# Predicting Anthocyanin Content in Canned Black Beans Based on Color

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## ABSTRACT

The dark color of black beans is generally associated with the presence of anthocyanins. Anthocyanins are phytochemicals known to contribute to improved health due to their antioxidant, anti-inflammatory, anti-viral and anti-cancer benefits. Therefore, the color of canned black beans could potentially predict the total concentration of anthocyanins present. To test this hypothesis, 12 black bean genotypes obtained from North Dakota State University dry bean breeding program were cooked and evaluated for anthocyanin content and color characteristics (L*, hue and chroma) of end-product. Pearson Correlation statistics was then applied to confirm if color values could be used as a reliable index to predict relative amounts of anthocyanin in cooked beans. Except for chroma, color overall did not prove to be a good predictor of anthocyanin content. Furthermore, genotypes with higher anthocyanin concentrations lost more anthocyanin after soaking and cooking. Results suggest the need to complement breeding with efforts to reduce anthocyanin loss using innovative food processing technologies.

## METHOD

### Canning

Forty grams of black beans (in triplicate) was collected in 8-ounce canning jars and soaked overnight by filling the jars with distilled water. After soaking, jars were drained and then hot-filled with distilled water at boiling temperature. The jars were then sealed tightly and thermally processed in an autoclave at 115 °C and 10 psi for 15 minutes. Following cooking, the jars were removed and cooled to room temperature.

### Anthocyanin Extraction

Ten grams of raw black bean seeds (in triplicate) was weighed in a 45 ml centrifuge tube and 20 ml of 50% ethanol (acidified with HCl, pH = 3.0) added. The tubes were then partially sealed and placed in a water bath at 65ºF for extraction for 2 hours. Similar steps were followed for cooked black beans except that the tubes were centrifuged (3000 rpm, 10 min) following incubator treatment in order to settle particulates produced during cooking.

### Anthocyanin Determination

Anthocyanin was determined (in triplicate) using a standard pH differential method (AOAC Official Method 2005.02)

### Color Measurement

Color was determined (in triplicate) using a CR-410 Konica Minolta Chroma meter (Konica Minolta Inc., Japan)

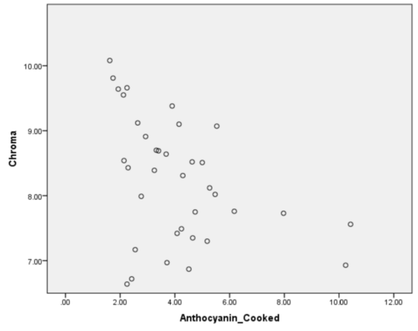
### Statistical Analysis

SPSS Software (IBM SPSS Statistics for Windows, Version 24.0) was used to conduct analysis of variance (ANOVA) following Tukey's multiple comparison test. Correlations were assessed by computing Pearson product-moment correlation coefficient. Differences were considered to be significant at $p < .05$.

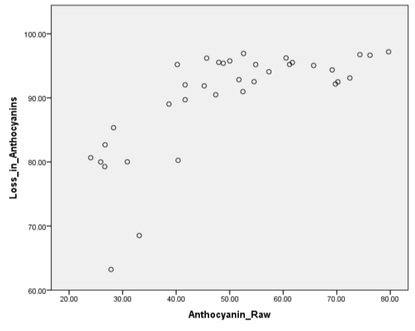
## RESULTS


Images showing genotypes and corresponding anthocyanin content from lowest (1) to highest (12)

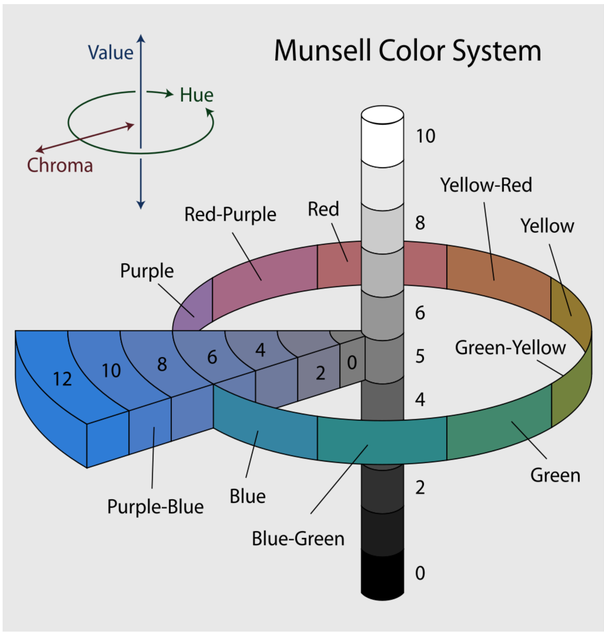
| Genotype | Anthocyanin Content in Raw Beans (g/100 mg) | Anthocyanin Content in Cooked Beans (g/100mg) | Loss in Anthocyanin Content After Cooking (%) | Colorimetric Evaluation of Canned Beans | | |
|---|---|---|---|---|---|---|
| | | | | L* | Hue Angle | Chroma |
| Zorro | 46.17 ± 6.2bc | 1.76 ± 0.16cde | 96.10 ± 0.86cd | 23.09 ± 0.23bcde | 17.98 ± 0.80ab | 9.85 ± 0.22e |
| NDF120253 | 76.74 ± 2.72cd | 2.41 ± 0.15abc | 96.86 ± 0.28d | 21.69 ± 0.45a | 13.11 ± 1.42a | 6.84 ± 0.29a |
| NDF120287 | 46.83 ± 4.51cd | 2.56 ± 0.66bcde | 94.39 ± 2.05d | 23.93 ± 0.53de | 24.69 ± 1.71cd | 9.3 ± 0.53de |
| NDF120066 | 59.86 ± 2.27a | 2.82 ± 0.56de | 95.27 ± 1.09bc | 22.77 ± 0.54abcde | 21.56 ± 2.34bcd | 8.37 ± 0.35bcd |
| NDF141248 | 49.35 ± 4.95f | 2.82 ± 0.79ab | 94.2 ± 2.03d | 22.94 ± 0.13abcde | 20.2 ± 0.13bc | 8.77 ± 0.31cd |
| ND132381 | 65.33 ± 3.99c | 3.36 ± 0.49abc | 94.87 ± 0.45d | 23.77 ± 0.67cde | 26.05 ± 2.8d | 8.89 ± 0.49cde |
| NDF141198 | 51.23 ± 3.61de | 4.10 ± 0.40abc | 91.94 ± 1.27d | 22.53 ± 0.35abc | 24.01 ± 1.54cd | 7.09 ± 0.30a |
| NDF141195 | 44.28 ± 7.26bc | 4.42 ± 0.28a | 89.9 ± 0.98d | 23.36 ± 0.47bcde | 25.93 ± 2.38d | 7.85 ± 0.42abc |
| T39 | 27.23 ± 0.93ef | 4.77 ± 0.70abcd | 82.43 ± 3.05d | 23.97 ± 0.57e | 19.92 ± 1.40bc | 8.9 ± 0.33cde |
| NDF141118 | 70.80 ± 1.44ef | 5.25 ± 0.24e | 92.58 ± 0.48d | 23.9 ± 0.34de | 25.92 ± 1.20d | 8.22 ± 0.26bc |
| ND132617 | 26.94 ± 3.54ab | 5.33 ± 0.77e | 80.23 ± 0.37a | 22.69 ± 0.31abcd | 18.39 ± 1.51b | 7.47 ± 0.25ab |
| NDF14122 | 33.77 ± 6.29a | 9.54 ± 1.37e | 70.66 ± 8.72b | 22.45 ± 0.26ab | 21.47 ± 1.38bcd | 7.41 ± 0.42ab |




Graph 1. Moderate negative correlation between anthocyanin content in cooked black beans (mg/100g) and Munsell chroma units, r(34) = -.421, p<.01.




Graph 2. Strong positive correlation between anthocyanin content in raw black beans (mg/100g) and percentage anthocyanins lost after cooking, r(34) = .719, p<.01.




## CONCLUSIONS

- Konica colorimeter can be used as a rapid method to identify significant differences in color parameters between black bean genotypes.
- Except for chroma which showed a moderate negative correlation with anthocyanin content, color should not be used to predict anthocyanin concentration in black beans.
- Anthocyanin content may be high even after apparent high color-bleaching and in contrast, it may be low even after high retention of dark color
- The lack of correlation between anthocyanin content with color (L* and hue values) could be due to confounding variables such as tannins in black beans which also contribute to dark color. Therefore, any further study should measure both anthocyanin and tannin concentrations.
- High anthocyanin content in raw black beans strongly correlates with high percentage anthocyanin loss after cooking. Therefore, a high anthocyanin content in raw black bean varieties does not guarantee that more will be present in the cooked beans.
- Future breeding studies to develop high-anthocyanin genotypes should be complemented by efforts to reduce anthocyanin loss using novel food technology approaches.

## REFERENCES

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