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Fermentation Characteristics of Wine Yeast Strains for White Wine Making

Seoktae Jeong, Nami Goto* and Jonguck Choi**

Postharvest Technology Division, National Horticultural Research Institute, Suwon 440-310, Korea
**Alcoholic Beverages Science Division, National Research Institute of Brewing, Higashihiroshima, Japan*
***Department of Food Science and Technology, Kyungpook National University, Taegu 702-701, Korea*

백포도주 양조에 있어서 포도주 효모의 발효 특성

정석태 · 고토나미* · 최종욱**

원예연구소 품질보전과, *양조연구소 주류이화학연구실, **경북대학교 식품공학과

Abstract

The characteristics of used wine yeast strains were as follows, S6U showed low fermentation speed than those of other yeast strains, but this strain fermented completely later. The wine fermented by W-3 was very low contents of total acid, 0.75% and the ones fermented by UCD530 and AC- contained much extract, 3.26 mg/L and 3.22 mg/L respectively. The wine fermented by CEG and CS2 were predominant in yellowness, and EC1118 produced large amount of acetaldehyde, 49.9 mg/L than those of other strains. EC1118 and CY3079 displayed low methylene blue dyeing ratio, below 15%, meaning high alcohol tolerance yeast. UCD530 produced extremely high contents of glycerol, succinate and lactate compared with other strains. These properties revealed that UCD530 was a typical Saccharomyces bayanus species. The main organic acids produced by wine yeasts were pyruvate, lactate, succinate and acetate. The concentration of acetate in experimental wine could be divided into two parts, one group had concentration below 170 mg/L (UCD530, EC1118, AC-, CY3079, W-3), and the other had concentration up to 350 mg/L (S6U, CEG, CS2).

Key words : wine yeast, fermentation characteristic, white wine.

Introduction

For wine making, two species, *Saccharomyces bayanus* and *Saccharomyces cerevisiae* have been using winery all over the world. In comparison of fermentation characteristics between *S. bayanus* and *S. cerevisiae, S. bayanus* yeast species possess ability to producing large amount of aroma components in fermentation of grape must (1). Studies of fermentation characteristics in comparison among several commercial wine yeast strains had been conducted by Iino et al. (2), and Ozawa S. and GOTO S. (3). The former report suggested that W-3 (Yamanashi yeast), produced large amount of organic acid and n-prOH but small amount of iso-AmOH, was good for white wine making in Koshu grape must. The latter report showed that W-3 strain was good at fast fermentation at low temperature and precipitation. In this report, small scale wine fermentation were conducted by using Chardonnay must

Corresponding author : Seoktae, Jeong, Postharvest Technology Division, National Horticultural Research Institute, Suwon 440-310, Korea

fermentation were conducted by using Chardonnay must for white wine making. The main objectives of this study are finding fermentation characteristics of wine yeast strains, and then apply these properties to wine making.

Materials and Methods

Yeast strains and must preparation

In this study 8 wine yeast strains were used for small scale white wine fermentation. In a laboratory-scale white wine making experiments was conducted using Chardonnay must which was adjusted to 24 °Brix by glucose and added 100 mg/L of potassium pyrosulfite to inhibit the development of undesirable microorganism in must. Dried wine yeast strains were dehydrated after suppliers protocol and 4.0 X 10^6/ml of yeast cell were inoculated to the grape must. The volume of grape must and fermentation bottle was 1L and 1.5L respectively, and the fermentation temperature was controlled by water bath at 15℃.

Table 1. Strains used in this study

Strains	Trade name or other designation	Species	Strains	Trade name or other designation	Species
UCD530	RIFY[1] 1071	*S. uvarum*	CY3079	Lalvin	*S. cerevisiae*
EC1118	Lalvin[2]	*S. bayanus*	W-3	RIFY 1001	*S. cerevisiae*
S6U	Lalvin	*S. uvarum*	CEG	Uvaferum[3]	*S. cerevisiae*
AC-	Lalvin	*S. cerevisiae*	CS2	Uvaferum	*S. cerevisiae*

[1] The Institute of Enology and Victiculture, Yamanashi University, Japan
[2] Lallemand Inc. Montreal, Canada
[3] Danstar Ferment AG, Zug, Switzerland

Analytical methods

To study of yeast characteristics in a laboratory-scale wine making, alcohol, methylene blue dyeing ratio, pH, total acid, glycerol, yellowness, acetaldehyde and organic acid were measured. Alcohol was determined using alcohol meter AL-2, Likenkeiki Ltd, Japan. Methylene blue dyeing ratio was measured by sampling as soon as complete fermentation (4). pH was measured by Horiva pH meter F-22, Horiva Ltd, Japan. For the analysis of total acid, 10 ml sample was titrated by 0.1 M NaOH and expressed as tartaric acid. Extract was calculated from alcohol concentration of distillation and specific gravity using KEM density/specific gravity meter DA-300, Kyoto Electronics Ltd, Japan (5). Sugar concentration was converted from specific gravity of must (6). Fermentation efficiency was calculated by this way. Fermentation efficiency (%) = [produced alcohol concentration (v/v, %) / {initial sugar concentration (g/100ml) × 0.654}] × 100. Glycerol, acetaldehyde and pyruvic acid of the organic acids were determined by enzymatic assay (Boehringer Mannheim Germany). Yellowness (7) was measured by spectrophotometer using 10 mm cell absorbance at 420 nm (A_{420}). Organic acids in samples were determined by HPLC, LC-workstation CLASS-LC 10, Shimadzu Ltd, Japan. Column, Sim-pack SCR-102H X2 and Guard column SCR-102HG were used under the following conditions; auto injector temperature 20℃, column oven 50℃, mobile phase 5 mM p-Toluensulfonic acid 0.6 ml/min, buffer solution 5 mM of p-Toluensulfonic acid, EDTA and Bis-Tris 0.6 ml/min, and internal standard 5000 ppm isovaleric acid. The detector condition was gain 1 μS/cm, range 1 and cell temperature 43℃.

Results

The characteristics of must used for white wine fermentation are as shown in Table 2 and Table 3. Must B was lower contents of total acid, yellowness, acetaldehyde and tartaric acid. It seems that the difference of these components were caused by the freezing storage of must B material. The main organic acids of Chardonnay must were tartrate and malate, but pyruvate, succinate and acetate were very low concentration.

Table 2. Analytical data of Chardonnay must used for white wine fermentation

Must[1]	pH	Total acid (%)	Yellowness (A_{420})	Sugar (g/100ml)	Glycerol (mg/L)	Acetaldehyde (mg/L)
A	3.29	0.84	0.191	26.7	24.7	16.2
B	3.47	0.75	0.092	26.8	33.1	11.6

[1] A : Ones used by EC1118, S6U, AC-, CY3079, W-3, CEG and CS2.
B : One used by UCD530.

Table 3. Organic acid contents of Chardonnay must used for white wine fermentation

Must[2)]	Organic acids (mg/L)						
	Pyruvate	Citrate	Lactate	Tartrate	Malate	Succinate	Acetate
A	1.0	314	5.4	3,679	5,235	19.4	21.8
B	1.6	415	11.1	2,825	5,807	19.8	45.1

[2)] same as indicated in Table 2.

Changes of alcohol concentration during the fermentation showed that S6U was low fermentation speed than those of other yeast strains, but this strain fermented completely later. This fermentation characteristic of S6U strain is able to use slow fermentation at low temperature. S6U, containing an almost complete set of *S. cerevisiae* and S. bayanus chromosomes, have cryotolerant characteristic, and this kind of strain produces more amount of higher alcohols at low temperature fermentation and these compounds influence wine quality (8, 9).

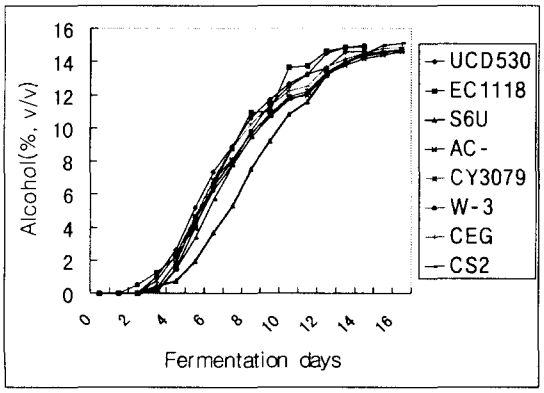

Fig. 1. Changes in alcohol concentration during the fermentation.

Table 4. Analytical data of white wine fermented by different yeast strains using Chardonnay must

Strains	pH	Total acid (%, w/v)	Fermentable efficiency(%)	Extract (g/100ml)	Yellowness (A420)	Acetaldehyde (mg/L)
UCD530	3.59	0.86	76.9	3.26	0.100	26.7
EC1118	3.28	0.86	83.1	2.63	0.095	49.9
S6U	3.32	0.89	83.1	2.73	0.083	23.2
AC-	3.32	0.86	80.8	3.22	0.083	26.7
CY3079	3.31	0.84	82.0	2.73	0.098	26.7
W-3	3.38	0.75	83.1	2.50	0.069	20.8
CEG	3.36	0.81	82.0	2.78	0.133	33.3
CS2	3.31	0.86	82.6	2.55	0.145	38.9

The analytical data of pH and alcohol showed that the wine fermented by UCD530 had higher pH (3.59) and lower alcohol concentration (13.3%) compared with other samples which revealed the range of pH 3.28 to 3.38 and alcohol concentration 13.9% to 14.3% (Table 4). The wine fermented by W-3 was very low contents of total acid (0.75%), and this result was caused by low contents of pyruvate, lactate, malate and acetate (Table 5). This result was similar to Lino's find that W-3 strain released small amount of total acid during fermentation (2). In fermentation efficiency, UCD530 revealed lowest fermentation efficiency (76.9%), but the others ranged from 80.8% to 83.1%. The wines of UCD530 and AC- contained much more extract, 3.26 g/100ml and 3.22 g/100ml respectively than those of other samples which had average contents 2.65 g/100ml. These fermentation efficiency and extract data revealed that UCD530 was not suitable for complete fermentation for white wine making. The wine fermented by the CEG and CS2 were predominant in yellowness, and EC1118 produced large amount of acetaldehyde, 49.9 mg/L than those of other strains.

The results of methylene blue dyeing ratio shows in Fig. 2. UCD530 and CS2 displayed high methylene blue dyeing ratio 64.1% and 53.3%, respectively, while EC1118 and CY3079 were low methylene blue dyeing ratio below 15%. These results suggest that the former two yeast strains are weaker and the latter two yeast strains are stronger than other yeast strains in alcohol tolerance.

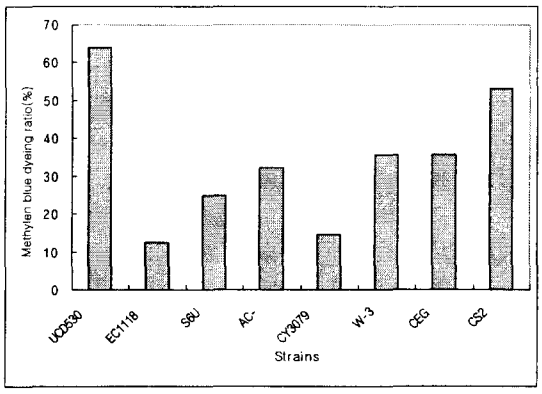

Fig. 2. Methylene blue dyeing ratio of yeast.

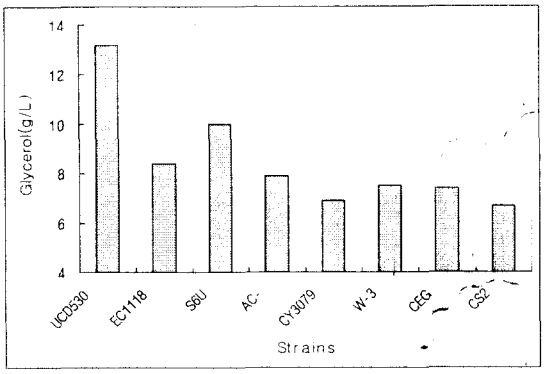

Fig. 3. Glycerol contents of white wine strains after complete fermentation. fermented by yeast strains.

Fig. 3 shows that the glycerol of wine produced by UCD530 is extremely high contents (13.2 g/L) compared with the average contents (7.8 g/L) of other strains. UCD530 is one of the S. bayanus species with cryophilic character, producing larger amount of glycerol, malic acid and succinic acid and releasing lesser amounts of acetic acid than those of S. cerevisiae strains (1, 10).

The main organic acids produced by wine yeasts were pyruvate, lactate, succinate and acetate. The concentration of these organic acids were dramatically increased in comparison to grape must and it express the difference of characteristics among the yeast strains. The contents of organic acid in white wine fermented by wine yeast strains are as shown in Table 5. UCD530 released significantly much of succinate (2004 mg/L) as well as lactic acid (465 mg/L). The concentration of these two organic acids in wine fermented by UCD530 was about two times as much as average concentration of other wines.

Table 5. Organic acid concentration in white wine produced by yeast strains

Strains	Organic acids (mg/L)						
	Pyruvate	Citrate	Lactate	Tartrate	Malate	Succinate	Acetate
UCD530	51.2	404	465	1,782	3,769	2,004	98.9
EC1118	60.3	382	213	1,425	4,775	1,056	157.6
S6U	65.3	358	259	1,377	4,070	1,306	449.4
AC-	38.7	382	301	1,394	4,475	1,063	86.5
CY3079	42.4	386	204	1,422	4,302	1,060	138.1
W-3	41.1	387	154	1,382	3,843	966	89.6
CEG	47.2	382	206	1,439	4,069	866	338.0
CS2	101.8	373	169	1,535	4,409	802	347.4

The concentration of acetic acid produced by wine yeast used in this experiment could be divided into two parts, one group had concentration below 170 mg/L (UCD530, EC1118, AC-, CY3079, W-3) and the other had concentration up to 350 mg/L (S6U, CEG ,CS2). Acetic acid have a negative effect in wine quality, and above 600-700mg/L of volatile acid is noticeable and it depreciate wine quality (11). Additionally (data not shown) S6U and CS2 produced large amount of foam during the fermentation. The white wines fermented by EC1118, CY3079 and CS2 revealed excellent flavor, while the wines, S6U and W-3, had some off-flavor.

요 약

샤르도네 품종을 이용한 포도주 양조용 효모의 발효 특성은 다음과 같다. S6U 균주는 다른 균주에 비해 발효속도는 느렸지만 발효 종료시점에 완전히 발효되는 특징을 보였다. W-3 균주는 발효중 산 생성량이 적었으며 (0.75%), UCD530과 AC- 균주로 발효된 포도주에는 잔류 extract 함량이 각각 3.26 mg/L 및 3.22 mg/L로써 다른 균주에 비해 많았다. CEG와 CS2 균주로 발효된 포도주는 특히 황색도 값이 높았으며, EC1118 균주는 다른 와인 효모에 비해 아세트알데하이드(49.9 mg/L)을 많이생성하였다. 효모의 알콜 내성 특성을 나타내는 methylene blue dyeing ratio에 있어서, EC1118 및 CY3079 균주는 약 15% 미만의 낮은 methylene blue dyeing ratio을 나타내어 이 두 균주가 다른균주에 비해 높은 알콜 내성이 있음을 보여주었다. 글리세롤 함량에 있어서 UCD530 균주는 다른 균주에 비해 극히 많은 생성능을 보였고 또한 succinic acid 및 lactic acid 생성량도 높아 전형적인 *S. bayanus* 특징을 나타내었다. 포도주의 Acetic acid 함량에 있어서 UCD530, EC1118, AC-, CY3079, W-3 균주로 발효된 것은 170 mg/L 이하로 비교적 낮았으며 S6U, CEG, CS2로 발효된 포도주는 350 mg/L 정도로서 높았다.

References

1. Kishimoto M., Soma E., Shinohara T. and Goto S.

(1998) Comparison of wine making properties between *Saccharomyces bayanus and Saccharomyces cerevisiae*. *J. Brew. Soc. Japan.* **93**, 231-237

2. Iino S. and Komiyama Y. (1991) White wine making by commercial dried European wine yeasts. Yamanashi-ken Industry Technology Center Research Report No. 5. 69-73
3. Ozawa S. and Goto S. (1992) Wine yeast Kyokai No. 4 (Yamanashi Yeast)-Its fermentation characteristics. *J. Brew. Soc. Japan.* **87**, 626-628
4. Collins C.H., Lyne P.M. and Grange J.M. (1989) Mi crobilogical Methods sixth edition, p 92. Butterworth-Heineman, Northants.
5. Ough C.S. and Amerine M.A. (1987) Methods for analysis of musts and wines second edition, pp 29-36. John Wiley & Sons Inc., New York
6. Zoecklein B.W., Fugelsang K.C., Gump B. H. and Nury F.S. (1995) Wine Analysis and Pruduction, p 520. Chapman & Hall, New York
7. Amerine M.A. and Ough C.S. (1974) Wine and Must Analysis, p 109. John Wiley & Sons Inc., New York
8. Masneuf I., Hansen J., Groth C., and Piskur J. (1998) New hybrides between Saccharomyces sensu strito yeast species found among wine and cider production strains. *Applied and environmental microbiology.* **64**, 3887-3892
9. Bertolin L., Zambonelli C., Giudic P. and Castellari L. (1996) Higher alcohol production by cryotolerant *Saccharomyces* strains. *Am. J. Enol. Vitic.*, **47**, 343-345
10. Kishimoto M., Shinohara T., Soma E. and Goto S. (1993) Identification and enological characteristics of cryophilic wine yeasts. *J. Brew. Soc. Japan.* **88**, 708-713
11. Yair Margalit. (1997) Concepts in wine chemistry, p 18. Wine Appreciation Guild

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