Korean J. Food Preserv.
Vol. 15, No. 6. pp. 783-790, December 2008

사단법인 한국식품저장유통학회
THE KOREAN SOCIETY OF FOOD PRESERVATION

Physicochemical and Sensory Properties, and Bioactive Compounds of Blended Grape Juice from Different Grape Varieties

Shirley G. Cabrera, Ji-Hyun Jang, Hyeon-Jeong Lee and Kwang-Deog Moon†
Department of Food Science & Technology, Kyungpook National University, Daegu 702-701, Korea

캠벨과 타품종 포도주스의 브렌딩에 의한 품질 및 기능특성

Shirley G. Cabrera · 장지현 · 이현정 · 문광덕†
경북대학교 식품공학과

Abstract

Campbell juice (25%, 50%, 70% and 90%) was blended with different concentrations (10%, 25%, 30% and 50%) of juice from a range of grape varieties including Kyoho, Steuben and MBA. The concentrations of Campbell and the grape variety juices influenced the physicochemical characteristics of the blended grape juice. As the concentration of Campbell juice increased, there was an increase in the mean content of bioactive compounds including total phenolics, anthocyanin and flavonoids, and the radical scavenging activity increased. The treatment containing 25% juice from the various grape varieties had the lowest level of bioactive compounds. A sensory evaluation showed there was no significant difference among the blended juice samples in terms of aroma. The sample comprising 50% Campbell + 50% Kyoho was the most acceptable in terms of taste and overall acceptability, while the sample comprising 90% Campbell + 10% MBA was the most acceptable in terms of color and aroma.

Key words : grape juice, juice blend, total phenolics, radical scavenging activity, total flavonoid, total anthocyanin

Introduction

Healthy and functional foods have a great impact on new food product development because consumers these days expect that the foods they buy are not only palatable but also wholesome and nutritious (1).

Flavonoids and polyphenolic compounds which have been shown to have a multiple biological effects such as antioxidant capacity are widely distributed in fruits and through fruit juices is the best way of consuming these compounds (2,3). One of the major sources of phenolic compounds among different fruits is grape (4). Consumers associate the fruit juices such as grape juice as the healthy products, so their commercialization has increased in the last few years (5). In addition, Wang *et al.* (2) and Vinson *et al.* (6) reported that grape juice is well known for their protective role in maintaining a healthy heart and reduction of heart disease. It was also reported that long term intake of grape juice can provide antioxidant which reduces peripheral lymphocyte DNA damage. Furthermore, grape juice has many flavonoids which are known to exert antioxidant, anti-inflammatory and platelet inhibitory effects both *in vitro* and in animal studies (3,7-8).

Recently, the fruit juice industry is one of the fastest growing sector worldwide (9). Juices with flavors and aromas are presently produced and there is an increasing demand in the international market for fruit juice blends (10). Blending fruit juices is a good way of improving the sensory and nutritional quality of juices. Accordingly, Akinwale (11), and Jain and Khurdiya (12) reported that mixing two or more kinds of fruits can result in a new product which is more nutritious and enhanced sensory quality as compared to raw materials.

†Corresponding author. E-mail : kdmoon@knu.ac.kr,
Phone : 82-53-950-5773; Fax : 82-53-950-6772

In Korea, it was reported that there is an increasing consumption demand in noncarbonated fruit and vegetable beverages (13) but blending of juices from different grape varieties is not prevalent. A grape cultivating area in Korea occupies 12% of the total fruit growing area in which Campbell Early cultivar is the major table grapes, followed by Kyoho, Siebel and Danored (14). Campbell grape is usually converted to juice and wine by farmers but blending of juices from other grape variety is not common. Blending with other grape varieties can improve the quality of the existing Campbell grape juice. At present, overproduction due to growing grape area and continuous importation is the farmer's big problem in Korea (15). Thus, there is a need to develop and process these grapes into alternative grape products such as blended juice.

Many previous studies focused on the sensory evaluation such as acceptability of blended juices from different kinds of fruits. The aims of this study were to produce and optimize an alternative grape product such as blended grape juice from four grape varieties and to evaluate the effect of concentration and grape variety on the physicochemical characteristics, sensory properties and bioactive compounds of these blended grape juices.

Materials and Methods

Juice preparation

The grape varieties used in this study, Campbell Early (*Vitis labrusca B.*), Kyoho (*Vitis vinifera X V. labrusca*), Steuben (*Wayne x Sheridan*) and Muscat Bailey A or MBA (*Bailey x Muscat Hamburg*), were cultivated and harvested at Sangju, Korea in 2007. The individually crushed grapes were added with pectinase (Pectinex 5XL, Novozyme, Bagsvaerd, Denmark) before heating to hydrolyze the pectin. The juice was obtained by heating the individually crushed Campbell Early, Kyoho, Steuben and MBA grapes at 80℃ for 30 min, 80℃ for 30 min, 70℃ for 60 min, and 70℃ for 30 min prior to pressing, respectively. The temperature and time combinations were obtained from previous experiment and were done in triplicates by the researcher (data not shown). The juice samples were placed in a container, covered and refrigerated at -5℃ overnight for tartrate precipitation (cold stabilization). The juice samples after the cold stabilization process were then filtered and pasteurized. Then, 50%, 70% and 90% of Campbell grape juice were added with 50%, 30%, and 10% each of the grape varieties to make a total of 100% grape juice (Table 1). A 25% concentration from each variety was also blended. All the blended juices were analyzed. The results were expressed as means ± SD which corresponds for the three analytical replicates.

Table 1. Composition of grape juice blends

Sample	Campbell grape juice (%)	Grape juice from other varieties (%)
A	50	50% Kyoho
B	50	50% Steuben
C	50	50% MBA
D	70	30% Kyoho
E	70	30% Steuben
F	70	30% MBA
G	90	10% Kyoho
H	90	10% Steuben
I	90	10% MBA
J	25	25% Kyoho, 25%Steuben, 25%MBA

Chemical analyses

The pH of the blended grape juice was measured using a pH meter (model Delta 320, Metler Toledo, China). The Total Soluble Solids (°Brix) were measured using a hand refractometer (model N-1E, ATAGO, Japan). Titratable acidity was measured by adding 10 mL of grape juice sample to 100 mL of distilled water and titrating with 0.1 N sodium hydroxide (Duksan Pure Chemical Co. Ltd., Korea) to an endpoint of pH 8.2 (16). The results were expressed as gram of tartaric acid per 100 mL.

Color measurement

Color of the processed blended grape juice was determined using a Hunter colorimeter (model CR－200, Minolta, Japan). The values obtained were expressed as "L" (lightness), "a" (green to red) and "b" (blue to yellow) values. These values were used to calculate chroma ($C=[(a)^2+(b)^2]^{0.5}$), which indicates the intensity or color saturation and hue angle ($h=\arctan(b/a)$).

Sensory evaluation

The sensory evaluation of the blended grape juice samples with some modification was conducted by trained panelists comprising of teacher and graduate students of Department of Food Science at Kyungpook National University, Korea. Grape juices were presented in glasses with three-digit numbers. The trained judges scored each attribute such as color, aroma, taste and overall acceptability on a nine point

hedonic scale of 1-9, in which 1 denotes like extremely and 9 denotes dislike extremely (17).

Total phenolics analysis

The total phenolic content was determined by the Folin – Ciocalteu method (18) previously modified (19) to reduce the assay volume. To 3.90 mL of H_2O, 0.1 mL of the sample (10% (v/v) grape juice) was added followed by 0.5 mL of Folin – Ciocalteu reagent (Junsei Chemical Co. Ltd., Japan). After 3 – 6 min 0.5 mL of saturated sodium carbonate (20 g of Na_2CO_3 in 100 mL of H_2O) (Yukuri Pure chemicals Co., Ltd., Japan) was added. After 30 min of vigorous mixing with a vortex mixer the absorbance was measured at 725 nm (2120 UV spectrophotometer, Optizen, Korea). The results were expressed as gallic acid equivalents (GAE) using a calibration curve with gallic acid (Sigma-Aldrich Chemical Co., Germany) as the standard (mg/L).

Total flavonoid analysis

Total flavonoid concentrations were determined using procedures outlined by Zhishen et al. (20). One milliliter of diluted grape juice (1 mL juice/ 5 mL distilled H_2O) was placed in a 10-mL flask. Four milliliters of distilled water was added followed by 0.3 mL of $NaNO_2$ (5 g/100 mL distilled water) was also added. After 5 min, 0.3 mL of $AlCl_3$ (10 g/ 100 mL distilled H_2O) was added. After another 6 min, 2 mL of 1 N NaOH was added and then the solution was diluted to a total volume of 10 mL with distilled water. The absorbance of the solution was measured at 510 nm and the flavonoid concentration was determined by using a cathechin standard curve.

Free radical – scavenging

The antioxidant activity of blended grape juice was measured in terms of hydrogen donating or radical scavenging ability, using the stable radical, DPPH (21). One milliliter of diluted sample (10%(v/v) grape juice) was placed in a test tube and 4 mL of $6x10^{-5}$ mol/L ethanolic solution of DPPH (Sigma-Aldrich Chemical Co., Germany) was added. The mixture was shaken vigorously for 40 sec and then absorbance measurements were taken immediately. The decrease in absorbance at 517 nm was determined with 2120 UV spectrophotometer, Optizen, Korea. Ethanol was used to zero the spectrophotometer. The absorbance of the DPPH radical ethanolic solution was measured daily. All evaluations were made in triplicate. The % DPPH radical scavenging activity of the sample was calculated according to the formula of Blois (22).

Anthocyanin analysis

The total anthocyanin contents of the blended grape juice samples were determined using the pH-differential method previously described by Giusti and Wrolstad (23). Grape juices were diluted with potassium chloride buffer solution, pH 1.0, so that the absorbance reading at 520 nm which is the wavelength of maximum absorption for anthocyanins, was less than 1.0 absorption units. Two dilutions of the grape juice samples, one with potassium chloride buffer, pH 1.0 and the other with sodium acetate buffer, were allowed to equilibrate for 15 min. The absorbance of each equilibrated solution was then measured at the wavelength of maximum absorption (λ_{max}) and 700 nm for haze correction, against a blank cell filled with distilled water. Malvidin-3-glucoside was used as a reference compound with a molar absorbance of 28,000 and molecular weight of the pigment (493.2 g) used to calculate the concentration of monomeric anthocyanin pigments (mg/L) in the juices.

Statistical analysis

Analysis of Variance and Duncan's multiple range tests were performed using the SAS program version 9.1 for windows to determine significance of grape variety and concentrations of grape juices from different grape variety on the quality of processed blended grape juice samples. The level of significance was set at $P < 0.05$ (24).

Results and Discussion

Physicochemical properties and color values

The changes in physicochemical properties in all juice blend samples were significantly apparent (Table 2). The concentration of Campbell juice and the grape variety significantly influenced the changes in the physicochemical characteristics of the blended grape juice. The addition of MBA in all Campbell grape juice concentrations showed a decrease in pH and an increased in titratable acidity and total soluble solids as compared to juice samples with Kyoho and Steuben. The blended juice sample with Kyoho juice in all concentrations had the highest pH of 3.61±0.0 - 3.66±0.0, whereas the sample with MBA juice had the lowest pH of 3.58±0.0 - 3.62±0.0 but the highest in titratable acidity (0.51±0.0 - 0.53±0.0 g tartaric acid /100 mL). The blended juice sample with 25% of all grape varieties showed high

Table 2. The physicochemical properties of blended grape juice

Sample[2)]	Physicochemical properties			
	pH	Total soluble solids (°Brix)	Titratable acidity (g/100 mL)	Sugar/acid ratio
A	3.61±0.01d[1)]	17.20±0.06d	0.49±0.01bc	34.99 ±0.15bc
B	3.59±0.01f	17.30±0.04c	0.44±0.00d	39.14±0.08a
C	3.58±0.01g	18.40±0.00a	0.51±0.06abc	36.17±2.63b
D	3.66±0.02a	16.40±0.00f	0.54±0.04a	30.15±0.13ef
E	3.63±0.01c	16.33±0.06g	0.48±0.01c	33.80 ±0.75bcd
F	3.56±0.02h	16.60±0.00e	0.51±0.01abc	32.56 ±0.29cde
G	3.63±0.01c	15.60±0.06h	0.51±0.00abc	30.83 ±0.14ef
H	3.62±0.01d	15.57±0.06i	0.49±0.02c	31.90 ±0.07def
I	3.60±0.01e	15.60±0.00h	0.53±0.01ab	29.34 ±0.16f
J	3.65±0.00b	17.80±0.04b	0.50±0.01bc	35.68 ±0.72b

[1)]Values with different letters within the same column are significantly different at 5% level by Duncan's Multiple Range Test. The results are expressed as the means ± SD (n=3).
[2)]Samples A to J are the same as in Table 1.

pH, total soluble solids and sugar/acid ratio but low titratable acidity which is comparable to that of the blended juice with 50% Campbell juice + 50% juice from other grape varieties. It is interesting to note that all the physicochemical characteristics of the juice sample with 25% of all grape varieties were in the range of physicochemical properties of the blended grape juice with 50% Campbell juice + 50% juice from other grape varieties. As the concentration of Campbell juice increases, the blended juice showed a decreased in pH, total soluble solids and sugar/acid ratio. Titratable acidity of the blended juice showed an inverse relationship with sugar/acid ratio. Among the juice samples, Campbell juice had the prominent characteristics which are expected to overcome the characteristics of the juices blended with different varieties especially at high percentage of concentration. The concentration of Campbell juice did show a significant effect on the characteristics of the blended juices but the changes in concentration of Campbell juice did not change the trend in each variety such as Kyoho, MBA and Steuben on the physicochemical properties and color values of the blended juice.

Table 3 shows that the color properties of the blended juice tended to be darker with the increasing concentration level of Campbell juice. The samples with Steuben showed the highest "L" value, thus are the lightest juice sample while the samples containing MBA had the lowest "L" values as compared to other grape juice samples, and thus are the darkest in color which is expected because MBA juice has the same color as that of Campbell juice. The results also showed that the sample with 30% concentration of Steuben juice had the highest "a", "b", chroma and hue values which means that these samples had intense red to purple color. It can also be observed that there is a significant change in color values in all juice blend samples except for blends with 90% Campbell juice. It can be suggested that high concentration level of Campbell juice in the juice blend masked the color of the grape juice from other grape variety.

Table 3. The color values of the blended grape juice samples

Sample[2)]	Color values				
	L	a	b	Chroma	Hue
A	27.61±0.33bc[1)]	7.60±1.47b	0.79±0.44b	7.65±1.49b	5.36±2.30bc
B	28.57±0.98ab	7.73±0.11b	0.76±0.28b	7.77±0.09b	5.74±2.11bc
C	25.40±0.50d	3.42±0.71c	-0.66±0.25c	3.44±0.62c	6.21±2.92bc
D	26.85±0.42cd	7.96±1.06b	1.28±0.53b	1.11±8.09b	8.38±3.05a
E	29.45±0.35a	12.26±2.50a	3.03±0.80a	12.64±2.61a	13.73±1.32abc
F	26.64±0.28cd	8.14±0.40b	0.90±0.29b	8.20±0.43b	6.14±1.61bc
G	25.47±0.31d	3.83±0.79c	-0.88±0.29c	3.86±0.77c	7.31±2.52bc
H	25.56±0.41d	3.10±0.36c	0.25±0.23c	3.13±0.34c	5.49±0.28bc
I	26.86±0.48cd	2.96±0.45c	-1.52±0.44c	3.08±0.39c	11.14±0.38ab
J	28.66±0.60ab	6.33±0.95bc	0.56±0.47bc	6.36±0.97bc	4.36±0.29ac

[1)]Values with different letters within the same column are significantly different at 5% level by Duncan's Multiple Range Test. The results are expressed as the means ± SD (n=3).
[2)]Samples A to J are the same as in Table 1.

Bioactive compounds and % radical scavenging activity

Figure 1 shows the phenolic concentration of the blended juice samples. The sample containing 90% Campbell + 10% Kyoho had the highest total phenolics whereas the juice sample with 25% of all the grape varieties had the lowest total phenolics. In a previous study made by Frankel et al. (25) about Concord grape juice blends it was reported that the total phenolic content and antioxidant activity were 1474 mg/L and 64%, respectively which shows that the result obtained for the grape juice blend in this study is comparable to there results. Figures 2 and 3 show that the juice with 90% Campbell + 10% Steuben had the highest radical scavenging activity and total flavonoid content whereas the sample with 25% of all the grape varieties had the lowest radical scavenging activity while the juice with 50% Campbell + 50% MBA showed the lowest total flavonoid content. Figure 4 displays the total anthocyanin content of blended grape juice. The results showed that as the concentration of Campbell juice increases there is also a significant increase

in the amount of total anthocyanin content in which the juice with 90% Campbell + 10% MBA had the highest content of 503.19±3.30 mg/L while the juice sample with 25% of all the grape varieties had the lowest content of 269.02±0.18 mg/L. Blending four grape varieties decreased almost 46% of the total anthocyanin of the juice. The observations pointed out that the samples with 90% Campbell + 10% different varieties such as Kyoho, Steuben and MBA had the highest total phenolic, total anthocyanin and total flavonoid compounds and showed the highest radical scavenging activity, whereas the sample with 25% of different grape varieties had the lowest bioactive compounds. This shows that increasing the concentration level of Campbell juice significantly increased the bioactive compounds of the blended juice. Furthermore, it is expected that the combination of MBA and Campbell will give higher bioactive compounds because it is darker and believed to have more bioactive compounds but the juice samples blended with Steuben showed a higher amount of total phenolics, total flavonoid and radical scavenging activity values while the juice samples blended with MBA showed a higher amount of total anthocyanin only which can be related to its low pH. According to Brouillard (26) anthocyanins are more stable at low pH than in high pH thus gives brighter and stable color and these colored forms of anthocyanin must be strongly stabilized by other natural component that are present in the berries. Furthermore, Gao and Mazza (27) reported that there are free phenolics that exist in plant materials which can affect the interactions of phenolic compounds in the juice. Blending four different grape varieties together significantly lowered the bioactive compounds of the resulting blended juice sample which can be suggested that the blending of these four grape varieties is detrimental to the bioactive compounds of the final blended grape juice. In this study

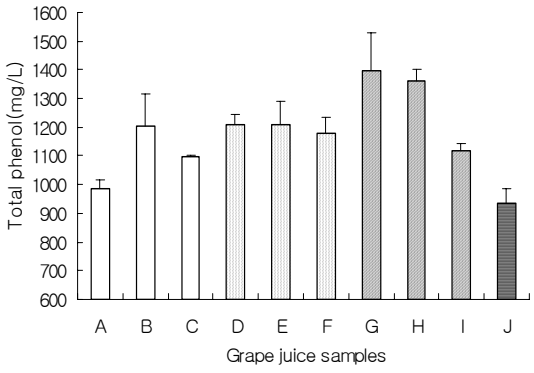

Fig. 1. The effect of campbell juice concentrations and grape juice variety on the total phenolic content of the blended grape juice. The results are expressed as the means ± SD (n=3).

Samples A to J are the same as in Table 1.

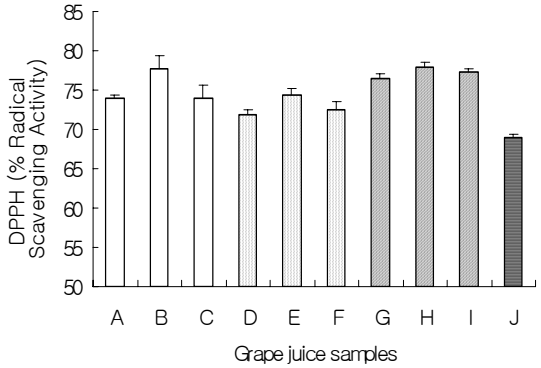

Fig. 2. The effect of campbell juice concentrations and grape juice variety on the % radical scavenging activity of the blended grape juice. The results are expressed as the means ± SD (n=3).

Samples A to J are the same as in Table 1.

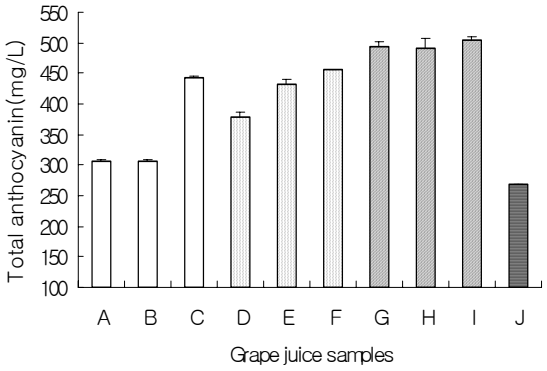

Fig.3. The effect of campbell juice concentrations and grape juice variety on the total flavonoid content of the blended grape juice. The results are expressed as the means ± SD (n=3).

Samples A to J are the same as in Table 1.

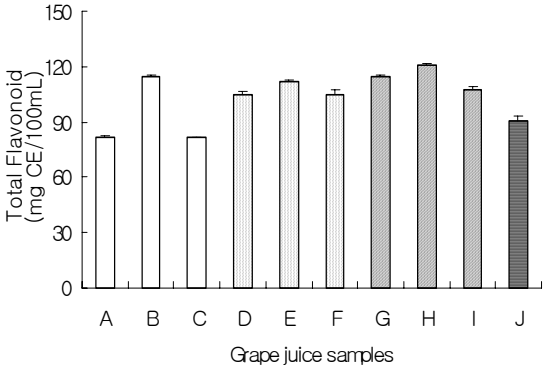

Fig. 4. The effect of campbell juice concentrations and grape juice variety on the total anthocyanin content of the blended grape juice. The results are expressed as the means ± SD (n=3).

Samples A to J are the same as in Table 1.

it can be noted that maybe the interactions of components of the four grape varieties in the blended juices, instead of stabilizing the phenolic compounds, leads to the lowering of the bioactive compounds of the final blended grape juice.

Sensory evaluation

Table 4 illustrates the panelists mean scores for acceptability test of the blended grape juice samples. Main et al. (28), Ghazanfar and Camire (29) reported that blending of fruit juices such as cranberry, blueberry, Venus and Concord grapes affects the sensory attributes of the final blended product. They also noted that percentage of specific juice in the blend and the type of blending juice also affects the final blended juice. In addition, Tipton *et al.* (30) investigated the characteristics of blueberry juice blended with Concord, Reliance, Sunbelt, Venus grape juices, and Thompson Seedless concentrate. They reported that the intensity of blueberry-related sensory attributes increased with increased concentration of blueberry juice.

Table 4. The mean scores of sensory evaluation of blended grape juice

Sensory Attributes	Blended grape juice samples									
	A[2)]	B	C	D	E	F	G	H	I	J
Color	2.60±0.89bc[1)]	4.00±1.00a	2.00±0.71bc	3.00±1.00ab	3.00±0.55ab	2.40±0.55bc	2.40±0.45bc	2.20±0.45bc	1.80±0.45c	3.80±1.10a
Aroma	3.20±1.46a	4.00±1.41a	3.40±1.22a	3.40±0.45a	2.60±0.45a	3.20±0.83a	2.80±0.83a	3.00±1.00a	2.40±1.00a	3.20±0.45a
Taste	2.40±0.45b	3.80±1.13ab	3.60±1.01ab	4.60±1.10a	3.80±1.18ab	4.00±1.34ab	4.40±1.10a	5.20±1.30a	5.00±1.50a	3.40±0.89ab
Overall acceptability	2.40±0.58b	4.40±0.50ab	2.80±0.81ab	4.40±1.10ab	4.20±1.26ab	3.80±1.50ab	4.20±1.00ab	4.60±1.17a	3.80±1.26ab	3.80±0.96ab

[1)]Values with different letters within the same row are significantly different at 5% level by Duncan's Multiple Range Test.
[2)]Samples A to J are the same as in Table 1.

The results of this study showed that there is no significant difference between blended juice samples in terms of aroma which suggests that grape variety had no effect on the aroma and it might be inferred that Campbell grape juice masked the aroma of the other grape variety thus the panelist did not detect the differences in aroma. Sensory evaluation also revealed that samples containing 50% Campbell juice was rated higher for taste and overall acceptability, whereas the sample with 90% Campbell juice was rated higher for color and aroma, respectively. This means that lower concentration of Campbell juice was more preferred in terms of taste and overall acceptability while higher concentration of Campbell juice was more preferred in terms of color and aroma. The juice sample with 50% Campbell + 50% Kyoho is the most acceptable in terms of taste and overall acceptability and was rated as like very much while the juice sample with 90% Campbell + 10% MBA is the most acceptable in terms of color and aroma and was also rated as like very much. Thus, this means that the panelists preferred the sweet sour blend of Campbell and Kyoho at the same level of concentration. In addition, the combination of Campbell and MBA gave a dark purple grape juice and a good grape juice aroma which are more preferred by the panelists as compared to other grape juice combinations. The panel members rated color and aroma of juice sample with 50% Campbell + 50% Steuben as like slightly while sample with 90% Campbell + 10% Steuben was rated in terms of taste and overall acceptability as slightly dislike and neither like or dislike, respectively. Both juice samples with 50% and 10% Steuben are the least acceptable in terms of the sensory parameters such as color and aroma, and taste and overall acceptability, respectively which implies that the grape juice blend with Steuben is not preferred by the panelists. Juice sample with 25% each of the four grape varieties was rated as like moderately by the panel members in all the sensory attributes.

요 약

최근 건강에 대한 관심이 높아지면서 과일 가공제품의 소비가 급증하고 있다. 포도는 페놀화합물의 주요 급원의 하나로 포도주스는 항산화, 항염증, 항혈소판 작용 등의 기능을 가지는 다수의 플라보노이드를 포함하고 있다. 일반적으로 캠벨 포도는 농가에서 주스나 와인으로 가장 널리 가공되고 있으나 다양한 포도 품종을 이용하여 브렌딩한 포도주스에 대한 연구는 거의 전무한 실정이다. 본 연구에서는 캠벨과 타품종 포도주스를 종류 및 비율을 달리하여 브렌딩 한 후 물리화학적 특성, 관능적 특성, 기능적 특성에 대하여 평가하였다. 품종과 브렌딩 비율에 따라 물리화학적 특성 및 기능적 특성에서 유의적인 차이를 확인할 수 있었으며 캠벨 주스의 비율이 증가함에 따라 total phenol, total anthocyanin, total flavonoid 함량과 radical scavenging activity가 증가하였으나, 모든 포도 품종을 동일비율로 혼합하여 만든 포도주스는 기능성이 가장 낮은 특징을 보였

다. 특히 캠벨 포도주스와 스투벤 포도주스를 브렌딩 한 경우 기능적 특성이 가장 우수하였으며 캠벨 포도주스와 거봉 포도주스를 동일 비율로 브렌딩 한 주스의 관능적 특성이 가장 우수하였다. 따라서 캠벨과 타품종 포도주스의 브렌딩을 통하여 기존의 캠벨 포도주스 제품의 품질을 향상시킬 수 있을 것으로 생각한다.

Acknowledgement

This study was supported by the Korean Research Foundation Grant funded by the Korean Government.

References

1. Mazza, G. (1988) Biochemical and processing Aspects In: Functional foods. Technomic Publishing Company, Lancaster, p.1-10
2. Wang, H., Cao, G. and Prior, R.L. (1996) Total antioxidant capacity of fruits. J. Agric. Food Chem., 44, 701–705
3. Rice-Evans, C.A., Miller, N.J. and Pagana, G. (1996) Structure-antioxidant activity relationships of flavonoids and phenolic acids. Free Radical Biol. Med., 20, 933-956
4. Macheix, J.J., Fleuriet, A. and Billot, J. (1990) The main phenolics of fruits. In Fruit Phenolics. CRC Press: Boca Raton, FL., p.1-98
5. Garde-Cerdán, T., Arias-Gil, M., Marsellés-Fontanet A., Ancín-Azpilicueta, C. and Martín-Belloso, O. (2007) Effects of thermal and non-thermal processing treatments on fatty acids and free amino acids of grape juice. Food Control, 18, 473-479
6. Vinson, J.A., Yang, J.H., Proch, J. and Liang, X. (2000) Grape juice, but not orange juice, has in vitro, ex vivo, and in vivo antioxidant properties. J. Med. Food, 2, 167–171
7. Demrow, H.S., Slane, P.R. and Folts, J.D. (1995) Administration of wine and grape juice inhibits in vivo platelet activity and thrombosis in stenosed canine coronary arteries. Circulation, 91, 1182–1188
8. Gryglewski, R.J. (1987) On the mechanism of antithrombotic action of flavonoids. Biochem. Pharmacol., 36, 317–322
9. Anderson, K.A. and Smith, B.W. (2002) Chemical profiling to differentiate geographic growing origins of coffee. J. Agric. Food Chem., 50, 2068-2075
10. De Carvalho, J.M., Maia, G.A., Figueiredo, R.W., De Brito, E.S. and Rodrigues, S. (2007) Storage stability of a stimulant coconut water-cashew apple juice beverage. J. Food Process. Preserv, 31, 178-189
11. Akinwale, T.O. (2000) Cashew apple juice: its use in fortifying the nutritional quality of some tropical fruits. Eur. Food Res. Technol., 211, 205-207
12. Jain, S.K. and Khurdiya, D.S. (2004) Vitamin C enrichment of fruit juice based ready-to-serve beverages through blending of Indian gooseberry (*Emblica officinalis Gaertn*) juice. Plant Foods Hum. Nutr., 59, 63-66
13. Lee, J.H. and Lee, E.J. (1997) Physicochemical characteristics of mixed fruit and vegetable juices produced using ultrafiltration. J. Food Sci. Biotechnol., 6, 2001-2008
14. Sung, J.K. (1996) The present grape processing industries In Grape, from Planation to Sales. Sung,J.K. (Editor), The Nongmin Press, Seoul, Korea, p.23-41,
15. FAOSTAT-FAO Statistical Database, http://www.fao.org. Accessed September 2006
16. Haight, K.G. and Gump, B.H. (1995) Red and White Grape Juice Concentrate Component Ranges. J. Food Compos. Anal., 8, 71-77
17. Bergara-Almeida, S., Aparecida, M. and Da Silva, A.P. (2002) Hedonic scale with reference: Performance in obtaining predictive models. Food Qual. Prefer., 13, 57-64
18. Singleton, V.L. and Rossi, J.A. (1965) Colorimetry of total phenolic with phosphomolibdic phosphotungustic acid reagent. Am. J. Enol. Vitic., 16, 144-158
19. Yildirim, H.K., Akçay, Y.D., Güvenç, U., Altindişli, A., Sözmen, E.Y. (2005) Antioxidant activities of organic grape, pomace, juice, must, wine and their correlation with phenolic content. Int. J. Food Sci. Technol., 40, 133-142
20. Zhishen, J., Mengcheng, T. and Jianming, W. (1999) The determination of flavonoid contents in mulberry and their scavenging effects on superoxide radicals. Food Chem., 64, 555-559
21. Brand-Williams W., Cuvelier M.E. and Berset, C. (1995) Use of a Free radical Method to evaluate antioxidant activity. LWT - Food Sci. Technol., 28, 25-30
22. Blois M.S. (1958) Antioxidant determination by the use of a stable free radical. Nature, 4617, 1198-1199
23. Giusti, M.M. and Wrolstad, R.E. (2005) Anthocyanins by UV-Visible Spectroscopy. Handbook of Food Analytical Chemistry: Pigments, colorants, flavor, texture

and bioactive components. Acree TE, Decker E.A, Penner MH, Reid DS, Schwartz SJ, Shoemaker CF, Smith D, Sporns P. A (Editors) John Wiley and Sons, Inc. Publication, New Jersey, USA, Vol I, p.19-30
24. SAS (2006) SAS 9.1 for Windows, Statistical Analysis System Institute, Cary, NC, USA
25. Frankel, E.N., Bosanek, C.A., Meyer, A.S., Silliman, K. and Kirk, L.L. (1998) Commercial Grape Juices Inhibit the in Vitro Oxidation of Human Low-Density Lipoproteins. J. Agric. Food Chem., 46, 834-838
26. Brouillard, R. (1982) Chemical structure of anthocyanins. In: Anthocyanins as Food Colors. Pericles Markakis (ed), Academic Press Inc., New York, p.1-38
27. Gao, L. and Mazza, G. (1994) Quantitation and distribution of simple and acylated anthocyanins and other phenolics in blueberries. J. Food Sci., 59, 1057-1059
28. Main, G. Faupel, M. Morris, J. and McNew, R. (2001) Quality and stability of blueberry juice blended with apple, grape and cranberry juice. J. Food Qual., 24, 111-125
29. Ghazanfar, S. and Camire, M.E. (2002) Influence of Health Attitudes on the Acceptability of Cranberry Juice. J. Food Sci., 67, 3497-3501
30. Tipton, S., Morris, J., Main, G., Sharp, C. and Mcnew, R. (1999) Grape juice as an extender and sweetener for blueberry drinks. J. Food Qual., 22, 275-285

(접수 2008년 7월 3일, 채택 2008년 11월 7일)