International Journal of Sciences

Research Article Volume 7 – October 2018 (10)

Quality Characteristics and Antioxidant Potential of Wine Prepared with Peppers

Chan Yong Kim[1], Kil Su Jang[1], Oh Hun Kwon[1], Il-Doo Kim[2]

[1]Yeongyang Pepper Research Institute, Gyeongbuk Agricultural Research & Extension Service, Yeongyangchangsu-ro, 36531, Korea
[2]International Institute of Research and Development, Kyungpook National University, Daegu 41566, Korea

Abstract: This study was conducted to investigate the quality characteristics and antioxidant potential of wine prepared with hot pepper. The pepper wine samples were divided into three groups based on the types of peppers used. The three groups were divided into MW (ordinary wine containing no added pepper), GW (green pepper wine prepared with green pepper) and RW (red pepper wine prepared with red pepper) sample. The wine samples prepared from the green and red peppers differed in general compositions (alcohol concentration, pH, titratable acidity and reducing sugar), Hunter's color values, total phenol and flavonoids contents, and sensory characteristics. The alcohol concentrations of GW (12.4% v/v) and RW (12.6% v/v) samples contained more than that of MW (11.6% v/v). The values of GW and RW samples were not significantly different ($p<0.05$). Titratable acidity (TA) value of pepper wine samples (GW and RW) were significantly low ($p<0.05$) as compared to MW sample. The lower values of reducing sugar were observed for GW (157.23 mg/L) and RW (160.12 mg/L). GW possessed the highest value for lightness (93.00) and RW for yellowness (39.53). The total phenolic contents of pepper wine (100.31 for GW and 111.23 for RW) were significantly ($p<0.05$) lower than that of the control (200.31). MW (116.40 mg/L) had the highest flavonoid content, followed by RW (84.53 mg/L) and GW (80.82 mg/L). Flavor values of pepper wine varieties were not significantly different ($p<0.05$). The overall acceptability of MW and RW wine samples were significantly ($p<0.05$) higher than that of the GW (3.0).

Keywords: Green Pepper, Red Pepper, Wine, Quality Characteristics, Antioxidant Potential

Introduction

Pepper (*Capsicum annuum* L.) used for food and traditional medicine, are widely used in many cuisines to add spiciness to dishes. Peppers are also popular spices in many parts in the world, valued for their sensory attributes. Pepper is a very important spicy food with different nutrients and phytochemicals having heath promoting effects like anti-obesity activity (Jang et al., 2015). Peppers also contain various therapeutic-related materials such as capsaicinoids, phenolic compounds, and carotenoids (Hernandez-Ortega et al., 2012). A study (Yazdizadeh Shotorban et al., 2012) conducted with rats showed that the antioxidant activity of bell pepper had a protective effect on brain cells. The fresh fruit of pepper is known as an excellent source of vitamin C and E as well as provitamin A, carotenoids and polyphenols (Nazzaro et al., 2009; Yazdizadeh Shotorban et al., 2012; Shaha et al., 2013).

Fermentation of foods involves the action of microorganisms or enzymes that cause desirable biochemical changes in quality of final products. Wine is an alcoholic beverage made, mostly, from grape and has long played an important role in religion. The quality of wine is mainly governed by the quality of the raw materials and the wine production technology (Lee et al., 2006).

Although peppers are rich in nutrients and phytochemicals, research works on the use of peppers in wine preparation is lacking. Considering the nutritional and antioxidant potential of pepper, this study was mainly investigated to enhance the quality characteristics and antioxidant potential of wine prepared with green and red peppers. Moreover, outstanding parameters such as the color and the sensory quality of pepper wines were also studied.

Materials and Methods

Chemicals and materials

Folin-Ciocalteu phenol reagent and DPPH were purchased from Sigma-Aldrich (St. Louis, MO, USA). All other reagents used were of analytical grade. Green and red pepper (*Capsicum annuum* L.), grown

Published at: http://www.ijsciences.com/pub/issue/2018-10/
DOI: 10.18483/ijSci.1807; Online ISSN: 2305-3925; Print ISSN: 2410-4477

Il-Doo Kim (Correspondence)
ildookim @ hanmail.net
+82-53-950-5707; Fax: +82-53-958-6880

at Youngyang-gun, Gyeongsangbuk-do, purchased from a local market in May of 2017, washed with tap water, kept under room conditions for 2 h for surface drying, then crushed with gentle pressure with the help of mortar and pestle, followed by homogenization in a mixer (HMF 3450S; Hanil Co., Seoul, Korea) without fluid addition (Smith et al, 2000).

Preparation of wine samples

Each weight of 3.5 kg of peppers (green and red) was crushed using a crusher/de-stemmer and the resulting 12 L, of must was transferred to 27 L fermenter vessel (stainless steel). The must was treated with 100 ppm SO_2 with subsequent stirring, The fermentation was carried out using a rehydrated inoculum of Fermivin 7013 dry yeast – *S. cerevisiae* (Gist brocades, France), 12.5 g pectinase, 1.5 g tannin and 1.2 g potassium metabisulfite in a 27-L fermenter vessel (stainless steel) at room temperature. Yeast was inoculated at 2.5 g dry yeast per liter. The wine was racked after fermentation and aged in a glass bottle (23 L). Wines were stored at 18℃ for 3 months. The finished wines were clarified with 250 mg/L of bentonite and filtered with 0.5 and 1.5 µm of filter paper (Buon vino MGF, Inc, Ontario, Canada). The finished wines were stored in a 750 mL glass bottle at 4℃ before analysis.

Physicochemical parameters

The pH value of pepper wine was measured using a pH Meter (Model 250; Beckman Coulter, Inc., Fullerton, CA, USA). Titratable acidity (lactic acid in g/L) was measured using addition of 5 mL of pepper wine to 125 mL of deionized water, followed by titration using 0.1 N sodium hydroxide to an endpoint pH of 8.2. Alcohol concentration analysis was conducted following the method of Ough and Amerine (1988). All chemical measurements were replicated 3 times and mean values were reported.

Color measurement

L* (lightness), a* (redness, + or greenness, -), and b* (yellowness, + or blueness,-) values of pepper wine were measured using a chroma meter (CR-300; Minolta Corp., Osaka, Japan). A Minolta calibration plate (YCIE=94.5, XCIE=0.3160, YCIE=0.330) and a Hunter Lab standard plate (L*=97.51, a*=-0.18, b*=+1.67) were used to standardize the instrument using a D65 illuminant (Kim et al., 2013). Color values were measured directly from 3 zones of pepper wine and mean values were calculated.

Determination of the total phenol content

The total phenol contents of pepper wine were estimated according to the Folin-Ciocalteau method (Singletot et al., 1999). An amount of 250 µL of undiluted Folin-Ciocalteau reagent was added to 50 µL of a pepper wine sample. After 1 min, 750 µL of 20% (w/v) aqueous Na_2CO_3 was added, and the volume was made up to 5.0 mL using distilled water. A control sample contained all the reaction reagents with the exception of the pepper wine sample. After 2 h of incubation at room temperature under dark condition, the absorbance value was measured at 760 nm (Multiskan GO Microplate Spectrophotometer, Thermo Fisher Scientic, Vantaa, Finland). Gallic acid was used to prepare a calibration curve. The total phenol contents were determined as gallic acid equivalents (ug/mL of pepper wine), and values are reported as mean values of triplicate analyses.

Determination of total flavonoids

The total flavonoid contents in pepper wines were determined by the method of Woisky and salatino (1998), with minor modifications. Here, 0.5 mL of pepper wines, 0.5 mL of 2% $AlCl_3$ ethanol solution was added. After 40 min at room temperature, the absorbance was measured at 420 nm. EEP sample were evaluated at the final concentration of 20 µg/mL. Total flavonoid contents were calculated as quercetin (mg/g) from a calibration curve.

Evaluation of sensory properties

Analysis of sensory properties was performed using freshly made pepper wine: Samples prepared using green and red peppers were rated for color, flavor, and overall taste using scale of 1= very poor, 2= poor, 3= moderate, 4= good, 5= very good. All the sensory properties were evaluated by 20 volunteer panelists (10 women and 10 men) selected from the list of graduate students of College of Agriculture and Life Sciences of Kyungpook National University, Daegu, Korea. Mean values of 10 evaluations for each sensory property were reported as scores.

Statistical analysis

Data were subjected to analysis of variance (ANOVA) using the statistics package version 4.0 (Analytical Software, Tucson, AZ, USA). Differences between means at $p<0.05$ were analyzed using the Tukey test.

Results and Discussion

Chemical characteristics

Table 1 shows alcohol concentration, pH, titratable acidity and reducing sugar of wines (MW, GW and RW) measured with and without pepper. The alcohol concentration was also significantly different ($p<0.05$) among different wine varieties.

The alcohol concentrations of GW (12.4% v/v) and RW (12.6% v/v) samples contained more than that of MW (11.6% v/v). The results of the alcohol concentration in pepper wine agreed with the results of Entwisle et al. (2008).

The pH values of pepper wine, with and without pepper treatment (MW, GW, and RW) were slightly different ($p<0.05$). The values of GW an RW sample were not significantly different ($p<0.05$). The high pH value of pepper wine varieties might be due to addition of green and red peppers for pepper wine (Derossi et al., 2010).

Titratable acidity (TA) value of pepper wine samples (GW and RW) were significantly low ($p<0.05$) as compared to MW sample. Between the pepper wine varieties (GW and RW), the TA values were not significantly different ($p<0.05$) (Ho et al., 1999).

The lower values of reducing sugar were observed for GW (157.23 mg/L) and RW (160.12 mg/L) wines, while the higher value (230.55 mg/L) was for MW sample. Similar results were reported in the literature (Darias-Martin et al., 2004).

Table 1. Chemical characteristics of wines prepared with hot pepper

Sample[1)]	Alcohol (%, v/v)	pH	Titratable acidity[2)] (g/100 mL)	Reducing sugar (mg/L)
MW	11.6±0.3b[3)]	4.21±0.02b	0.73±0.02a	230.55±11.2a
GW	12.4±0.3a	4.32±0.03a	0.63±0.02b	157.23±10.2b
RW	12.6±0.2a	4.30±0.04a	0.64±0.02b	160.12±9.3b

[1)]MW: Ordinary wine containing no added pepper, GW: Green pepper wine prepared with green pepper, RW: Red pepper wine prepared with red pepper.
[2)]As lactic acid.
[3)]Quoted values are means±SD of triplicate measurements. Values followed by different letters in the same column are significantly different ($p<0.05$).

Hunter color value

Color value of the wine is known to play an important role in the consumer's acceptability. Color is also an important sensory evaluation of food and contributes a significant position in overall food quality and characteristics. Table 2 shows Hunter's color value of the pepper wine with and without hot pepper, expressed by the means of three analytical replicates. GW possessed the highest value for lightness (93.00) and RW for yellowness (39.53). The color value enhanced from redness to Yellowness in RW sample. The color of the sample was changed according to kind and amount of peppers (Kim et al., 1986).

Table 2. Hunter's color values of wines prepared with hot pepper

Sample[1)]	Color value[2)]		
	L*	a*	b*
MW	62.00±0.09c[3)]	0.18±0.03b	0.49±0.02c
GW	93.00±0.06a	-1.50±0.02c	14.16±0.04b
RW	86.95±0.05b	8.36±0.02a	39.53±0.03a

[1)]Abbreviations are specified in Table 1.
[2)]L*, lightness (100, white; 0, black); a*, redness (-, green; +, red); b*, yellowness (-, blue; +, yellow).
[3)]Quoted values are means ±SD of triplicate measurements. Values followed by different letters in the same column are significantly different ($p<0.05$).

Total phenol and flavonoid contents of pepper wine

Foods, vegetables and medicinal plants contain phenolic compounds which possess the antioxident potentials (Maksimovic et al., 2005). Table 3 shows the total phenol and flavonoid contents of pepper wine. Phenolic compounds like palyphenols, flavonoids and flavonols in alcoholic beverage are considered as important constituents as they are accounted for antioxidant activities (Park and Lee, 2002).

The total phenolic contents of pepper wine (100.31 for GW and 111.23 for RW) were significantly ($p<0.05$) lower than that of MW (200.31). Low total phenol contents of pepper wines were probably caused by the addition of peppers (Kedage et al., 2007; Jang et al., 2015). It is difficult to precisely identify the antioxidant potential of wine, using any single assay as a several mechanisms, which are involved in wine preparation (Hong et al., 2009). The flavonoid content in pepper wines showed varying results in the range of 80.82–116.40 mg/L. MW wine (116.40 mg/L) had the highest flavonoid content, followed by RW (84.53 mg/L) and GW(80.82 mg/L) sample. These results support the hypotheses that the addition of pepper in the preparation of wine decrease the antioxidative potential of pepper wine.

Table 3. Total phenol and flavonoid content of wines prepared with hot pepper

Sample[1)]	Total polyphenol content (GAE[2)] mg/L)	Flavonoids (mg/L)
MW	200.31±1.21a[3)]	116.40±5.62a
GW	100.32±2.93b	80.82±9.31b
RW	111.23±3.01b	84.53±2.02b

[1)]Abbreviations are specified in Table 1.
[2)]Gallic acid equivalents.
[3)]Quoted values are means ±SD of triplicate measurements. Values followed by different letters in the same column are significantly different ($p<0.05$).

Sensory characteristics of pepper wine
Table 4 shows the evaluation of sensory characteristics of pepper wine. Sensory evaluation is a useful parameter to evaluate the human perception of flavor attributes (Jabalpurwala et al., 2009). Measurement of sensory characteristics is a key in evaluation the wine quality. Color values RW wine (3.8) was significantly higher ($p<0.05$) than MW sample (3.5). Flavor values of pepper wine varieties were not significantly different ($p<0.05$). The overall acceptability of MW and RW wine samples were significantly ($p<0.05$) higher than that of the GW (3.0).

Table 4. Sensory characteristics of wines prepared with hot pepper

Sample[1)]	Sensory characteristics			
	Color	Flavor	Taste	Overall acceptance
MW	3.5±0.1b[2)]	3.1±0.2a	3.2±0.1a	3.4±0.2a
GW	3.6±0.1ab	3.3±0.2a	3.3±0.2a	3.0±0.1b
RW	3.8±0.1a	3.0±0.1a	3.4±0.1a	3.2±0.2ab

[1)]Abbreviations are specified in Table 1.
[2)]Quoted values are means ±SD of triplicate experiments (n=20) based on 5-point scores (1, very poor; 2, poor; 3, fair; 4, good; 5, very good). Values followed by different letters in the same column are significantly different ($p<0.05$).

Conclusion
Hot pepper wine samples were prepared by fermenting red and green pepper. Alcohol concentration, pH of GW and RW wine were significantly high compared to MW sample, however, titratable acidity, reducing sugar, total phenol and flavonoid contents were significantly low in GW and RW wine. In addition, color score of RW wine was higher than those of the others. Results of this experiment suggest that green and red pepper could be used to enhance the quality characteristics of wine. With greater studying of pepper wines, vegetable wines of higher quality can be produced in the future.

Conflict of Interest
The authors declare no conflict of interest.

References
1. Darias-Martin J, Diaz-Gonzalez D, Diaz-Romero C. 2004. Influence of two pressing processes on the quality of must in white wine production. J. Food Eng. 63: 335-340.
2. Derossi A, De pilli T, Severini C. 2010. Reduction in the pH of vegetables by vacuum impregnation: A study on pepper. J. Food Eng. 9: 9-15.
3. Dominguez-Martinez I, Meza-Márquez OG, Osorio-Revilla G, Proal-Nájera J, Gallardo-Velázquez T. 2014. Determination of capsaicin, ascorbic acid, total phenolic compounds and antioxidant activity *Capsicum annuum* L. var Serano by mid infrared spectroscopy (Mid-FTIR) and chemometric analysis. J. Korean Soc. Appl. Bio Chem. 57: 133-142.
4. Entwisle J, Garrentt J, Elahi S, Roper P. 2008. Investigations into the effect of selected storage conditions on the alcohol content and original gravity of beers samples. Food Control 19: 461-464.
5. Hernandez-Ortega M, Ortiz-Moreno A, Hernandez-Navarro MD, ChamorroCevallos G, Dorantes-Alvarez L, Necoechea-Mondragon H. 2012. Antioxidant, antinociceptive, and anti-inflammatory effects of carotenoids extracted from dried pepper (*Capsicum annuum* L.). J. Biomed. Biotechnol. 2012: 1–10.
6. Ho P, Rogerson FS, Watkins SJ, Silva MC, Hogg TA, Vasconcelos I. 1999. Effect of skin contact and oxygenation of musts on the composition of white port wines. Sciences des Aliments (France). 19: 687-699.
7. Hong YH. Bae SH, Jung EY, Son HS, Shin KS. Kwon RH, Suh HJ. 2009. Radical scavenging activities of Korean traditional rice wine, takiu. J. Food Sci. Nutr, 14: 109-115.
8. Jabalpurwala FA, Smoot JM, Rouseff RL. 2009. A. comparison of Citrus blossom volatiles. Phytochemistry 70: 1428-1434.
9. Jang YK, Jung ES, Lee HA, Choi D, Lee CH. 2015. Metabolomic characterization of hot pepper (*Capsicum*

annuum "CM334") during fruit development. J. Agr. Food Chem. 63: 9452–9460.
10. Kedage V, Tilak J, Dixit G. Devasagayam T, Mhatre M. 2007. A study of antioxidant properties of some varieties of pepper seeds (*Vitis vinifera* L.). Crit. Rev. Food Sci. Nutr, 47: 175-185.
11. Kim ID, Lee JW, Kim SJ, Cho JW, Dhungana SK, Lim YS, Shin DH. 2013. Exogenous application of natural extracts of persimmon (*Diospyros kaki* Thumb.) can help in maintaining nutritional and mineral composition of dried persimmon. Afr. J. Biotechnol. 13: 2231-2239.
12. Kim JH. Kim JC Ko GC. 1986. Orchard Horticulture Outline, Hvanamoonsa, Korea. Pp. 220-229.
13. Lee SJ, Lee JE, Kim HW, Kim SS, Koh KH. 2006. Development of Korean red wines using *Vitis labrusca* varieties, instrumental and sensory characterization. Food Chem. 94: 385-393.
14. Maksimovic Z. Malencic D, Kovacevic N. 2005. Polyphenol contents and antioxidant activity of Maydis stigma extracts. Bioresour Technol. 96: 873-877.
15. Mojet J, Christ-Hazelhof E, Heidema J. 2003. Taste perception with age: Generic or specific losses in threshold sensitivity to the tive basic tastes? Chem. Senses. 28. 397-413.
16. Nazzaro F, Caliendo G, Arnesi G, Veronesi A, Sarzi P, Fratianni F. 2009. Comparative content of some bioactive compounds in two varieties of *Capsicum annuum* L. sweet pepper and evaluation of their antimicrobial and mutagenic activities. J. Food Biochem. 33: 852–868.
17. Ough CS, Amerine MA. 1988. Methods for Analysis of Musts and Wines. 2nd ed. John Weily and Sons, New york, NY, USA, pp.80-107.
18. Park C-S. Lee T-S. 2002. Quality characteristics of takju prepared by wheat flour nuruks. Korean J. Food Sci, Technol. 34: 296-302.
19. Prescott J, Bell G. 1995. Cross-cultural determinants of food acceptability: Recent research on sensory perceptions and preferences. Trends Food Sci. Technol. 6: 201-205.
20. Shaha RK, Rahman S, Asrul A. 2013. Bioactive compounds in chilli peppers (*Capsicum annuum* L.) at various ripening (green, yellow and red) stages. Ann. Biol. Res. 4: 27–34.
21. Singletot V, Orthofer R, Lamuela-Raventos R. 1999. Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteu reagent. Vol. 299, pp 152-178, In: Oxidants and Antioxidants. Packer L (ed). Academic Press, New York, NY, USA (1999)
22. Smith MAL, Marley KA, Seigler DA, Singletary KW, Meline B. 2000. Bioactive properties of wild blueberry fruits. J. Food sci. 65: 352-356.
23. Woisky RG, Salatino A. 1998. Analysis of propolis: some parameters and procedures for chemical quality control. J. Apic Res. 37: 99-105.
24. Yazdizadeh Shotorban NI, Jamei R, Heidari R. 2012. Antioxidant activities of two sweet pepper *Capsicum annuum* L. varieties phenolic extracts and the effects of thermal treatment. Avicenna J. Phytomed. 3: 25–34.