from year to year and orchard to orchard. Recently, in central Washington, some dark sweet cherries have been damaged extensively during pit removal.

The use of Ca has been reported (3, 4, 7, 11, 12) to decrease softening of fresh apples during storage, and to improve the firmness of processed products as well. Surfactants and temperature differential have been shown (10) to influence Ca uptake in apples. Daminozide has been reported (13) to hasten coloring, increase soluble solids, and reduce firmness in fresh 'Bing' cherries. In processed sweet cherries (5, 6), daminozide increased drained weight losses, red color, and anthocyanin content, and reduced the USDA character or firmness grade. The addition of Ca to red tart cherries has been shown to increase firmness and drained weights (2, 9). This study was conducted to compare the quality of nonpitted and pitted cherries, and to determine if adding Ca could reduce mechanical damage associated with pitting and increase the firmness of canned sweet cherries.

Materials and Methods

This study was conducted with 'Bing' cherries (*Prunus avium* L.) from trees planted in 1963. Triplicate tree plots for each treatment (control and daminozide) were used in both 1982 and 1983. The trees with daminozide in this study had been treated for the past 10 consecutive years. Daminozide was applied on 5 May 1982, and 26 Apr. 1983, 14 and 19 days after full bloom, respectively, at 2000 ppm as a foliar spray to runoff with a hand gun. A nonionic wetting agent, X77 (Chevron Chem. Co., San Francisco, Calif.), was added. The trees were uniform in size

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and vigor with similar crop loads. In 1982, a once over harvest at initial canning maturity was conducted. To investigate the effect of maturity, the experiment was conducted in 1983 with 2 harvest dates 8 days apart.

After harvest, the stems were removed and the cherries cleaned, washed, and fruit from each tree divided into 3 lots. One lot was canned as either whole or pitted cherries and covered with 20° Brix sucrose syrup. The 2nd lot was canned as either whole or pitted cherries and covered with 20° Brix syrup containing 1% $CaCl_2$. The 3rd lot was immersed into a 3% $CaCl_2$ solution containing an experimental wetting agent, Concentrate F (Leffingwell Chemical Co., 111 S. Berry St., Brea, Calif.), for 3 min. After immersion, the cherries were allowed to drain, then held for 12 hr prior to canning and canned either whole or pitted and covered with a 20° Brix syrup. Cherries were pitted with a Dunckley (Dunckley Co., Kalamazoo, Mich.) commercial cherry pitter. A weighed amount of fruit was filled into 303 × 406 cans and covered with 220 ml of syrup at 93°C. The cans were exhausted at 93° for 5 min and processed at 100° for 18 min.

Fruit color was determined with an Agtron model 300-A reflectance spectrophotometer. Total anthocyanin of the fruit was determined colorimetrically (8). Turbidity of the canned syrup was measured with a Hach Ratio Turbidity meter (Hach Co., P.O. Box 389, Loveland, Colo.), and expressed as Nephelomatric Turbidity Units (NTU). Soluble solids content of the canned cherries was determined by an Abbe-type refractometer with a sucrose scale calibrated at 20°C.

The pH was determined with a Coleman model 12 pH meter. Acids were titrated to pH 8.2 with 0.1 N NaOH and expressed as the percentage of malic acid. Drained weights were determined by official AOAC methods (1). Shear values are reported as the force required to shear 100 g of product and are reported in newtons. The incidence of "splits" of the whole nonpitted cherries were determined visually and expressed as the percentage of the total fruit content. A USDA inspector graded the canned fruit by using USDA standards (14). The design consisted of growth regulators (2 levels) as the main plot, Ca treatment (3 levels), and pitting treatment (2 levels) as the subplots, and trees (6/year) were used as replications. Harvest date (2 levels) was added as an additional subplot in 1983.

Results and Discussion

When pitted prior to canning, sweet cherries had increased drained weight losses, higher turbidity syrup, and increased total anthocyanin content with darker Agtron red values. Shear or firmness values and reduced pH also were evident for pitted when compared to nonpitted cherries (Tables 1 and 2). Mesocarp fragments from fruit torn or crushed during pit removal were suspended in the syrup, resulting in increased drained weight losses and contributing to the turbidity of the syrup. This damage caused by pitting is probably the reason for reduced shear or firmness values, and a reduced USDA character grade (Table 3).

Damaged cherry tissue in pitted cherries would tend to lose color into the syrup more readily than nonpitted fruit. This leaching of color into the syrup from damaged or pitted fruit could also be the reason for increased total anthocyanin content and decreased Agtron red value of the fruit, in that color is relatively uniform throughout the product. This objective color difference between nonpitted and pitted cherries also was evident in USDA color grades. In addition, water soluble material other than color pigments also would tend to leach into the syrup resulting in increased turbidity (Table 3).

These differences in drained weights, shear or firmness values, turbidity, Agtron red, total anthocyanin, and pH values, between nonpitted and pitted cherries, were significant differences for 2 growing seasons, 1982 and 1983. The difference in USDA color grades was significant for only the 1982 season, but the same trend was present in 1983. There was no difference in soluble solids between nonpitted and pitted cherries.

In this study, daminozide-treated cherries had increased drained weight losses and total anthocyanin content, and a darker Agtron red color (Table 1 and 2) and a reduced USDA character grade (Table 3), as reported previously (5, 6). Increased shear values generally indicate a firm product with improved texture (character). The differences in shear values and USDA color values were not significant for the 2nd year, but a trend for increased shear values and USDA color was evident. The use of daminozide on cherries to be processed did not influence soluble solids content, pH, or the incidence of "splits" for either 1982 or 1983 (Tables 1 and 2). In addition, the syrup turbidity from daminozide-treated processed cherries increased in both years, and shear values and USDA color of the fruit were higher in 1982, compared to those not treated.

Drained weight losses between daminozide-treated cherries and the control were significant at the 1st harvest only, indicating an interaction between harvest date and daminozide (Table 4). Color of the daminozide-treated cherries measured either

Table 1. Effect of pitting, Ca, and daminozide on the objective quality of canned dark sweet cherries, 1982.

Treatment	Drained wt lost (%)	Shear (N)	Turbidity (NTU)	Agtron red[z]	Total anthocyanins (Abs/ml)	pH	Soluble solids (%)	Incidence of splits (%)
Pitting treatment								
Nonpitted	13.1 b[y]	408 a	47.2 b	37.5 a	58.8 b	4.25 a	18.6 NS	---
Pitted	15.1 a	364 b	138.9 a	35.4 b	66.2 a	4.08 b	18.5	---
Ca treatment								
No $CaCl_2$	14.0 ab	279 b	97.9 a	36.9 NS	62.5 NS	4.18 NS	18.7 NS	81.5 a
1% syrup	16.0 a	426 a	85.6 b	35.5	60.7	4.08	18.5	38.0 c
3% dip	12.8 b	454 a	95.7 ab	36.9	63.4	4.23	18.3	60.4 b
Growth regulator								
No daminozide	12.4 b	362 b	83.0 b	40.9 a	58.3 b	4.15 NS	18.4 NS	58.8 NS
Daminozide	16.2 a	411 a	103.1 a	31.9 b	66.7 a	4.17	18.7	61.8

[z]Values were determined with an Agtron Model 300-A reflectance spectrophotometer using the red mode and calibrated with disks 00 and 12.

[y]Mean separation in a column within treatments by Duncan's multiple range test, 5% level.

Table 2. Effect of pitting, Ca, daminozide, and harvest date on the objective quality of canned dark sweet cherries, 1983.

Treatment	Drained wt lost (%)	Shear (N)	Turbidity (NTU)	Agtron red[z]	Total anthocyanins (Abs/ml)	pH	Soluble solids (%)	Incidence of splits (%)
Pitting treatment								
Nonpitted	12.3 b[y]	485 a	28.8 b	25.4 a	64.3 b	4.09 NS	21.2 NS	---
Pitted	16.1 a	463 b	109.4 a	20.7 b	69.3 a	4.03	21.6	---
Ca treatment								
No $CaCl_2$	13.9 b	383 b	79.2 a	22.9 NS	65.5 NS	4.13 a	21.1 NS	84.4 a
1% syrup	14.7 a	519 a	57.4 c	24.6	69.0	3.87 b	21.7	61.6 c
3% syrup	13.9 b	522 a	70.8 b	21.7	65.9	4.11 a	21.3	75.2 b
Growth regulator								
No daminozide	12.7 b	471 NS	63.6 b	26.5 a	59.2 b	4.04 NS	21.3 NS	73.4 NS
Daminozide	15.6 a	476	74.5 a	19.6 b	74.3 a	4.03	21.5	74.1
Harvest date								
29 June	15.9 a	476 NS	66.6 NS	26.7 a	61.1 b	3.98 b	20.6 b	77.9 NS
7 July	12.5 b	467	71.5	19.4 b	72.5 a	4.09 a	22.1 a	69.6

[z]Values were determined with an Agtron Model 300-A reflectance spectrophotometer using the red mode and calibrated with disks 00 and 12.
[y]Mean separation in a column within treatments by Duncan's multiple range test, 5% level.

Table 3. Effect of pitting, Ca, daminozide and harvest date on the USDA color and character grade of canned dark sweet cherries.

Treatment	1982		1983	
	Color	Character	Color	Character
Pitting treatment				
Nonpitted	26.6 b[z]	17.6 a	25.5 NS	18.3 a
Pitted	27.2 a	16.4 b	26.4	17.5 b
Ca treatment				
No $CaCl_2$	27.3 a	16.4 b	26.4 NS	17.4 b
1% Syrup	26.7 b	17.3 a	25.2	18.0 a
3% Dip	26.7 b	17.3 a	26.3	18.3 a
Growth regulator				
Control	26.5 b	17.7 a	25.7 NS	18.3 a
Daminozide	27.2 a	16.4 b	26.2	17.5 b
Harvest date				
29 June	---	--	25.6 NS	17.7 b
7 July	---	---	26.3	18.2 a

[z]Mean separation in a column within treatments by Duncan's multilple range test, 5% level.

Table 4. Effect of the interaction between harvest date and daminozide on the objective quality of canned dark sweet cherries, 1983.

Harvest date	Growth Regulator	Drained wt loss (%)	Agtron red[z]	Total anthocyanins (Abs/ml)	pH	Soluble solids (%)
29 June	Control	13.7 b[y]	28.5 a	57.5 c	3.96 c	20.8 c
	Daminozide	18.0 a	24.9 b	64.5 b	4.00 c	20.5 c
7 July	Control	11.8 c	24.6 b	60.8 c	4.13 a	21.7 b
	Daminozide	13.2 bc	14.3 c	84.1 a	4.06 b	22.5 a

[z]Values were determined with an Agtron Model 300-A reflectance spectrophotometer using the red mode and calibrated with disks 00 and 12.
[y]Mean separation in a column by Duncan's multiple range test, 5% level.

with the Agtron or as total anthocyanin concentration was enhanced over the control. Daminozide hastened color development, as color of the control cherries at the 2nd harvest approximated the color of the daminozide-treated cherries at the 1st harvest. Daminozide-treated cherries at the 2nd harvest had higher pH and soluble solids than the control. The use of daminozide-treated cherries at later harvest dates, with their higher soluble solids, possibly could reduce the use of sweetening agents to meet labeled cut-out percentages or required °Brix for the processed product.

Delay of harvest by 8 days resulted in reduced drained weight losses, Agtron red values darkened, and total anthocyanin concentration, pH, and soluble solids (Table 2) and USDA character grade increased (Table 3). The approximate 21% reduction in drained weight losses or 7% gain in soluble solids could make a significant difference in a profitable vs. a nonprofitable cherry pack. The mature cherries with reduced drained weight losses would allow for less overfill to meet minimum drained weight standards, and an increased soluble solids content would allow for reduced use of sweetening agents to meet required Brix cut-out level. These differences in drained weights, color, soluble solids, and character grade have been reported previously (6), and there is good indication that these differences would be consistent from year-to-year.

Shear or firmness values increased dramatically with the use of $CaCl_2$ (Tables 1 and 2), averaging about 44% using 1% $CaCl_2$ in the syrup and 50% using $CaCl_2$ (3%) as a dip prior to canning. Firmer cherries had less turbid syrup and fewer splits than those not firm, producing a more visually attractive product, particularly when 1% $CaCl_2$ was used in the syrup. The less turbid syrup allowed for a canning medium with bright, clear characteristic color, and the reduced splitting of $CaCl_2$-treated cherries produced a more acceptable visual pack of cherries.

A nonreplicated tasting session indicated no flavor difference resulting from the use of $CaCl_2$. Drained weight increased significantly with the use of $CaCl_2$ in the 1983 pack, particularly when the $CaCl_2$ was used in the syrup.

$CaCl_2$ increased USDA character grade (Table 5) either as a dip or in the syrup. Sweet cherries that were not treated with $CaCl_2$ did not score more than 17 points, which would limit these cherries to no higher than U.S. Grade B, regardless of total score for the product (14). A character score of 17 or less is considered limiting by USDA standards (14). The character score for cherries treated with $CaCl_2$ was 18 or better in 1983, and 1 point higher than cherries without $CaCl_2$ in 1982. USDA

Table 5. USDA character grades for canned dark sweet cherries as influenced by pitting, calcium addition, and daminozide 1982 and 1983.

	Control		Daminozide	
$CaCl_2$ content	Nonpitted	Pitted	Nonpitted	Pitted
No $CaCl_2$	18.1 bc[z]	17.1 d	17.3 d	15.8 e
1% $CaCl_2$ syrup	18.3 b	18.0 bc	17.8 cd	17.0 d
3% $CaCl_2$ dip	19.0 a	17.8 cd	18.1 bc	17.0 d

[z]Mean separation by Duncan's multiple range test, 5% level.

color grade was reduced when cherries were treated with $CaCl_2$ during the 1982 pack, but this effect was not evident for the 1983 pack.

$CaCl_2$ compensated for the reduced USDA character scores for character caused by pitting or daminozide, increasing character equal to that of nonpitted or nontreated, respectively. Although only 1 to 2 points difference, this increase in character grade of pitted or daminozide-treated cherries as a result of the use of Ca is enough to change the U.S. Grade from C to B or B to A in some instances.

The use of $CaCl_2$ in the processing of sweet cherries either as a dip or added in the syrup improved the quality of pitted or daminozide-treated cherries. These improvements in quality of sweet cherries were of significant magnitude to justify the use of $CaCl_2$ in sweet cherry processing.

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