International Journal of Bio-Science and Bio-Technology
Vol.6, No.1 (2014), pp.123-128
http://dx.doi.org/10.14257/ijbsbt.2014.6.1.13

Comparison of Quality Characteristics and Instrumental Analysis on Korean *Makgeolli*

Hyeong-Eun Kim[1], Yong-Sung Kim[2] and Yong-Suk Kim[1*]

[1*]*Department of Food Science and Technology, Chonbuk National University, Republic of Korea*
[2]*Division of Computer Science & Engineering, Chonbuk National University, Republic of Korea*

[*]*Corresponding author: kimys08@jbnu.ac.kr*

Abstract

To compare different taste evaluating methods on Makgeolli, quality characteristics and instrumental analysis on 41 commercial Makgeolli (unheated 21, heated 20) produced in different regions of South Korea were investigated. Physicochemical characteristics including pH, total titratable acidity, amino-type nitrogen, reducing sugar, and color of Makgeolli samples were analyzed. Sensory characteristics including appearance (turbidity, color), flavor (aroma), taste (sweet, sour, bitter, thick, cool), and total acceptability were evaluated. Five tastes (umami, sour, salty, bitter, astringent) and three after tastes (umami, bitter, astringent) were evaluated by using Taste Sensing System (TS-5000Z). In correlation between analytical values of physicochemical and sensory characteristics, 'pH, amino-type nitrogen - sourness, refreshing, balances' was showed high correlation. In addition, analytical items between sensory characteristics and Taste Sensing System showed a strong correlation. Results indicate the analytical values of quality characteristics and Taste Sensing System on Makgeolli were highly correlated.

Keywords: *Taste sensing system, Makgeolli, correlation, physicochemical and sensory characteristics.*

1. Introduction

Makgeolli is one of the most often drunk traditional alcoholic beverages in Korea for thousands years. *Makgeolli* are prepared with rice, wheat flour, corn, barley, sweet potato, and glucose as major raw materials, and fermented with *koji* or *Nuruk*. [1, 2] Physicochemical characteristics and sensory characteristics of *Makgeolli* depend on raw materials used for the preparation, *Nuruk*, sterilization methods, and prepared regions. [3] Qualities of *Makgeolli* heated at 62-65℃ for 30 min are not changed for a long time and maintained its good flavor and harmonized taste. However, heated *Makgeolli* have disadvantages like as heated flavor, death of useful microbes, and low carbon dioxide content [3, 4].

The taste sensor (electronic tongue) is a sensor, which has been developed on the basis of mechanisms found in biological systems. [5] In a gustatory system, substances producing taste are received by the biological membrane of gustatory cells in taste buds on the tongue. Information on taste substances is transduced into an electric signal, which is transmitted along the nerve fiber to the brain, where the taste is perceived [6]. In addition, correlation of brain waves according to sensory evaluation and taste of *Makgeolli* was analyzed. [7]

ISSN: 2233-7849 IJBSBT

In this study, we investigated the correlation between analytical values of physicochemical and sensory characteristics and Taste Sensing System on 41 commercial *Makgeolli* produced in different regions of South Korea.

2. Material and Methods

Commercial 41 *Makgeolli* samples (unheated 21, heated 20) from different regions in South Korea were collected, kept at 4°C refrigerator, and used for the test. Numbers of sample collected from Gangwon-do, Gyeonggi-do, Gyeongsang-do, Jeonla-do, and Chungcheong-do regions were 5, 11, 7, 9, and 9, respectively.

Table 1. Commercial *Makgeolli* samples produced in different regions

	Gangwon-do	Gyeonggi-do	Gyeonsang-do	Jeonla-do	Chungcheong-do
Non-heated	GS2, GS5	CS1, DL1, BH1, LD2, BS1	WP1, SD1, DB2, PG1, PS1, CT1	JJ1, JJ2, NW1, CD1	WM1, SG1, JS2, CW1
Heated	GS3, GS4, GS6	WR1, WR2, LD1, LD3, BA1, SS1	BJ1	DS1, DS2, JJ3, SH1, GS1	JS1, CJ1, SC1, SJ1, SW1

Physicochemical characteristics of *Makgeolli* samples including pH, total titratable acidity, amino-type nitrogen, reducing sugar, color, and precipitate contents were analyzed [8, 9].

For sensory evaluation, graduate and undergraduate students (n=42) of Department of Food Science and Technology, Chonbuk National University received an orientation about the purpose of the test and the evaluation method prior to the evaluation. The samples were evaluated using a 9-point hedonic scale ranging from ‘like extremely’ (scale-9) to ‘dislike extremely’ (scale-1). Appearance (turbidity, color), flavor (aroma), taste (sweet, sour, bitter, thick, cool), and total acceptability were evaluated for sensory evaluation [9].

Taste Sensing System (TS-5000Z, Insent Inc., Japan) in Daesang Research Center (Icheon, Korea) was used for instrumental test. The Taste Sensing System consisting of five taste sensors (umami, sour, salty, bitter, astringent) and three after taste sensors (umami, bitter, astringent) [9].

The data was analyzed using the Statistic Analysis System (SAS 1998) package software for the analysis of variance and Duncan’s test. All experiments were carried out in triplicate except for sensory evaluation that was measured by 42 determinations. The significance was established at $P < 0.05$.

3. Results and Discussion

3.1. Physicochemical characteristics of *Makgeolli*

The pH of *Makgeolli* was an important indicator of fermentation progress and alcohol generated amount. GS5 (Gangwon-do, heated) was the lowest pH of 3.20 and BS1 (Gyeonggi-do, non-heated) was the highest pH of 4.68 [Figure 1].

Total titratable acidity was important factors affecting the drink flavor and preservation, these came from the yeast or raw materials of fermentation agent, and as the fermentation progress various organic acids produced by the action of microorganisms of yeast and lactic acid bacteria can be increased. [10] The total titratable acidity of JS2 (Chungcheong-do, non-heated) 0.64% and GS4 (Gangwon-do, non-heated) 0.56% was the highest, and SC1 (Chungcheong-do, heated) was the lowest total acidity of 0.15% [Figure 2].

Amino-type nitrogen contents of GS4 (Gangwon-do, non-heated) was the highest content at 86.19 mg%, and those of other *Makgeolli* was ranged from 10 to 20 mg% [Figure 3].

Reducing sugar contents of GS4 (Gangwon-do, non-heated) and GS1 (Jeonla-do, heated) was the highest at 8.30% and those of GS6 (Gangwon-do, heated) and BS1 (Gyeonggi-do, non-heated) 7.45% and 4.87%, respectively. In addition, reducing sugar contents of the other *Makgeolli* was less than 1%. Soluble solid contents of GS4 (Gangwon-do, non-heated), GS1 (Jeonla-do, heated), and BS1 (Gyeonggi-do, non-heated) were higher 14.7, 12.3, and 11.5°brix, respectively, than the other samples, and these results was consistent with the reducing sugar contents [Figure 4].

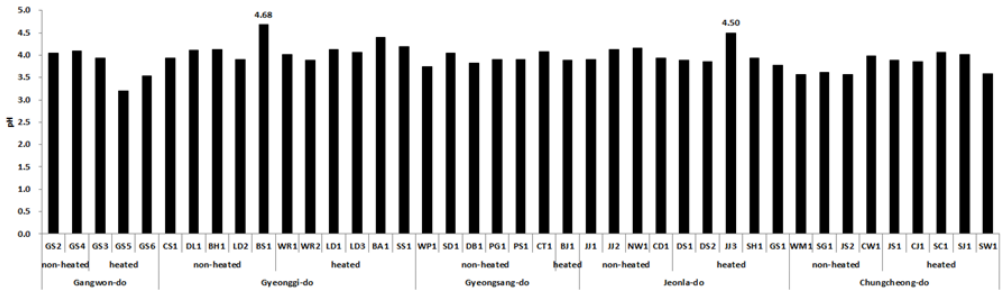

Figure 1. pH of commercial *Makgeolli* produced in different regions

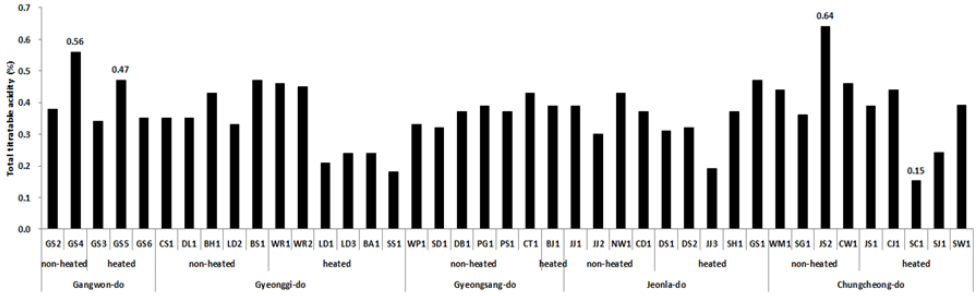

Figure 2. Total titratable acidity of commercial *Makgeolli* produced in different regions

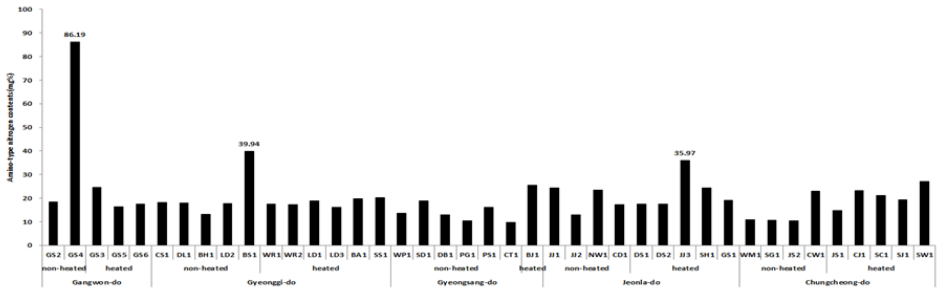

Figure 3. Amino-type nitrogen contents of commercial *Makgeolli* produced in different regions

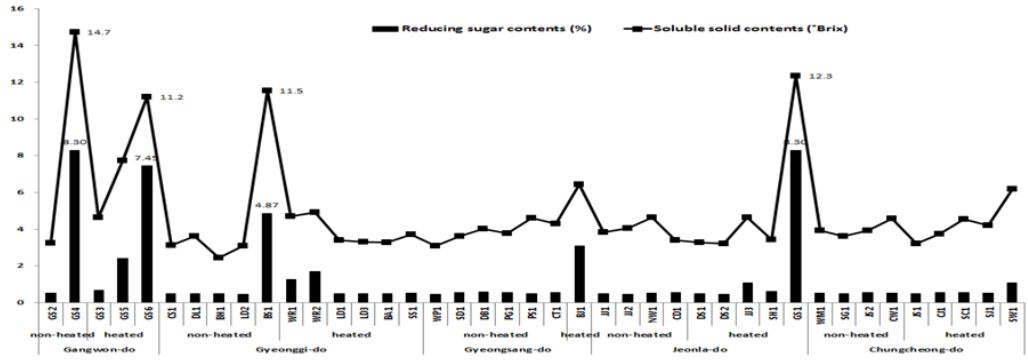

Figure 4. Reducing sugar and soluble solid contents of commercial *Makgeolli* produced in different regions

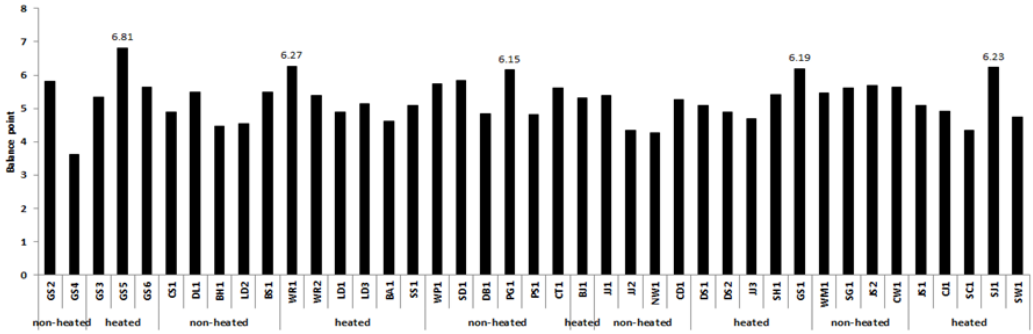

Figure 5. Sensory evaluation of commercial *Makgeolli* produced in different regions

3.2. Sensory evaluation of *Makgeolli*

Sensory evaluation results on 41 kinds commercial *Makgeolli* were showed in [Figure 5]. GS5 (6.81±1.33), WR1 (6.27±1.12), PG1 (6.15±1.29), GS1 (6.19±1.70), and SJ1 (6.23±1.90) were significantly high in balance and overall acceptability. No significant differences were observed between heated and non-heated treatments in refreshment and balance of sensory characteristics. In addition, no difference was observed in the balance with produced regions.

3.3. Taste Sensing System analysis on *Makgeolli*

Used in this experiment, the Taste Sensing System TS-5000z was to set the standard and test sample compared to the standard. In this experiment, the standard was CD1 (Jeonla-do, non-heated), which showed intermediate value in sensory evaluation test. At the results of the taste sensor [Figure 6], sourness showed significant difference between WM1 (7.96) ~ BS1 (-23.84), and the value of sourness was non-heated *Makgeolli* was usually higher than heated *Makgeolli*. Bitterness was high in WR1 (5.20), WR2 (5.47), SD1 (5.03), CW1 (5.13), SJ1 (5.56), and CJ1 (5.59). Umami and richness of *Makgeolli* showed high at GS5, WR1, PG1,

GS1, and SJ1 samples. The SD1 showed the highest value (6.65) in umami and 0.83 in richness at taste evaluation by the Taste Sensing System.

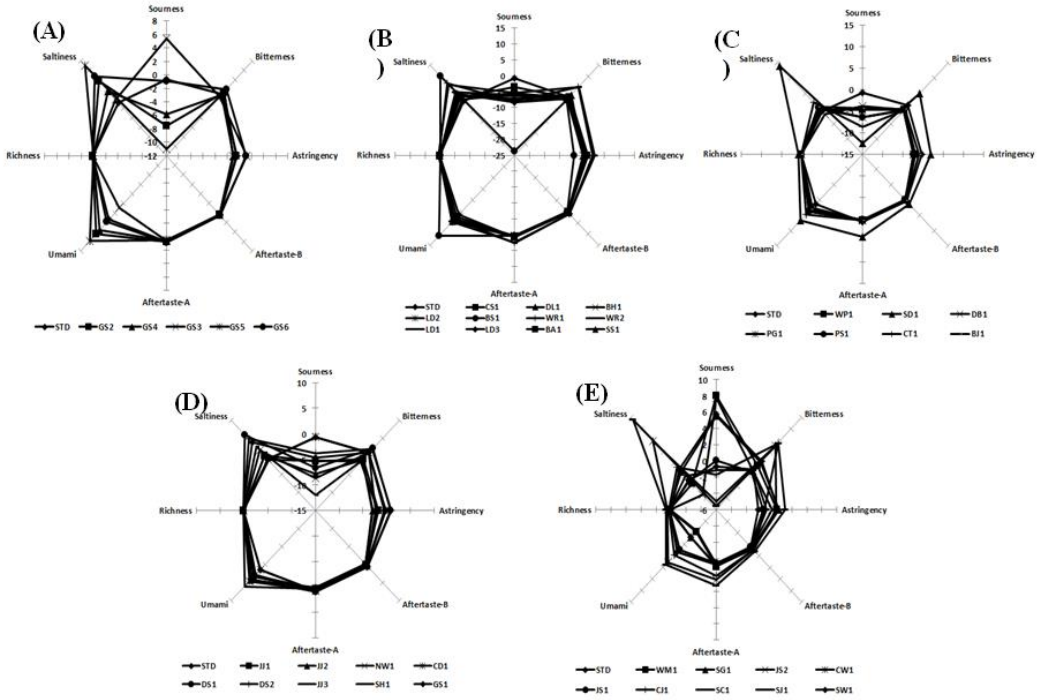

Figure 6. Evaluation results by Taste Sensing System on commercial *Makgeolli* produced in different regions. (A) Gangwon-do, (B) Gyeonggi-do, (C) Gyeongsang-do, (D) Jeonla-do, (E) Chungcheong-do

3.4. Correlation

Correlation between analytical values of physicochemical and sensory characteristics and Taste Sensing System on 41 kinds of commercial *Makgeolli* were investigated. In physicochemical characteristics, ‘reducing sugar - amino-type nitrogen contents’, ‘sugar content - total acidity, amino-type nitrogen, reducing sugar’ and ‘sediment contents - amino-type nitrogen, reducing sugar, sugar contents’ showed high correlation. In correlation between analytical values of physicochemical and sensory characteristics, ‘pH, amino-type nitrogen - sourness, refreshing, balances’ was showed high correlation. In addition, like previous results, analytical items between sensory characteristics and Taste Sensing System showed a strong correlation [Table 2].

Table 2. Correlation between analytical values of physicochemical and sensory characteristics and Taste Sensing System on 41 kinds of commercial *Makgeolli*

		Physicochemical properties										Sensory properties										Taste sensor								
		pH	Total acidity	Amino -type nitrogen	Reducing sugar	Soluble solid	Light Ness	Red ness	Yellow ness	Precipit ate	Turbidit y	Color	Flavor	Sweet	Sour	Bitter	Thick	Cool	Total accepta bility	Sournes s	Bitter ness	Astring ency	Astring ency2	Asterin gency1	Umami	Richnes s	Saltines s
Physico-chemical properties	pH	NA[1]	-.357*	.337*	-.060	-0.029	-.418**	-.415**	-.186	.193	-.072	-.238	-.163	-.308	-.419**	-.279	-.260	-.537**	-.402**	-.605**	-.192	-.496**	-.268	-.036	.582**	-.095	.190
	Total acidity		NA	.186	.359*	.399**	-.040	.457**	.289	.248	-.034	.098	-.022	.135	.184	.155	.299	.378*	.220	.134	.147	.060	.107	.055	-.130	.030	-.054
	Amino-type nitrogen			NA	.571**	.655**	-.058	-.035	-.255	.526**	-.460**	-.491**	-.361*	-.433**	-.520**	-.354*	-.278	-.420**	-.428**	-.236	-.042	-.146	-.079	-.030	.234	-.144	.131
	Reducing sugar				NA	.959**	-.158	.346*	-.321*	.538**	-.198	.006	-.062	.111	-.078	-.008	.189	.006	.042	-.154	-.020	-.047	-.052	-.085	.176	-.118	.225
	Soluble solid					NA	-.059	.353*	-.276	.542**	-.258	-.09	-.073	.071	-.088	-.053	.135	.005	.025	-.203	-.010	-.075	-.049	-.079	.219	-.144	.267
	Lightness						NA	-.024	.028	-.509**	-.215	-.099	-.118	.008	.084	.021	-.188	.203	.056	.308	.116	.283	.160	.050	-.303	.010	-.067
	Redness							NA	.683**	.101	.159	.268	.272	.381*	.302	.139	.360*	.280	.299	.105	-.091	.067	-.042	-.075	-.101	.009	-.018
	Yellowness								NA	-.158	.209	.138	.138	.107	.142	.032	.116	.114	.109	.231	-.053	.066	-.003	-.027	-.252	.021	-.244
	Precipitate									NA	.041	-.174	-.176	-.183	-.298	-.232	.257	-.306	-.207	-.076	-.048	-.098	-.047	-.046	.079	-.027	.014
Sensory properties	Turbidity										NA	.797**	.432**	.372*	.444**	.269	.361*	.335*	.439**	.033	.032	.066	.109	.167	-.029	.268	.048
	Color											NA	.443**	.533**	.544**	.403**	.352*	.469**	.570**	.083	.039	.106	.099	.070	-.066	.150	.072
	Flavor												NA	.739**	.642**	.540**	.351*	.441**	.732**	-.193	.181	.125	.176	.254	.206	.320*	.360*
	Sweetness													NA	.800**	.766**	.668**	.726**	.900**	-.154	.199	.151	.193	.278	.175	.309*	.410**
	Sourness														NA	.775**	.584**	.823**	.851**	-.117	.126	.107	.129	.223	.138	.285	.304
	Bitterness															NA	.594**	.722**	.861**	-.118	.172	.111	.167	.228	.139	.212	.309*
	Thickness																NA	.538**	.643**	.007	.115	.136	.138	.200	.009	.296	.169
	Refreshing																	NA	.785**	-.020	.024	.067	.051	.063	.033	.060	.181
	Balanced																		NA	-.062	.312*	.266	.324*	.345*	.084	.348*	.402**
Taste Sensor	Sourness																			NA	.114	.630**	.273	-.043	-.998**	.076	-.590**
	Bitterness																				NA	.749**	.956**	.907**	-.081	.795**	.591**
	Astringency																					NA	.869**	.653**	-.599**	.649**	.224
	Astringency2																						NA	.893**	-.240	.815**	.527**
	Asteringency1																							NA	.073	.931**	.682**
	Umami																								NA	-.047	.624**
	Richness																									NA	.524**
	Saltiness																										NA

[1] NA : Not analyzed; * $p<0.05$; ** $p<0.01$

Acknowledgements

This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology [No. : 1201000870].

References

[1] D. H. Jung, "Historical Development of Korean Liquor", Shinkwang Publisher, Seoul, Korea, **(2004)**.
[2] I. S. Ryu, "We Enjoy the Taste of 101 Kinds of Makgeolli Notebooks", The Treetop (Woodemji), Seoul, Korea, **(2010)**.
[3] Ministry of Agriculture, "Food and Rural Affairs, Introduction of Takju and Yakju", Suhwasa, Seoul, Korea, **(2012)**.
[4] C. H. Baek, J. H. Choi, H. S. Choi, S. T. Jeong, J. H. Kim, Y. J. Jeong and S. H. Yeo, Korean J. Microbiol. Biotechnol., vol. 41, **(2013)**, pp. 168.
[5] T. Kiyoshi, Sensors and Actuators B, vol. 64, **(2000)**, pp. 205.
[6] T. U. Tran, K. Suzuki, H. Okadome, S. Homma and K. Ohtsubo, Food Chem., vol. 88, **(2004)**, pp. 557.
[7] S. H. Kim, Y. S. Kim and Y. S. Kim, Adv. Sci. Technol. Lett., vol. 39, **(2013)**, pp. 42.
[8] H. J. Kim, K. H. Lee, H. I. Yong and C. U. Jo, Korean J. Food Preserv., vol. 20, **(2013)**, pp. 45.
[9] H. E. Kim, Y. S. Kim and Y. S. Kim, Adv. Sci. Technol. Lett., vol. 39, **(2013)**, pp. 50.
[10] C. W. Park, S. Y. Jang, E. J. Park, S. H. Yeo, O. M. Kim and Y. J. Jeong, Korean J. Food Preserv., vol. 18, **(2011)**, pp. 884.

