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# Color Stability of Blackberry Nectars During Storage

Semra Yuksel and Ilkay Koca
Department of Food Engineering, Faculty of Engineering,
University of Ondokuz Mayis, Samsun, Turkey

**Abstract:** Color is one of the most important factors indicating the quality of food. It plays a significant role in consumer's acceptance of and preference for products. Anthocyanins are phenolic compounds responsible for the attractive color of blackberry nectars. This research was conducted to identify the effect of storage time and temperature on color and pigment during the storage of the blackberry nectars. Nectar samples were stored at room temperature (+20°C) and refrigerator temperature (+4°C) for 7 months. Color and pigment analyses were done monthly. As the results of statistical analyses of the properties periodically studied, the effects of storage temperatures and storage time on L, a, hue engle, polymeric color, color density, tannin contribution and total anthocyanin were found to be significant at $p<0.01$ level. The decrease in the amount of total anthocyanin which gives original color to nectar was 95% in nectars stored at room temperature and 77% in nectars stored at refrigerator temperature.

**Key words:** Anthocyanin, blackberry, color, nectar

## INTRODUCTION

Anthocyanins are responsible for the attractive color of blackberry nectars (Rommel *et al*., 1992). They have been hypothesized as important antioxidants. However, anthocyanins dissappear as monomeric compounds and are transformed into polymeric forms. This transformation results in a color change to a more brownish shade (Iversen, 1999; Rein and Heinonen, 2004).

Storage temperature is the main responsible factor for anthocyanin loss. Degradation rate increases as corresponding with food properties and anthocyanins compositions. Many researchers (Abers and Wrolstad, 1979; Rommel *et al*., 1990, 1992; García-Viguera *et al*., 1998, 1999; Iversen, 1999) reported anthocyanin losses in different foods during storage.

Anthocyanin loss can be easily determine by pigment, color analysis and also tristimulus colorimetry. Tristimulus colorimetry in color is a valuable tool for discriminating changes in color due to both Maillard reaction and anthocyanin degradation (Buglione and Lozano, 2002).

This research was conducted to identify the effect of storage period and temperature on color and pigment during the storage of the blackberry nectars.

## MATERIALS AND METHODS

Blackberry nectars were obtained from a commercial factory (Sinope Fruit Juice Company, Sinop-Turkey). A total of 60 samples each were in 200 mL glass bottles were brought to the laboratory. Twenty eight of the samples were stored at room temperature (+20°C) in darkness and 28 of them at refrigerator temperature (+4°C) for 7 months. Color and pigment analyses were done monthly. Initially, the nectars had a 3.61 pH, 10 °Brix, 60.92 g $L^{-1}$ reducing sugar, 38.85 g $L^{-1}$ unreducing sugar, 15.12 mg $L^{-1}$ ascorbic acid and 9.62 mg $L^{-1}$ hydroxymethyl furfural.

For determining color parameters (L, a, b), a 1 mL sample was diluted with 1 mL distilled water and the absorbances of these solutions were recorded in transmittance in the interval 200-900 nm using 1 cm quartz cell by a spectrophotometer (Jasco UV-Visible V-530 Japan) which was equipped with a computer software programe with illuminant $D_{65}$ and 2° observer angle. The L, a and b values describe a three dimensional color space. L is a measure of lightness, from completely opaque (0) to completely transperent (100), while a is measure of redness (or -a of greenness) and b of yellowness (or -b of blueness). Hue angle (H) was calculated according to the following equation:

$$H = \tan^{-1}(b/a)$$

Polymeric color, color density and the percent of tannin contribution were determined using spectral methods described by Spayd *et al.* (1984). Color density (CD) was measured by adding 2 mL of distilled water to 2 mL of sample. The absorbance was measured with the spectrophotometer at 420, 515 and 700 nm. CD was

**Corresponding Author:** Ilkay Koca, Department of Food Engineering, Faculty of Engineering, University of Ondokuz Mayis, Samsun, Turkey

calculated as CD = $(A_{420}+A_{515})- 2(A_{700})$. Polymeric color (PC) was measured by adding 2 mL of 20% potassium metabisulfite to 2 mL of sample. Polymeric color was calculated as PC = $(A_{420}+A_{515})-2(A_{700})$. The percent contribution of tannin (% CDT) was calculated as the ratio of polymeric color to color density (%CDT = PC/CD×100).

Total anthocyanin (Tacy) content was determined by the pH differential method as described by Wrolstad (1976). Absorbance was measured in the spectrophotometer at 515 and 700 nm in buffers at pH 1.0 and pH 4.5, using $A = (A_{515}-A_{700})_{pH1.0}-(A_{515}-A_{700})_{pH4.5}$, with a molar extinction coefficient of cyanidin 3-glucoside of 29,600. Results were expressed as mg $L^{-1}$ wet weight (cyn 3-glu equivalents) of fresh weight.

**Statistical analysis:** The study was designed as a factorial within two temperature and eight storage times with four repetitions. Data were subject to analysis of variance and the changes of statistical analyses were performed using MSTAT with significance at $p<0.01$. Correlation analyses were performed using SPSS 11.0 packed programme.

## RESULTS AND DISCUSSION

The analysis results of periodically examined properties of the blackberry nectars are shown in Table 1.

In this study, the effects of storage temperature and time on L value (lightness index), a value (redness index), hue, polymeric color, color density, tannin contribution and total anthocyanin were statistically significant found ($p<0.01$). The effect of storage temperature on b values (yellowness index) was no significant ($p<0.01$) (Table 1).

L values were generally increased during storage at room and refrigerator temperature, that is, the color was to clear up. The increase in L values point to loss of the color. Loss of the color was result of anthocyanin degradation. Main and Morris (1994) obtained decrease for grape juice wines, while Pilando *et al.* (1985) and Rommel *et al.* (1992) obtained increase in L values.

Until the 1st months of storage, at both temperature degrees, a values increased and then generally decreased. The highest a values obtained in samples stored at refrigerator temperature. At this temperature, since the loss of anthocyanin was less a values were more high. During storage, the changes of a values are similar to results reported by Pilando *et al.* (1985), however it was different from the results of several researchers (Rommel *et al.*, 1990; Skrede *et al.*, 1992; García-Viguera *et al.*, 1998, 1999; Garzün and Wrolstad, 2000). The increase of a values may stem from polimerization of anthocyanins and browning. The increase of *a* values may stem from polimerization of anthocyanins and browning. b values of samples stored at room temperature more slowly increase than the samples stored in refrigerator. Rommel *et al.* (1990, 1992) reported similar results.

The Hue angle is a parameter frequently used to characterise color in food products. Hue describes what the average person thinks of when he speaks of color (i.e green, red, yellow, etc) (Ochoa *et al.*, 1999). An angle of 0 or 360° represedent red Hue, while 90, 180 and 270° represent yellow, green and blue Hue, respectively. It has been extensively used in evaulation of color parameters in vegetables, fruits and meats (Barreiro *et al.*, 1997). As given in Table 1, the lowest hue angle value was found samples stored in refrigerator.

Table 1: Changes in color and pigment during storage of blackberry nectars (n = 4)

| | | Hunter values | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Months | Temp. | L | +a | +b | Hue | PC | CD | %CDT | Tacy, mg $L^{-1}$ |
| 0 | 20°C | 12.70 | 21.98 | 7.59 | 19.05 | 1.09 | 3.27 | 33.45 | 135.63 |
| | 4°C | 12.70 | 21.98 | 7.59 | 19.05 | 1.09 | 3.27 | 33.45 | 135.63 |
| 1 | 20°C | 22.86 | 37.75 | 12.77 | 18.69 | 3.21 | 6.40 | 50.12 | 100.62 |
| | 4°C | 17.93 | 30.16 | 10.15 | 18.60 | 3.22 | 6.63 | 48.66 | 120.10 |
| 2 | 20°C | 18.42 | 24.22 | 9.38 | 21.19 | 3.11 | 5.49 | 56.63 | 49.63 |
| | 4°C | 19.49 | 26.36 | 9.96 | 20.70 | 2.70 | 5.48 | 49.23 | 73.03 |
| 3 | 20°C | 19.58 | 26.15 | 10.10 | 21.13 | 3.08 | 5.54 | 55.71 | 42.47 |
| | 4°C | 20.81 | 28.58 | 10.82 | 20.75 | 2.57 | 5.39 | 47.63 | 64.62 |
| 4 | 20°C | 18.32 | 22.95 | 9.44 | 22.37 | 3.53 | 5.85 | 60.42 | 18.64 |
| | 4°C | 20.47 | 25.64 | 10.35 | 22.05 | 2.98 | 5.49 | 54.34 | 56.53 |
| 5 | 20°C | 17.77 | 22.04 | 9.25 | 22.80 | 3.56 | 5.55 | 64.18 | 16.28 |
| | 4°C | 19.54 | 25.60 | 9.96 | 21.28 | 2.83 | 5.23 | 54.13 | 43.75 |
| 6 | 20°C | 17.33 | 20.36 | 9.12 | 24.19 | 3.54 | 5.34 | 67.15 | 11.73 |
| | 4°C | 21.41 | 25.54 | 10.76 | 22.85 | 2.83 | 5.04 | 56.08 | 36.04 |
| 7 | 20°C | 17.75 | 19.43 | 9.45 | 25.95 | 3.96 | 5.56 | 71.13 | 7.39 |
| | 4°C | 18.65 | 22.55 | 9.59 | 23.05 | 3.11 | 5.54 | 56.22 | 31.50 |
| Time (A) | | ** | ** | ** | ** | ** | ** | ** | ** |
| Temperature (B) | | ** | ** | | ** | ** | ** | ** | ** |
| A×B | | ** | ** | ** | ** | ** | ** | ** | ** |

**Significant at $p<0.01$

Table 2: Correlation between other variables and total anthocyanin

| Parameters | Correlation coefficient (r) |
|---|---|
| Hunter L | -0.375* |
| Hunter + a | 0.392* |
| Hunter + b | -0.140 |
| Hue | -0.838** |
| Polimeric color | -0.771** |
| Color density | -0.400* |
| Tannin contribution | -0.910** |

*Significant at p< 0.05, ** Significant at p<0.01

Polymeric color values of nectars increased during storage. The results similar to reports of García-Viguera *et al.* (1999) and Skrede *et al.* (1992). Storage temperatures effected on polymeric color values. The lowest values of polymeric color was obtained samples stored in refrigerator and similar to results of Rommel *et al.* (1992). As it was also explained by Rommel *et al.* (1992) and Abers and Wrolstad (1979), increasing polymeric color values show loss in monomeric anyhocyanin pigments and the increase in polimerize pigments.

Color density shown different behaviour depending on temperature degrees during storage. The highest color density value was obtained samples stored at room temperature. Rommel *et al.* (1992) reported similar results for blackberry wines.

The tannin contribution values of samples stored at room and refrigerator temperature increased during storage. Highest values obtained on stored samples at room temperature. The results are similar to Rommel *et al.* (1992).

The colors of blackberry nectars changed during seven months of storage. Storage temperatures was the main responsible factor for color changes. Total anthocyanin contents of samples stored in refrigerator were higher than samples stored at room temperature. The rate of degradation anthocyanin increased when increasing temperature in nectars. Several researchers (Abers and Wrolstad, 1979; Rommel *et al.*, 1990, 1992; García-Viguera *et al.*, 1998; Tosun and Yuksel, 2002) reported similar results. As pointed out by Ochoa *et al.* (1999), it was indicated that for some berry products color deterioration cannot be characterized by changes in total anthocyanin alone. Most of the anthocyanin was polymerized, rather than lost during storage. Percentage tannin contribution is a measure of the pigment resistance to bleaching and indicates, to some degree, the anthocyanin polymerization.

The anthocyanin values decreased with increasing storage time. This manner was also reported by several researchers (Abers and Wrolstad, 1979; Rommel *et al.*, 1990, 1992; Cemeroglu *et al.*, 1994; García-Viguera *et al.*, 1998).

Total anthocyanin loss was 95% for samples room temperature and 77% for the samples stored in refrigerator. This results shown the importance of storage temperature on total anthocyanin retention. Total anthocyanin contents in samples stored at room temperature were in agreement with the findings of several researchers (Rommel *et al.*, 1992; García-Viguera *et al.*, 1998; Tosun and Yuksel, 2002).

The anthocyanin loss in stored samples at refrigerator temperature was more than the results belongs to Tosun and Yuksel (2002). This difference may due to different composition and anthocyanin profiles.

In this study, it was evaulated correlation coefficients between the other parameters and total anthocyanin values (Table 2). According to the result of correlation analyses, it was found that the correlation between b values and total anthocyanin was not significant. It was found that there was only positive correlation between a values and total anthocyanin values. The correlation coefficient was highly negative for total anthocyanin with hue, tannin contribution and polymeric color. Rommel *et al.* (1990, 1992) found negative correlation between total anthocyanin and L, b and tannin contribution and our results agree with these reports.

## CONCLUSION

Total anthocyanin contents of blackberry nectars decreased during seven months of storage at room and refrigerator temperature and the colors of samples changed. This research showed that the anthocyanin contents changed severely in blackberry nectars stored at room temperature. Cold storage of blackberry nectars is recommended to minimize anthocyanin degradation.

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