ISBN : 978-602-14917-9-9

FEASIBILITY OF BREWING *MAKGEOLLI* (TURBID RICE WINE) USING PARTIALLY GELATINIZED WHEAT FLOUR AND TAPIOCA FLOUR

Woo-Won Kang[a,1*] Agung Wahyono[b,2], Jin-Ah Jeon[c,2], and Seok-Tae Jeong[c,3]

[a]Department of Food & Food-service Industry, Kyungpook National University, Sangju 742-711, Korea
[1]E-mail address: wwkang@knu.ac.kr
[b]Department of Food Engineering Technology, State Polytechnic of Jember, Jember 68121, Indonesia
[2]E-mail address: wahyono_agung@yahoo.com
[c]Fermentation & Food Processing Division, National Academy of Agricultural Sience, RDA, Suwon 441-835, Korea
[3]E-mail address: jazz16a@khu.ac.kr
[3]E-mail address: jst@korea.kr

Abstract. Makgeolli is made from cooked rice or wheat, then brewed with nuruk (Korean fermentation starter) for several days. But, nowadays, attempts have been made to use various raw materials and process innovations to make makgeolli for particular purposes. This study aimed to evaluate the quality of makgeolly made from partially gelatinized wheat flour and tapioca flour. Five different combination of wheat flour and tapioca flour were used to manufacture makgeolli. The results showed that different combination of partially gelatinized wheat flour and tapioca flour significantly affected the chemical and sensorial characteristics of makgeolli. Increasing proportion of wheat flour produced higher level of total acid, amino acidity, reducing sugar and total solid of makgeolli. Inversely, alcohol content was higher when higher level of tapioca flour was used. In general, sensorial characteristics of makgeolli made from partially gelatinized wheat flour and tapioca flour didn't acceptable by panelists. Thus, brewing makgeolli by using partially gelatinized wheat flour and tapioca flour isn't acceptable in term of sensorial characteristics.

Key words: Makgeolli, Partially gelatinized, Tapioca flour, Wheat Flour

ISBN : 978-602-14917-9-9

1. INTRODUCTION

Alcoholic beverages made from rice are quite popular in Asian countries. The final product of these beverages may be distillated or not depends on the production purposes. Sort of popular alcoholic beverages made from rice in Asian countries are Japanese *sake*, Chinese lao-chao, Indian rice beer, Thai rice wine, Malaysian tapuy, Philippine tapuy, Indonesia brem, Vietnamese rice wine and Korean *soju* or *makgeolli*. In Korea, makgeolli refers to the non-distillated fermented rice. This makes its appearance to be turbid or unclear due to the rice solid and incorporated live yeast. These solid materials provide the nutritious ingredients such as essential amino acids, proteins, sugars (H. R. Kim et al. 2012) which contribute human health (Kim et al. 2008) (Min et al. 2012) (Shin et al., 2008). Due to the understanding of its functionality, the marketability and market share of makgeolli always increase in Korea and Japan (H. R. Kim et al. 2012).

Makgeolli is made from cooked rice or wheat, then brewed with nuruk (Korean fermentation starter) for several days. But, nowadays, attempts have been made to use various raw materials and process innovations to make makgeolli for particular purposes. These included the use of uncooked germinated black rice (D. Kim et al. 2012), the use of the combination of wheat and rice (Seo, et al. 2012), the addition of processed persimmon (Im, et al. 2012), the use of different milling degrees of rice (Lee, et al. 2012), the use of partially gelatinized wheat flour (Wahyono, et al. 2015), and the use of purple sweet potato-rice starter (Cho, et al. 2012).

Generally, TRW is prepared by steaming a raw material until fully gelatinized. However, this process considered to be time consuming and required enormous energy. Previously, we demonstrated that TRW could be prepared with partially gelatinized wheat flour by using geryang nuruk with decent chemical qualities (Division and Industry 2015). Nevertheless, its sensorial properties were not yet examined. Furthermore, producing makgeolli using a raw material cheaper than rice such as wheat flour and tapioca flour is challenge not only in term of economical aspects but also quality aspects. Thus, in this study, we used different proportion of partially gelatinized wheat flour and tapioca flour in the making of makgeolli. The chemical characteristics and sensorial properties of makgeolli were evaluated during brewing.

2. MATERIALS AND METHODS

2.1 Materials

Wheat flour was purchased from market in Suwon City, Korea. Yeast *Saccharomices cerevisiae* was purchased from La-pharjang Inc. (French). Geryang *nuruk* (SP 1800) was purchased from Korea Enzyme Co., Ltd.

2.2 Methods

Makgeolli Brewing

Standard process at Brewing Research Center, RDA, Suwon City, Korea was used in the making of *makgeolli*. Total weight of *makgeolli* ingredients was 4480 g, which comprises of 1600 g of blended flour and 2880 g of drinking water. *Nuruk* was adjusted to 2% of blended flour weight. Yeast, *Saccharomices cerevisiae* was adjusted to 0.1% of total weight. A known amount of wheat flour and tapioca flour were steamed for 1 hour, then allowed to cold down at 40 ^{o}C. Steamed but ungelatinized wheat flour and tapioca flour were then divided accordingly based on the composition. Afterward, *nuruk*, yeast, and water were mixed thoroughly, followed by fermentation at 22 ^{o}C for 6 days. *Makgeolli* brewing was done in triplicates. Samples were taken from each treatment during fermentation at the day of 0, 2, 4 and 6.

ISBN : 978-602-14917-9-9

Sample Preparation

Sample preparation was done as described previously (Wahyono, et al., 2015). Approximately 200 mL *makgeolli* sample was taken from each treatment. To clarify the sample, centrifugation at 10.000 rpm for 10 minutes was done using a large-capacity High-Speed Refrigerated Centrifuge Hitachi CR22GIII (Hitachi, Japan). The supernatant was taken from tubes and poured in a sample bottle. Samples were stored at freezing temperature until required for chemical analysis.

pH, total acid and amino acidity

The pH was measured with Orion 3 Star pH Benchtop (Thermo Scientific). Amino acidity was determined by titration method using Burette Digital III (Brand). Three drops of phenolphthalein indicator was added to a 10 ml sample and then titrating with 0.1 N NaOH until the solution become pale pink. A 5 ml formalin was added to solution, then mixed thoroughtly until pale pink color disappeared and titrating again with 0.1 N NaOH until the solution turned pale pink. Amino acidity was calculated as a volume nedeed for titration after formalin addition. Total acid was determined by titrating 10 ml of sample with 0.1 N NaOH until the pH reached 8.2 to 8.3. Total acid was calculated as lactic acid concentration (%) by using its molecular weight number as a convertion value.

Soluble solid

Soluble solids was measured with a portable refractometer (ATAGO PR32-α; ATAGO Co. Ltd., Tokyo, Japan) and recorded in brix units. Firstly, standard measurement was done using distilled water as zero brix units. After cleaning the loading side of refractometer, approximately 4 to 5 drops of sample was loaded into loading side. Then, soluble solid was measured by pressing read knob, and brix unit simply recorded on the refractometer display.

Reducing sugar

Reducing sugar was determined by dinitrosalicylic acid method. Sample absorbance was recorded using spectrophotometer at 550 nm (Shimadzu UV-2450, UV-Vis Spectrophotometer). Reducing sugar consentration was calculated by using glucose as a standard (Sigma-Aldrich, St. Louis, MO, USA) and presented in mg/ml.

Alcohol content

Alcohol content was determined by distillation method. A 100 ml distilled water was added to 100 ml sample in erlenmeyer flask, followed by adding 3-4 drops anti-foaming agent. Then, sample was distilled by using parallel distillation machine. Distillate was collected in 100 ml volumetric flask up to 80 ml of distillate. After that, distilled water was added to reach 100 ml volume. Furthermore, distillate was cooled down at refrigerator to reach 15^{o}C, then, alcohol content was measured by using alcohol meter. Alcohol content was calculated as percent volume (v/v).

Sensory analysis

Sensory characteristics of *makgeolli* were tested by 10 trained panelists from Brewing Research Center, RDA, Suwon City, Korea. Six criteria were used to evaluate the quality of makgeolli. The quality of makgeolli was scored from 1 to 7 based on the preference of panelist, where 1 represent an extremely dislike and 7 represent extremely like. The resulting data were analyzed and then presented in spider chart.

Statistical Analysis

Each data point represents the mean of three samples ± SD. Mean separation of the experimental parameters was calculated using one-way analysis of variance (ANOVA) followed by Duncan's Multiple

ISBN : 978-602-14917-9-9

Range Test at the significance level $p<0.05$. The statistical analysis was done using SPSS for Windows ver. 19 (IBM corp.).

3. RESULTS AND DISCUSSION

Chemical characteristics

Chemical characteristics of makgeolli made from different proportion of partially gelatinized wheat flour and tapioca flour is presented in Table 1. The pH of makgeolli made from 100% of tapioca was the lowest than those made with the addition of wheat flour. The pH value is widely recognized measurement of the strength of an acid. It is well known that pH is important for controlling microbes and a maximum level of 4 is required for any application where rogue microbes could cause issues in food preservation.

Total acid of makgeolli increased as the proportion of wheat flour increased. The highest total acid was achieved when 75% and 100% of wheat flour were used. Total acid of makgeolli was high when wheat flour was added. The The same results have been reported by SEO *et al*. (2012) they reported that the total acid content of *makgeolli* concurrently increased (0.68±0.02% to 1.04±0.02%) when the proportion of wheat was increased. Wheat flour is an affluent media for microorganisms. It contains abundant amino acid, vitamins, carbohydrates, and minerals which are needed for growing of microorganisms. We presumed that lactic acid bacteria growing faster in wheat flour media. It has been reported that, the viable cell numbers of lactic acid bacteria in *makgeolli* increased, when the wheat proportion was increased instead of rice (SEO *et al*. 2012).

Amino acidity of makgeolli increased as the proportion of wheat flour increased (Tabel 1). Increased level of wheat flour significantly increased amino acidity of makgeolli. Amino acidity is needed in *makgeolli*, particularly to contribute to delicious taste, thus moderate amount is preferred.

It can be seen in Table 1 that reducing sugar of makgeolli was affected significantly by increased level of wheat flour. The highest reducing sugar was shown in makgeolli with 100% wheat flour. The lowest reducing sugar was found in makgeolli with 100% tapioca flour. The higher reducing sugar indicating the strong sweet taste that can be attributed to incomplete fermentation (KIM *et al*. 2012). Total solid of makgeolli was in accordance with the reducing sugar content. Total solid is commonly used as a predicted of sugar content.

Increased level of wheat flour in composite flour with tapioca significantly affected alcohol content of makgeolli. Makgeolli without wheat flour and with 25% wheat flour (higher tapioca flour) produced highest alcohol content than those with higher wheat flour (more than 25%). We assumed that tapioca flour is more accessible to be degrade and fermented to produce alcohol than wheat flour.

Tabel 1. Chemical characteristic of *makgeolli* made from partially gelatinized wheat flour and tapioca flour

Nuruk	pH	Total Acid (%)	Amino Acidity (%)	Reducing Sugar (mg/mL)	Total Solid (%brix)	Alcohol (% v/v)
W-0	3.30±0.06^{b}	0.31±0.01^{d}	0.37±0.01^{d}	0.86±0.02^{c}	5.43±0.15^{e}	11.43±0.06^{ab}
W-25	3.60±0.08^{a}	0.48±0.02^{c}	1.44±0.13^{c}	1.10±0.08^{b}	6.67±0.12^{d}	11.57±0.15^{a}
W-50	3.51±0.02^{a}	0.75±0.04^{b}	1.95±0.12^{b}	0.93±0.03^{c}	7.67±0.21^{c}	10.73±0.50^{c}
W-75	3.55±0.04^{a}	0.83±0.05^{a}	2.10±0.08^{b}	1.14±0.08^{ab}	8.53±0.06^{b}	10.53±0.23^{c}
W-100	3.59±0.08^{a}	0.89±0.07^{a}	2.37±0.14^{a}	1.21±0.03^{a}	9.47±0.12^{a}	10.93±0.42^{bc}

Result are presented as mean ± SD (n=3)
Means with superscript letters (a-e) indicate statistically differences at the 5% level, as determined by Duncan's multiple range test.

ISBN : 978-602-14917-9-9

Sensorial Characteristic

Figure 1 show effect of proportion of partially gelatinized wheat flour and tapioca flour on sensorial characteristics of makgeolli. Higher level of tapioca flour (W-0) produced higher granule taste but lower sourness. Color attribute scored higher with less proportion of wheat flour. On the contrary, aroma scored better with higher proportion of wheat flour instead of tapioca flour. Generally, taste of makgeolli made from wheat flour and tapioca flour didn't acceptable (<2 score). Overall attributes also didn't acceptable based on the score given by panelist.

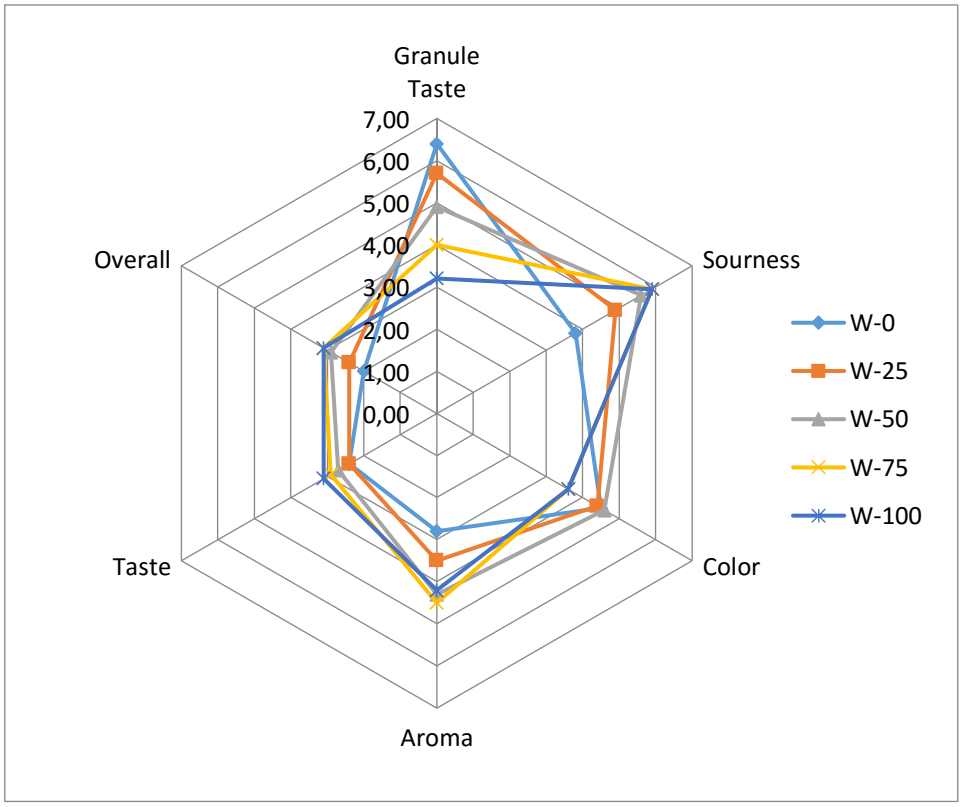

Figure 1. Sensory characteristic of *makgeolli* made from partially gelatinized wheat flour and tapioca flour

4. CONCLUSIONS

The results showed that different combination of partially gelatinized wheat flour and tapioca flour significantly affected the chemical and sensorial characteristics of makgeolli. Increasing proportion of wheat flour produced higher level of total acid, amino acidity, reducing sugar and total solid of makgeolli. Inversely, alcohol content was higher when higher level of tapioca flour was used. In general, sensorial characteristics of makgeolli made from partially gelatinized wheat flour and tapioca flour didn't acceptable by panelists. Thus, brewing makgeolli by using partially gelatinized wheat flour and tapioca flour isn't acceptable in term of sensorial characteristics.

ISBN : 978-602-14917-9-9

REFERENCES

[1]. KIM H.R., KIM J.H., BAI D.H., AHN B.H. (2012): Feasibility of brewing makgeolli using *Pichia anomala* Y197-13, a non-*Saccharomyces cerevisiae*. J. Microbiol Biotechnol, **22**(12): 1749–1757.

[2]. Kim, J.U., Jung, S.K. Lee, S.J. Lee, K.W. Kim, G.W. and Lee, H.J. 2008. Nuruk extract inhibits lipopolysaccharide-induced production of nitrite and interleukin-6 in RAW 264.7 cells through blocking activation of p38 mitogen-activated protein kinase. Journal of Microbiology and Biotechnology 18(8): 1423–1426.

[3]. Min, J.H., Kim, Y.H., Kim, J.H., Choi, S.Y., Lee, J.S. and Kim, H.K. 2012. Comparison of microbial diversity of Korean commercial makgeolli showing high β-glucan content and high antihypertensive activity, respectively. Mycobiology 40(2) : 138-141.

[4]. Shin, M.O., Kang, D.Y., Kim, M.H. and Bae, S.J. 2008. Effect of growth inhibition and quinine reductase activity stimulation of makgeolli fractions in various cancer cells. Journal of the Korean Society of Food Science and Nutrition 37: 288-293.

[5]. Kim, D.R., Seo, B.M., Noh, M.H. and Kim, Y.W. 2012. Comparison of temperature effects on brewing of makgeolli using uncooked germinated black rice. Korean Society for Biotechnology and Bioengineering Journal 27: 251-256.

[6]. Seo, W.T., Cho, H.K., Lee, J.Y., Kim, B. and Cho, K.M. 2012. Quality characteristics of wheat-rice makgeolli by making of rice nuruk prepared by Rhizopus oryzae CCS01. Korean Journal of Microbiology 48(2):147- 155.

[7]. Im, C.Y., Jong, S.T., Choi, H.S., Choi, J.H., Yeo, S.H. and Kang, W.W. 2012. Characteristics of gammakgeolli added with processed forms of persimmon. Korean Journal of Food Preservation 19(1): 159-166.

[8]. Lee, Y., Yi, H., Hwang, K.T., Kim, D.H., Kim, H.J., Jung, C.M. and Choi, Y.H. 2012. The qualities of makgeolli (Korean rice wine) made with different rice cultivars, milling degrees of rice, and nuruks. Journal of the Korean Society of Food Science and Nutrition 41(12): 1785-1791.

[9]. Wahyono, A, Jeon, J.A, Jeong, S.T, Kang, W.W. 2015. "Chemical Characteristics of Korean Turbid Rice Wine Prepared with Partially Gelatinized Wheat Flour Brewed Using Different Starters." 22(2):713–20.

[10]. CHO H.K., LEE J.Y., SEO W.T., KIM M.K., CHO K.M. (2012): Quality characteristics and antioxidant effects during makgeolli fermentation by purple sweet potato-rice nuruk. Korean J. Food Sci. Technol, **44** (6): 728-735.