The Use of Grape Juice Concentrate for Winemaking

Mr. Jessada Laicharoenkiat

A special problem submitted to the Faculty of Biotechnology,
Assumption University, in part fulfillment of the requirements
for the degree of Bachelor of Science in Biotechnology

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Senior Project

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Title	**:**	**The Use of Grape Juice Concentrate for Winemaking**
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(Dr. Churdchai Cheowtirakul)

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May I dedicate this work to my advisors, other teachers, and all dear friends. Without these people, this work will never be done. Through out this project, I had encountered many problems, but they were so little, comparing to all the support that those people had given to me. The encouragement from them were so great, and those impressions will be in my memory forever.

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Introduction

Wine is generally made from grape of certain varieties. However, the winemakers are still struggled with these following problems :

1. Seasonal variation
2. Contamination from juice extracting methods
3. Slow filtration
4. Scarcity of right varieties of grapevine

Nowadays the distillation technology becomes much more advanced that the organoleptic quality is still completely conserved in the grape juice concentrate after undergoing the heating processes, therefore it might be possible for the winemakers to use it instead of the ordinary cultivars, and of course, they could solve the previously mentioned problems.

This research was aimed to study the optimal fermentation condition for wine made from grape juice concentrate. Besides, the advantages of using grape juice concentrate for winemaking were also studied and compared to conventional winemaking which has been using fresh grapes as raw material.

Objectives

1. To achieve an optimum condition for grape juice concentrate fermentation

2. To study the advantages of using grape juice concentrate for making wine

Materials and Methods

Part 1: Selection of fermentation condition and type of yeast

Raw material : Grape juice concentrate from Brazil

Microorganism : fresh yeast (*Saccharomyces cerevisiae 1411*) and dry yeast

Procedures :

Different fermentation conditions are studied by 3 different factors as followed.

1. Temperature : 11°C and ambient (30-35°C)

2. pH : 3.0 and 4.0

3. Type of yeast : active dry and fresh yeast

All wine samples are made accordingly to the following procedures :

Grape juice concentrate

↓

Diluted with boiled water to 25 %

↓

Adjusted % TSS to 23°Bx

↓

Adjusted pH

↓

Inoculated with yeast starter

↓

Fermented until % TSS become constant

↓

Filtered

↓

Stored at refrigerating temperature

As a consequence, there were 8 fermentation conditions as shown in Table 1.

Table 1: Fermentation conditions

Sample no.	Temperature (C°)	pH	Type of Yeast
1	11	3.0	dry
2	11	3.0	fresh
3	11	4.0	dry
4	11	4.0	fresh
5	ambient	3.0	dry
6	ambient	3.0	fresh
7	ambient	4.0	dry
8	ambient	4.0	fresh

After fermentation completed, the following parameters were measured :

1. Alcohol content

2. The amount of residual sugar

3. Acidity level referred to tartaric acid

Part 2: Improvement of fermentation rate and organoleptic qualities

After finishing part 1, the optimum fermentation condition was selected for conducting further experiments as followed.

1. Adding yeast nutrient near the end of fermentation.

2. Adding fresh grape into a must at the pre-fermentation stage.

3. Starting the fermentation with lower % TSS (20°Bx).

4. Adding oak chips at the post-fermentation stage.

Finally, the wines made from part 2 were measured the previously mentioned parameters, and roughly analysed the difference after comparing to the wine made from part 1.

Results

Part 1: Selection of fermentation condition and type of yeast

Table 2. Percentage of alcohol after fermentation

Sample no.	Temperature (C°)	pH	Type of Yeast	Alcohol (% v/v)
1	11	3.0	dry	12.6
2	11	3.0	fresh	11.6
3	11	4.0	dry	12.4
4	11	4.0	fresh	12.0
5	ambient	3.0	dry	10.9
6	ambient	3.0	fresh	11.1
7	ambient	4.0	dry	12.4
8	ambient	4.0	fresh	11.0

Alcohol content after fermentation is between 10.9 to 12.6 %. Sample no. 1 and 5 contain the highest and lowest alcohol content respectively.

Table 3: The amount residual sugar after fermentation

Sample no.	Temperature (C°)	pH	Type of Yeast	Residual Sugar (%)
1	11	3.0	dry	3.15
2	11	3.0	fresh	3.31
3	11	4.0	dry	3.18
4	11	4.0	fresh	3.25
5	ambient	3.0	dry	3.44
6	ambient	3.0	fresh	3.42
7	ambient	4.0	dry	3.19
8	ambient	4.0	fresh	3.43

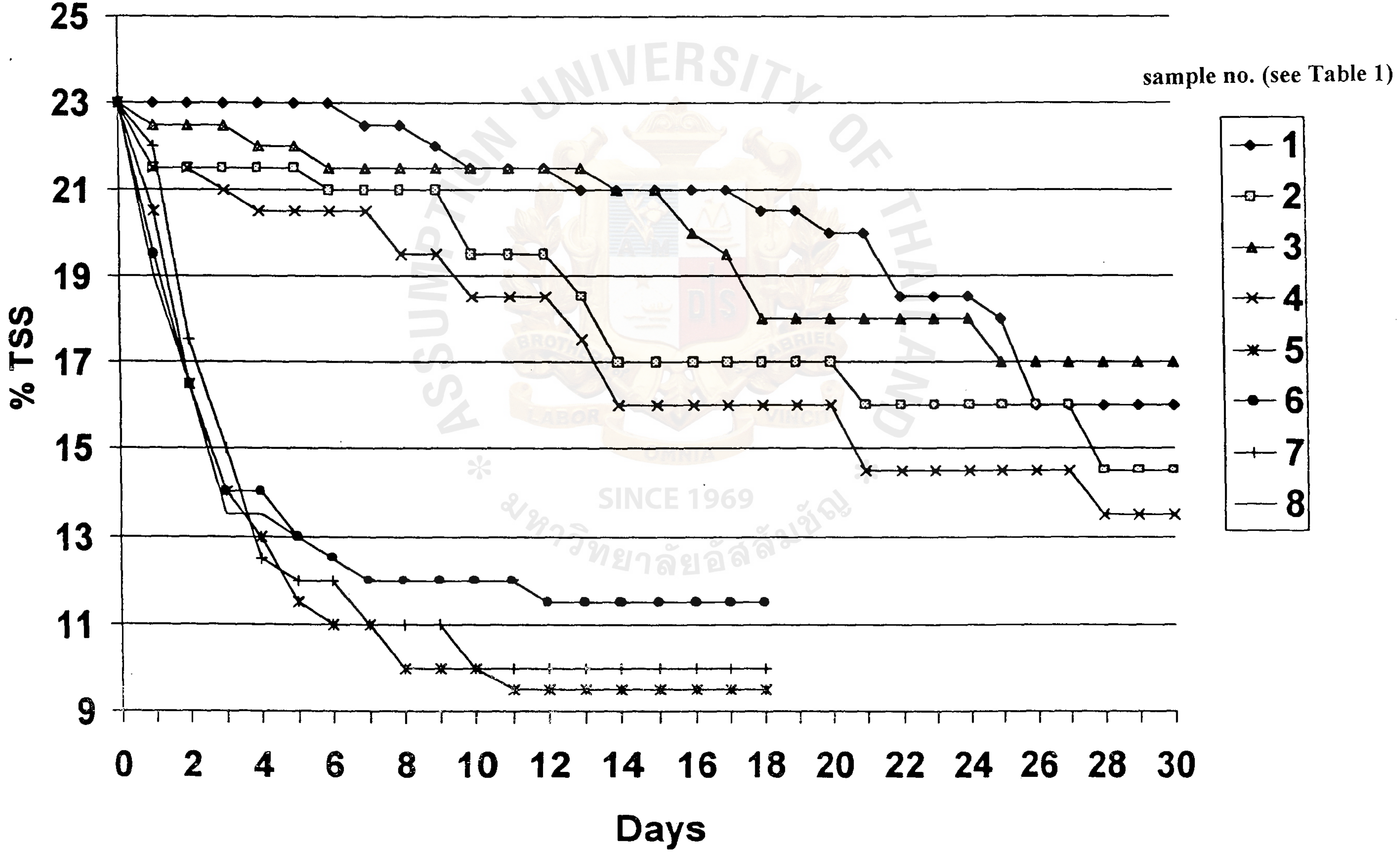
The amount of residual sugar after fermentation is between 3.15 to 3.44 %. Sample no. 5 and 1 contain the highest and lowest respectively.

Table 4: Acidity contents after fermentation

Sample no.	Temperature (C°)	pH	Type of Yeast	Acidity Levels (g / 100 ml)
1	11	3.0	dry	0.930
2	11	3.0	fresh	0.825
3	11	4.0	dry	0.900
4	11	4.0	fresh	0.788
5	ambient	3.0	dry	0.953
6	ambient	3.0	fresh	0.855
7	ambient	4.0	dry	0.900
8	ambient	4.0	fresh	0.795

Acidity contents after fermentation are between 0.788 to 0.953 g / 100 ml. Sample no. 5 and 4 contain the highest and lowest respectively.

Figure 1. Changes in % TSS during fermentation



Part 2: Improvement of fermentation rate and organoleptic qualities

Table 5: Changes in % TSS during fermentation

Experiment / Day	2	4	6	8	10	12	14	16
control	15	12.5	10.5	10.5	10.5	10.5	10	10
yeast nutrient added	15	12.5	10.5	10.5	10.5	10.5	10	10
diammonium phosphate added	16.5	13	12	11.5	11	11	11	11

Fermentation rates of wines added with yeast nutrient and diammonium phosphate were not faster than the unadded (control).

Table 6: The amount of residual sugar and acidity levels after fermentation

Experiment	Residual Sugar (%)	Acidity Level (g/100 ml)
fresh grape added	3.38	0.825
20°Bx initial % TSS	2.69	0.878
oak chips added	3.51	0.818

Wine started fermentation at 20°Bx resulted in lower amount of residual sugar after fermentation (2.69 %). There was no change in acidity level as they were still above 0.8 g / 100 ml.

Discussion

Figure 1 indicates that wines fermented at 11°C had low fermentation rates, and took more than a month to finish. This is because they were not stored in a proper temperature. The ideal temperature for wine fermentation is between 18 and 32°C (Chateau Carsin, 1997), therefore wines fermented at ambient temperature (30 - 35°C) had a higher fermentation rate. At ambient temperature, %TSS of wines decreased rapidly, and seemed to be constant after 10 days of fermentation. Finally it is obvious that ambient temperature is better than 11°C in term of fermentation rate. About pH and type of yeast, there was no significant change in the fermentation rate.

From Table 2, wines fermented in cold condition resulted in slightly higher average alcohol content, compared to those fermented in ambient condition. This is quite common because yeast fermentation at lower temperatures generally result in higher alcohol yields, due in part to reduced losses of alcohol resulting from evaporation (Bruce et al., 1995, p. 108). High alcohol content is ideal for wines because alcohol directly modifies the perception of acidity, making acidic wines appear less sour and more balance. Further, the dissolving action of alcohol probably reduces the escape of aromatic compounds with carbon dioxide during fermentation (Ron, J., 1994, p. 184).

Table 3 indicates that residual sugar of each sample is above 3.00% which is considered sweet. The amount of sugar was not decreased by yeast fermentation anymore, because wines had been already high in alcohol content. This problem could be solved by reducing the initial %TSS, therefore at the end of fermentation, wines should end up with lower amount of residual sugar. As a consequence, wines will appear less sweet.

From Table 4, it is obvious that all the wines were high in acidity contents. The lowest acidity content was still over 0.750 g/100 ml. Most of them had more than 0.800 g/100 ml of acidity levels, which were considered sharp (Richard et al., 1997, p. 101). Although wines were too acidic, it is not proper to start fermentation at pH above 4.0, because anthocyanins decolorize as pH rises, and wines of high pH are much more likely to become oxidized and lose their fresh aroma and young color (Ron, J., 1994, p. 187).

After finishing Part 1, all results were analyzed in order to select the optimum fermentation condition by considering 3 factors: temperature, pH, and type of yeast. Ambient temperature was more preferable because it provides a speed fermentation. A less alcohol production could be neglected due to the non-significant difference of alcohol content, and temperature might not be the only factor affecting the losses of alcohol. For the selection of pH, since wines from Part 1 were quite acidic, and there was no significant difference between pH 3.0 and 4.0 in terms of fermentation rate and alcohol production, then pH 4.0 was chosen because of wines fermented at pH 4.0 resulted in lower average acidity, compared to those fermented at pH 3.0 (See Table 4). For the selection of dry and fresh yeast, although dry yeast produced more alcohol (See Table 2), fresh yeast was chosen due to lower cost and the differences of alcohol contents were not much.

The experiment Part 2 was to ferment wines at ambient temperature and pH 4.0 with fresh yeast inoculum. Figure 1 indicates that wines completed fermentation at 9 - 10°Bx. Yeast nutrient and diammonium phosphate were added to wines when fermentation was tending to stop, in order to continue further fermentation and result in less %TSS. Normally the addition of yeast nutrient will encourage fast fermentation

After finishing Part 1 and 2, good practices of using grape juice concentrate for winemaking could be described. Must should be fermented at ambient temperature, because warm condition will promote fast fermentation. Although high temperature increases losses of alcohol, a tighter closure can be applied to the container (this experiment used glass jars as a container, and just covered by plastic sheet on the top) in order to prevent evaporation of alcohol. pH 4.0 was also preferable because wines from concentrate were quite acidic (See Table 4 and 6), therefore lower initial acidity level was required. For starter, normal yeast should be used because it is cheaper than dry yeast and there was no significant difference between them in terms of fermentation rates and wine qualities.

Although proper temperature and pH have been provided for fermentation, it is still possible that deterioration and spoilage will occur from excessive exposure to oxygen. Although oxygen aids color stabilization and reduces bitterness and astringency of tannins in wine, excessive oxygen exposure produces an oxidized odor and browning (Ron, J., 1994, p. 208). If free air is allowed above table wine, growth of *Acetobacter* and conversion to vinegar also begins (Roger et al., 1996, p. 407), and acetaldehyde is a major intermediate in bacterial formation of acetic acid. It is critical to store wines in reducing (low oxygen) conditions, because under such conditions and/or alcohol levels greater than 10%, acetaldehyde tends to accumulate instead of being oxidized to acetic acid (Bruce et al., 1995, p. 221). Wine preservation can be done by adding SO_2 after fermentation completed. This will prolong shelf-life of wines, but also has disadvantage that wines might lose color intensity, notably owing to the bleaching of anthocyanins by SO_2 (Ron, J., 1994, p. 208). However, no preservative has been used in this experiment. The study of SO_2 limitation for wines from concentrate still needs further experiments to be conducted. Aging is also ideal for wines, but it was not applied in this experiment because of the limitation of time. In fact, wines should be aged a few years to soften harsh flavors and allow desirable flavors to develop (ComNet Solution, 1997).

From this study we concluded that winemakers will be able to solve many problems by using grape juice concentrate. Seasonal variation will not affect wine quality because grape juice concentrate can be stored for long time under refrigerating temperature, and finally result in wines with a certain quality for all year round. Since must was prepared by making dilutions of grape juice concentrate, then problem of contamination from juice extracting methods will not occur. For the filtration, grape juice concentrate promotes faster filtration because it does not contain grape skin which is the source of some strongly colloidal substances resisting filtration, therefore it saves the filtration time. Besides, the right varieties of grapevine can be selected from manufacturers of grape juice concentrate. This is useful that winemakers are able to make wine from quality grapevines which cannot be grown domestically.

However, further studies and experiments are still necessary for the development of wine quality by using grape juice concentrate, because comparison between two different fermentation temperatures (ambient and 11°C) and pHs (pH 3.0 and 4.0) might not be enough to conclude that wine from concentrate should be fermented at a certain condition. Yeast strains are also critical, because each strain has its own optimum condition, the winemakers had to take this into consideration for setting up the experiments in order to find out the best condition for a certain strains of yeast. We sincerely hope that, this contribution will provide the guideline of wine production from grape juice concentrate in order to overcome geographical and climatic constraints.

Conclusions

1. From this experiment, the optimum condition for making wine from grape juice concentrate is at ambient temperature, pH 4.0, with fresh yeast inoculum.

2. Grape juice concentrate helps winemakers to overcome the problems of seasonal variation, contamination from juice extracting methods, slow filtration, and scarcity of right varieties of grapevine.

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Appendix

Preparation of must

- Diluted grape juice concentrate with boiled water by 1 : 4, then %TSS reduced from 68 to 17°Bx.
- Added some sugar to increase %TSS to 23°Bx.
- If pH 4.0 was required, added sodium bicarbonate for reducing pH from 3.0 to 4.0.
- Allowed to stand until temperature decreased to around 35 - 40°C which was ready for inoculation.

Preparation of starters

I. Active dry yeast

- Reconstituted 25 g of dry yeast per 100 litres of juice.
- Rehydrated by slowly sprinkling it into 5 - 10 times its weight of clean water between 35 - 40°C.
- Allowed to stand for 15 minutes then adjust the temperature of the rehydrated yeast to within 5°C of must.
- Added into the must withing 30 minutes of rehydration.

II. Fresh yeast (*Saccharomyces cerevisiae 1411*)

- Diluted grape juice concentrate with boiled water by 1 : 4.
- Inoculated with fresh *Saccharomyces cerevisiae 1411* from YM slant.
- Kept on shaking at ambient temperature (about 30°C) for 8 hours.
- Added into the must.