Ethanol and methanol levels of red dragon fruit wine
(*Hylocereus costaricensis*) with the treatment of sugar and fermentation time

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**Abstract.** Red dragon fruit (*Hylocereus costaricensis*) contains anthocyanin which is a polyphenol compound that is rich in pigments, determining the formation of red, purple and blue colors of various fruits and vegetables. Wine fermentation is the process of breaking down sugar into alcohol and CO2 gas due to enzymes produced by yeast cells. Factors that influence the fermentation process are the type of yeast, sugar content, nutrition, temperature, aeration, and pH. The fermentation time in making fruit wine is very important to know to produce wine with good characteristics. This study aims to determine the effect of sugar levels and the best fermentation time on the characteristics of red dragon fruit wine (*Hylocereus costaricensis*). This research was conducted at the Food Processing Laboratory of the Faculty of Agriculture, University of Warmadewa. Research with a Completely Randomized Design (CRD) consisting of 2 (two) factors and two replications, the first factor is sugar content, which consists of four levels: 10%, 15%, 20%, 25%. The second factor is the fermentation time, which consists of three levels: 10 days, 15 days, 20 days. Variables observed in dragon fruit wine include objective observations: levels of methanol and levels of ethanol. From the results of the study obtained 10.42% ethanol content, and the wine produced does not contain methanol.

1. Introduction
The fruit is an essential part of your diet using an essential part of vitamins and minerals that contribute to overall strength for your health. Fruit wines are undistilled alcoholic beverages usually made from grapes or other fruits such as peaches, plums or apricots, banana, elderberry, or black current which are nutritive, tastier, and mild stimulants. These fruits undergo a period of fermentation and aging. They usually have an alcohol content ranging between 5 and 13%. Wines made from fruits are often named after the fruits [1]. Dragon fruit or Dragon fruit (*Hylocereus costaricensis*) is currently being developed in Indonesia. This Mexican fruit is different from other *Cactaceae* families, which have a sweet and fresh taste. Dragon fruit that can reduce cholesterol and blood sugar has a protein content of 0.48-0.5%, carbohydrates 4.33-4.98, fat 0.17-0.18, and vitamins such as carotene, thiamine, riboflavin, niacin and ascorbic acid [2]. Red dragon fruit is also rich in anthocyanin antioxidants [3]. Anthocyanin levels range from 8.8 mg / 100 g of dragon fruit [2,4], anthocyanin is a polyphenol compound that contains pigments, determining the formation of red, purple and blue colors of various fruits and vegetables. Flavonoids found in dragon fruit are betacyanin. The function of anthocyanin and betacyanin in red dragon fruit is...
as an antioxidant in the body so that it can help prevent certain diseases, such as cancer and heart disease [5].

Wine is a type of beverage made from fruit juice with high sugar content, which is produced from the fermentation process with the help of yeast microbes in anaerobic conditions. Fermented beverage products besides using wine can also be used as raw materials for red dragon fruit. The selection of raw materials and also the addition of a different volume of the starter can determine the taste and quality of a wine [6].

Wine fermentation is the process of breaking down sugar into alcohol and CO2 gas due to enzymes produced by yeast cells although in some cases it can occur without living cells or microbes [7]. Factors that influence the fermentation process are the type of yeast, sugar content, nutrition, temperature, aeration, and pH. Fermentation time and sugar content in making fruit wine is very important to know to produce wine with good characteristics. The problem is then carried out research to determine the concentration of sugar during fermentation of the alcohol concentration of dragon fruit wine produced.

2. Materials and methods

The research was conducted at the Food Processing Laboratory and Agriculture Analysis Laboratory of the Faculty of Agriculture, University of Warmadewa and analysis of the methanol and ethanol content of the red dragon fruit wine was carried out at the Analytical Laboratory of Udayana University, Denpasar. The raw materials used in making wine are red dragon fruit (Hylocereus costaricensis) obtained from Denpasar Badung Market, sugar, yeast (saccharomyces cerevisiae) for starters, aqua dest and chemicals for testing the levels of methanol and ethanol by gas chromatography [8]. The method used in this research is a completely randomized design (CRD) factorial pattern with two factors, namely sugar content in the fermentation media (10%, 15%, 20%, and 25%) and the second factor is the duration of fermentation (10 days, 15 days and 20 days). Data obtained from the results of this study will be analyzed by the Anova method. If the analysis shows that the treatment effect is real or very real followed by the Least Significant Difference test (LSD) [9].

3. Results and discussion

3.1. Ethanol levels

Based on the Anova analysis, sugar treatment showed a very significant effect (p <0.01), fermentation time showed no significant effect (p> 0.05) while the interaction showed a significant effect (p <0.05) on the ethanol content of red dragon fruit. The average ethanol content of red dragon fruit wine can be seen in Table 1, the ethanol content of dragon fruit wine in all treatments ranged from 0.72 - 10.42%. The highest ethanol content was obtained in the treatment of adding 20% sugar with a 10-day fermentation time of 10.42% which was not significantly different from the treatment of adding 25% sugar with a 10-day fermentation time of 10.12%. Fruit wines contain 8–11% alcohol and 2–3% sugar with energy value ranging between 70 and 90 kcal per 100 ml [2].

The addition of sugar in the process of making red dragon fruit wine causes ethanol concentrations to increase, the addition of sugar also influences fermentation to produce ethanol because the amount of substrate that can be converted into ethanol is determined by the amount of sugar contained in the material [9]. Different amounts of sugar will produce different levels of ethanol, sugar will be converted by yeast to ethanol and CO2 during fermentation [10,11]. The fermentation time also affects the ethanol concentration that will be obtained. Fermentation time is an influential factor in producing alcohol content obtained from yeast. Yeast will break down simple sugars into alcohol and CO2 [12]. Quality standards of fruit wine, namely ethanol content not less than 7% and no more than 24% v / v and methanol content not more than 0.01% v/v (calculated on product volume) [13].

The study of an alternative utilization of these wastes into winemaking that could tremendously minimize financial disposal requirements. Averagely, 80 kg of peels yielded 180, 144 and 72 liters of wine from pineapple, mango-pineapple mix and mango peels, respectively. In this study, three products were formulated which involved mango peels, pineapple peels and a mixture of mango and pineapple
peels in the ratio of 1:2.25, respectively. The effects of initial total soluble solids (24, 26 and 32\textdegree Brix) on physical and sensory characteristics of musts and wines were examined. During fermentation for 6 months, the total soluble solids of all musts decreased to 10.1, 11.4 and 14.5\textdegree Brix, respectively while the pH was decreased from 4.5 to 3.65-3.78. The resultant wines alcohol content in the range of (12 - 18\%) by the end of the aging period [14]. Cashew fruit which has a sugar content of 9.67\% fermented with \textit{Saccharomyces} during fermentation for 60 hours, with a 6\% inoculum level resulting in an alcohol content of 14.98\% [15]. Graph Interaction of Ethanol Content of red dragon fruit wine (\% w/v) in the treatment of sugar content and length of fermentation can be seen in Figure 1.

\textbf{Table 1.} Red dragon fruit wine ethanol concentration (\%) in sugar treatment and fermentation time.

| Treatment  | Fermentation Time (days) |
|------------|--------------------------|
|            | 10           | 15           | 20           |
| Sugar Concentration (%) |       |       |       |
| 10         | 0.72        | 2.01        | 1.58        |
| c          |             | b           | c           |
| 15         | 2.48        | 5.13        | 2.21        |
| b          |             | a           | bc          |
| 20         | 10.42       | 5.72        | 3.83        |
| a          |             | a           | ab          |
| 25         | 10.12       | 6.59        | 6.34        |
| a          |             | a           | a           |
| BNT 0.05   | 2.24        |             |             |

Note:
1. The same letter next to the average value on the same line shows no significant effect (p > 0.05).
2. Different letters below the mean in the same column show significant effects (p <0.05) to very real (p <0.01).

\textbf{Figure 1.} Red dragon fruit wine ethanol concentration (\% w/v) in sugar treatment and fermentation time.

3.2. \textit{Methanol levels}

The results of the methanol analysis showed that there was no methanol detected in the red dragon fruit wine product. The level of methanol in wine products is very limited, it is even recommended not to exist because this type of alcohol is toxic to the body, especially on nerves. From the results of the wine test, the red dragon fruit shows that the wine made has fulfilled the SNI set requirements. The maximum methanol content in alcoholic drinks is 0.1\% (v/v) [16]. The results of the analysis of methanol content of dragon fruit wine can be seen in Table 2.

\textbf{Table 2.} Red dragon fruit wine methanol levels in the treatment of sugar and fermentation time.

| Treatment | 10 days | 15 days | 20 days |
|-----------|---------|---------|---------|
| 10\%      | Negative| Negative| Negative|
| 15\%      | Negative| Negative| Negative|
| 20\%      | Negative| Negative| Negative|
| 25\%      | Negative| Negative| Negative|
4. Conclusions
In this study it was found that the alcohol content of dragon fruit wine was 10.42% and methanol was not detected. The treatment 20% sugar concentration and 10 days fermentation time produce red dragon fruit wine products that meet the requirements of the Indonesian National Standard, namely alcohol content between 10-20%.

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