International Journal of Sciences

Research Article Volume 9 – June 2020 (06)

Influence of Ulmi (*Ulmus macrocarpa Hance*) Cortex on Quality Characteristics and Antioxidant activity of Korean Traditional Wine, *Takju*

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Abstract: Ulmi (*Ulmus macrocarpa* Hance) is an oriental medicinal plant that shows huge potential against several metabolic disorders. The purpose of this study was to investigate the effect of addition of ulmi root cortex extracts on the quality characteristics and antioxidant activity of Korean traditional wine *(takju)*. Four *takju* samples containing different proportions of the extracts were prepared; namely UCT-0: *takju* prepared by adding 0% ulmi cortex extracts, UCT-1: *takju* prepared by adding 1% ulmi cortex extracts, UCT-5: *takju* prepared by adding 5% ulmi cortex extracts, and UCT-10: *takju* prepared by adding 10% ulmi cortex extracts. Alcohol contents (6.01–6.11%) and pH levels (4.01–4.11) of all four types of *takju* were not significantly different. The titratable acidity value was the lowest in UCT-0 (0.19 g/100 ml) among the four samples. The soluble solid content was the highest in UCT-10 (4.1 °Brix). The lightness (L*) values were in the order of UCT-0 (55.66) > UCT-1 (50.22) > UCT-5 (47.12) > UCT-10 (40.00). The more the amount of ulmi cortex extracts added, the more the redness (a*) values of the *takju* observed. The higher scores for overall taste were found for UCT-5 sample as compared to the other samples. The range of the DPPH (1,1-Diphenyl-2-picryl-hydrazyl) free radical scavenging potential in all samples ranged from 39.83% (UCT-0) to 45.91% (UCT-5). Total polyphenol content was in order of UCT-5 (373.44 μg/ml) > UCT-5 (362.11 μg/ml) > UCT-1 (340.44 μg/ml) > UCT-0 (344.22 μg/ml). The results indicated that addition of 5% root cortex extract of ulmi could be used to produce antioxidant-rich *takju* with highest overall acceptance.

Keywords: Ulmi Cortex Extract, Quality Characteristics, Antioxidant Activity, Korean Traditional Wine, *takju*

Introduction

Ulmi (*Ulmus macrocarpa* Hance) is a deciduous medicinal plant that is widely distributed in Korea. The stem and root cortexes of this plant have been used as oriental traditional medicine for the treatment of various health disorders, such as edema, gastric cancer, and inflammation (Kwon et al., 2011; Oh et al., 2008; Park et al., 2020; Han et al., 2019). The cortexes contain several phytochemicals, including flavonoids, saponins, tannins, phlegmatic, β-sitosterol, phytosterol, sigmasterol, and resin. Ulmi cortex extracts are effective as anti-inflammatory, anthelmintic, and antibacterial activity. *Takju*, more commonly known as *makgeolli*, a famous Korean traditional alcoholic beverage, is produced by brewing yeast (*Saccharomyces cerevisiae*); cereals, mostly glutinous rice; *nuruk*, a fermentation starter, containing yeast and several types of fungi. It is rich in protein and carbohydrates and also contains a small amount of organic compounds. Traditional alcoholic beverages are widely consumed in Korea. It contains about 6% alcohol with a characteristic fragrance and a sweet taste.

Several studies have been carried out to improve the quality of Korean traditional rice wines and liquors (Takizawa, 1999, Kim et al., 2002). Different additives such as chamomile (Lee et al., 2002), acasia (Seo et al., 2002), *Paecilomyces japonica* (Lee et al., 2002) have already been used to produce varieties of Korean traditional rice wines of improved quality. The physicochemical characteristics and antioxidant potential of traditional wine has gradually improved with the addition of different additives, resulting in increased sales in recent years; however, problems still exist.

A number of active substances, including polyphenols, polysaccharides, and polysaccharide-peptide complexes are detected in *takju* (Lee et al., 1996; Park and Lee, 2002). These active substances found in *takju* show various chemical characteristics and biological effects, such as antioxidant and immunomodulating activities. Few *takju* samples also

Published at: http://www.ijsciences.com/pub/issue/2020-06/
DOI: 10.18483/ijSci.2333; Online ISSN: 2305-3925; Print ISSN: 2410-4477

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contain substantial amount of total polyphenol contents compared to white wine. The objective of this study was to investigate the physicochemical characteristics and antioxidant activity of *takju* prepared by the addition of different proportions of ulmi cortex extracts.

Materals and methods

Materials

Ulmi cortex powder, rice, yeast *(Saccharomyces cerevisiae)*, and *nuruk* were purchased from a local market in Daegu, Korea.

Preparation of ulmi cortex extracts

Entire roots (15 g) of ulmi cortex were thoroughly washed with tap water and were cut into small pieces, and then boiled with 3 L water for 30 min in a stainless steel container. The extraction solution was allowed to cool and filtered through Whatman No. 2 filter paper. The samples were stored at 4°C.

***Takju* sample preparation**

A typical Korean traditional wine, *takju* is prepared by 2-step fermentation of steamed rice. *Nuruk* is added only in the second step but not in the first step of fermentation. However, in this experiment, we studied the effect of the addition of *nuruk* in the first step of fermentation as well. The ulmi cortex extracts were added in the second step of fermentation. Briefly, in the first step, the mixture of rice *koji*, commercially available steamed rice (2 kg), yeast (2.5 g), and water (3 L) was fermented at 25°C for 1 d. In the second step, the mixture of steamed rice (8 kg), *nuruk* (200 g), water (12 L), and different proportions of ulmi cortex extracts were mixed and fermented at 25°C for 6 d. Four different samples were prepared and named as UCT-0: Ulmi cortex *takju* prepared with adding of 0 % ulmi cortex extracts, UCT-1: Ulmi cortex *takju* prepared with adding of 1% ulmi cortex extracts, UCT-5: Ulmi cortex *takju* prepared with adding of 5% ulmi cortex extracts, UCT-10: Ulmi cortex *takju* prepared with adding of 10% ulmi cortex extracts

Chemical parameters

Chemical parameters, such as pH, titratable acidity (TA), alcohol, and soluble solid content (SSC) were considered for the evaluation of different t*akju* samples. The pH was measured with a pH meter (Beckman 250, Beckman Coulter Inc., Fullerton, CA, USA). The TA (g/100 ml lactic acid) was measured by adding 5 mL of *takju* samples to 125 mL of deionized water and titrating with 0.1 N sodium hydroxide to an endpoint pH of 8.2. The alcohol level was analyzed by following a method described earlier (Ough and Amerine, 1988), and the SSC (°Brix) was measured according to the Official Methods of National Tax Service, Korea (NRRDI, 2006). All the measurements were replicated three times and the average values were reported.

Color value measurement

L* (lightness), a* (redness), and b* (yellowness) values of *takju* samples were measured using a Chroma meter (Minolta CR-300, Minolta Corp., Tokyo, Japan). Minolta calibration plate(YCIE= 94.5, XCIE= 0.3160, YCIE= 0.330) and Hunter Lab standard plate (L*= 97.51, a*= −0.18, b*= + 1.67) were used to standardize the instrument with D 65 illuminant (Kim et al., 2014).

Determination of DPPH radical scavenging activity

The DPPH'(1,1-diphenyl-2-picrylhydrazol) radical scavenging activity of ulmi cortex *takju* was measured by following the method described earlier (Blois, 1958; Shyu and Hwang, 2002). Briefly, 0.5 mM solution of DPPH' in methanol and 0.05 M acetate buffer (pH 5.5) was prepared. An aliquot of 0.1 mL (at concentrations 0.5−0.1 mg/mL) of the *takju* sample was added to 2 mL acetate buffer, 1.9 mL methanol and 1 mL DPPH' solution. Blanks contained 2 mL acetate buffer, 1.9 mL methanol and 0.1 mL ulmi cortex *takju*, while the control contained 2 mL acetate buffer, 1 mL DPPH' and 2 mL methanol. The mixture was shaken immediately after adding DPPH' and allowed to stand at room temperature in the dark, and the decrease in absorbance at 517 nm using a spectrophotometer (Shimadzu UV-1700UV, Shimadzu Corporation, Kyoto, Japan) was measured after 30 min until they reached a plateau. The inhibitory percentage of the DPPH' radical by the samples was calculated as follows:

$$\text{Scavenging effect (\%)} = [(A_0 - (A - A_b))/A_0] \times 100$$

where A, A_b, and A_o are the absorbance values of the sample extracts with DPPH, control, and blank, respectively.

Determination of total phenol content

The total phenol content of ulmi cortex *takju* samples were determined by following the Folin-Ciocalteu method as described by George et al. (2005) with some modification. In brief, 0.79 ml of distilled water 0.01 ml of diluted sample, and 0.05 ml of phenol reagent were added to a 1.5 ml Eppendorf tube, then mixed. After 1 min, 0.15 ml of 20% sodium carbonate was added, and the mixture was mixed and allowed to stand at room temperature for 120 min. The absorbance was then read at 750 nm and the total polyphenol content was calculated from calibration curve, using gallic acid as a standard.

Sensory analyses

Sensory analyses were performed on freshly made

ulmi cortex *takju*. Samples made with different conditions were rated for overall taste on the following scales: 1 point= very poor, 2 point= poor, 3 point= fair, 4 point= good, 5 point= very good. The results showed average value of each evaluation. All tests were conducted by 15 evaluators randomly selected from our department.

Statistical analysis

Analysis of variance was conducted using SAS 9.4 (SAS Institute, Cary, NC, USA) and the significance differences between sample means were determined using the Tukey test at 5% probability. Average values of three replications are reported unless otherwise mentioned.

Results and discussion

General composition of ulmi cortex *takju*

Analysis of the physicochemical characteristics of the ulmi cortex *takju*s comprised of analyses of alcohol, pH, titratable acidity (TA), and soluble solid (SS) of the four different samples (UCT-0, UCT-1, UCT-5, and UCT-10). Alcohol contents (6.01~6.11%) and pH levels (4.01~4.11) of all four types of *takju* were also almost equal. The TA (titratable acidity) value was the lowest in UCT-0 *takju* (0.19 g/100ml) among the four samples. The SS values was the highest in UCT-10 *takju* (4.1 °Brix).

Table 1. General composition of four ulmi cortex *takjus*

Properties	Ulmi cortex *takju*[1)]			
	UCT-0	UCT-1	UCT-5	UCT-10
Ethanol(%, v/v)	6.10±0.12a[3)]	6.11±0.22a	6.03±0.15a	6.01±0.11a
pH	4.01±0.03a	4.02±0.02a	4.11±0.04a	4.05±0.05a
Titratable acidity[2)] (g/100 ml)	0.19±0.01b	0.21±0.03a	0.24±0.04a	0.28±0.05a
Soluble solid (°Brix)	3.1±0.2c	3.3±0.2b	3.5±0.1b	4.1±0.2a

[1)] UCT-0: Ulmi cortex *takju* prepared with adding of 0 % ulmi cortex extracts, UCT-1: Ulmi cortex *takju* prepared with adding of 1 % ulmi cortex extracts, UCT-5: Ulmi cortex *takju* prepared with adding of 5% ulmi cortex extracts, UCT-10: Ulmi cortex *takju* prepared with adding of 10% ulmi cortex extracts.
[2)] As lactic acid.
[3)] Quoted values are means±SD of triplicate measurements. Values followed by different letters in the same row are significantly different (p<0.05).

Color and overall taste of ulmi *takjus*

Color values and overall taste of four ulmi cortex *takju*s prepared by the addition of different ulmi cortex extracts were presented in Table 2. The L* value is a measure of lightness (100, white; 0, black), from completely opaque (0) to completely transparent (100); a* is a measure of redness (-, blue; +, yellow) and b* is a measure of yellowness (-, blue; +, yellow). The L* (lightness) values were shown of UCT-0 (55.66) > UCT-1 (50.22) > UCT-5(47.12) > UCT-10 (40.00) *takju*. When the percentage of ulmi cortex extracts was increased from 1.0% (UCT-1) to 10.0% (UCT-10), this was consistently reduced the lightness (L*) of the ulmi cortex *takju* preparations.

The more the amount of ulmi cortex extracts added the more the redness (a*) values of the *takju* increased. Sensory characteristics was determined by overall taste. It was found that higher scores for overall taste were found for UCT-5 sample as compared to the other sample.

Table 2. Hunter's color values and overall taste of four ulmi cortex *takjus*

Properties		Ulmi cortex *takju*[1)]			
		UCT-0	UCT-1	UCT-5	UCT-10
Color value[2)]	L* (Lightness)	55.66±0.34a[4)]	50.22±0.44b	47.12±0.22c	40.00±0.44d
	a* (Redness)	-0.44±0.02d	1.00±0.31c	3.44±0.21b	5.33±0.44a
	b* (Yellowness)	4.20±0.05a	3.22±0.03b	2.33±0.12c	1.00±0.31d
Overall taste[3)]		3.0±0.3c	3.3±0.1c	4.3±0.2a	3.7±0.2b

[1)]Abbreviations are specified in Table 1.
[2)]L*: lightness (100, white; 0, black), a*: redness (-, green; +, red), b*: yellowness (-,blue;+,yellow).
[3)]Mean ± standard deviation of triplicate experiments, means of n=15 based on 5 points score (very poor, 1; poor, 2; fair, 3; good, 4; very good, 5).
[4)]Quoted values are means±SD of triplicate measurements. Values followed by different letters in the same row are significantly different (p<0.05).

Scavenging activities and total phenolic contents of ulmi cortex *takjus*

DPPH' radical scavenging ability and total phenolic content in ulmi cortex *takjus* were determined. The results were presented in Table 3. The range of the DPPH (%) in all samples ranged from a low of 39.83% (UCT-0) to a high of 45.91% (UCT-10) and the orders of antioxidant capacity in the four *takjus* were UCT-10 (45.91%) > UCT-5 (43.42 %) > UCT-1 (40.91%) > UCT-0 (39.83 %). Total phenolic contents of four *takjus* ranged from 340.44 μg/ml to 373.44 μg/ml. Total phenolic content in order was UCT-10 (373.44 μg/ml) >UCT-5 (362.11μg/ml) >UCT-1 (340.44 μg/ml) >UCT-0 (344.22 μg/ml).

Table 3. DPPH radical scavenging activity and total phenolic content of four ulmi cortex *takjus*

Takju[1)]	Total phenolics (μg/GAE[3)]/ml of sample)	DPPH (% Inhibition)[2)]
UCT-0	344.22±2.33c[4)]	39.83±0.33c
UCT-1	340.44±3.00c	40.91±1.11c
UCT-5	362.11±0.92b	43.42±0.93b
UCT-10	373.44±1.02a	45.91±0.21a

[1)]Abbreviations are specified in Table 1.
[2)]DPPH: DPPH free radical scavenging activity.
[3)]GAE: garlic acid equivant.
[4)]Quoted values are means±SD of triplicate measurements. Values followed by different letters in the same column are significantly different (p<0.05).

Conclusions

The addition of ulmi cortex extracts to *takju* enhanced the overall taste and antioxidant potentials. *Takjus* prepared by adding different concentrations of ulmi cortex extracts could be used as good sources of taste and antioxidants in the human health. Optimum conditions for the addition of ulmi cortex extracts of ulmi cortex *takjus* were evaluated with adding of 5% ulmi cortex extracts (UCT-5 sample). Results of this study suggested that addition of ulmi cortex extracts to *takju* could impart better physicochemical properties as well as enhance the antioxidant potentials.

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