

The Effect of Heating Temperature and Duration Process of Nira Fermentation by the Content of Alcohol in the Process of Arak Distillation

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Abstract—The process of making Balinese arak used distillation of coconut palm through a process of heating and re-condensing the heated nira so that it becomes arak with alcohol content. Based on the results of the research the effect of fermentation time on alcohol content in coconut nira (Tuak), fermentation time for 6 hours, 8 hours and 12 hours on alcohol content in coconut nira, with heating temperature of the reactor tube 70°C, temperature 75 °C and temperature 80°C, the length of time for sampling used was 10 minutes, 20 minutes, and 30 minutes, indicated by an increase in the percentage of alcohol content. The average alcohol content of coconut nira in fermentation for 6 hours, heating temperature of 70° C is 38%, fermentation for 8 hours, heating temperature of 70°C is 53%, fermentation for 12 hours, heating temperature of 70°C is 63%, fermentation for 6 hours, heating temperature 75°C is 41%, fermentation for 8 hours, heating temperature 75°C is 55%, fermentation for 12 hours, heating temperature 75°C is 65%, and fermentation for 6 hours, heating temperature 80°C is 45%, fermentation for 8 hours, heating temperature 80 °C is 63%, fermentation for 12 hours, heating temperature 80°C is 70%. Based on the ANOVA test output, a significance probability value of 0.000 can be obtained. Therefore, the significance probability value is $0.000 < 0.05$, so that the hypothesis is rejected, which means that there is a significant difference in fermentation time for 6 hours, 8 hours and 12 hours on the alcohol content with heating temperature in the reactor tube which is 70°C, 75°C and 80°C and temperature holding time for 10 minutes, 20 minutes and 30 minutes.

Keywords—Nira, fermentation, heating, distillation, Arak

I. INTRODUCTION

Arak Bali is one of the two types of traditional drink that many Balinese people like and also popular with young and old people. Apart from drinking arak, it is also commonly used as a means of offering in Hindu religious ceremonies in Bali. Arak is a type of fermented liquor containing 37-60% alcohol (ethyl alcohol) which has been known in Bali since ancient times. Arak is generally made from coconut wine by distillation. Arak can also be made from rice or glutinous rice through the

fermentation process (*pentapean*), then squeezed. The liquid is fermented and continues to be distilled [1].

Based on information from the Karangasem Industry Service (Disperindag), that the number of traditional arak farmers in Karangasem is 7.600 people. The number is spread across four districts, namely Manggis, Sidemen, Kubu and Abang. Arak production in Karangasem reaches 2.65 million bottles per year [2].

Tri Eka Buana Village, Sidemen District is one of the centers home industry for making arak. The tool for distilling coconut nira into arak is still using the traditional way. The coconut nira distillery is now capable of producing arak, however still used firewood as heating and requires a relatively long time to produce arak. Arak is divided into several levels of alcohol levels. For first class, the alcohol content is between 35 to 40 percent, for class two the alcohol content is 30 percent, while for class 3 the alcohol content is 25 percent.

In the heating process using the optimum temperature, namely at a temperature of 70°C due to it is possible to have the activity of various kinds of microorganisms that cause alcohol content. If it is heated at a temperature of more than 80°C, it is feared that it will quickly evaporate and decrease because it is the boiling point of alcohol [3]. Through research by developing this arak distillation tool, it is hoped that it can become one of the innovations in the development of appropriate technology in supporting the home industry, especially the distillation of arak.

II. RESEARCH METHODS

This research is an experimental research through testing a prototype of a distillation device with a heater from an LPG stove. Before carrying out the test (distillation process), coconut nira is treated or prepared by the sample material. The treatments were permentation for 6 hours, 8 hours and 12 hours, filtering the nira with a sieve. The purpose of treating the nira or sample raw material to be tested is of good quality nira. Furthermore, the test is conducted on the distilled arak to

get the alcohol content. The heating time of Coconut Nira is carried out at temperatures of 70°C, 75°C and 80°C and the heating time is 10 minutes, 20, minutes and 30 minutes [4]. The dependent variable is the alcohol content found in coconut nira which is expressed in (%) and is determined using an Alcoholmeter. The test data were analyzed using the ANOVA statistical program [5].

A. Alcohol Content

The tool used to measure alcohol content is an alcoholmeter. Measurement of alcohol content is conducted after each distillation and the measurement is stopped if the measured alcohol content is e "90% (alcohol content is in accordance with ASTM for liquid fuels) and the ethanol content is e" 94%. The steps for measuring using an alcohol meter [6]. is to enter 100 ml of distillate into a measuring cup, then dip the alcohol meter into the distillate. The immersed limit on the distillate surface indicated the alcohol content of the sample under test.

III. RESULTS AND DISCUSSION

A. Fermented Coconut Nira

The process of making Balinese arak from tuak, according to the community in Tri Eka Bhuana Village, making arak does not require standard provisions, which is only based on observation and experience. Making arak begins with ripe tuak which has been tapped. The tapped tuak will then be accommodated in a plastic barrel for 3 to 4 days until the tuak feels sour. This tuak will be processed together with coconut fibers in a closed barrel as a fermentation process. Once this is enough, tuak will be put into a series of fermentation consisting of three jars. Each jar will contain 4 buckets of tuak with a capacity of 5 liters. The distillation process usually starts from 5 a.m. to 3 p.m. This activity is practiced almost every day by the tuak farmer.

In the coconut nira fermentation process which will be used for this research with fermentation time of 6 hours, 8 hours and 12 hours, after the tuak is tapped from the coconut tree then the tuak farmers carried out the fermentation process as they have been doing so far in Tri Eka Bhuana Village. The first stage of fermentation of the tapped tuak is carried out by a filtering process to separate the impurities contained in the tuak, the second stage of the tuak that has been filtered is then mixed with coconut fibers that are not so old and closed, then deposited for 6 hours, 8 hours and 12 hours.

B. Coconut Nira Distillation Process

The evaporation of the fraction of the liquid is such that the vapor, which is in equilibrium with the residual liquid, separated the vapor from the liquid and condensed the vapor. It is based on the production of steam by heating the liquid to be separated and condensing the vapor without allowing the liquid to return to the heating process. The Distillation tool has a working principle of separating several substances through heating and cooling. The basic ingredients of the arak will be

heated, heating is carried out at a certain temperature causing evaporation, this occurred due to of differences in the density of the nira. There is heating circulation, the density of the non-volatile nira will collect below and the light specific gravity will go up so that fogging occurred and underwent a cooling process to change the phase from hot vapor to liquid [7].

In this research, the distillation process of coconut nira into arak was carried out using a distillation device that was equipped with heating temperature settings, cooling water temperature settings on the nira vapor flow and using a burner stove with LPG gas as fuel.

C. Distillation Tool Testing

- Setting the heating temperature in the reactor tube. Testing of a distillation device that is equipped with a Solenoid Valve Gas to adjust the flame of the stove to get the desired temperature in the reactor tube so that the heating temperature of the tuak can be adjusted and is equipped with a temperature detector (thermocouple) to determine the temperature rate in the tuak heating process in the reactor tube.
- Setting the water temperature in the condenser tube. In testing the condenser pipe distillation tool which distributes steam from the heating of tuak in the reactor tube to the condenser tube, to control the cooling water, a Solenoid valve is installed. The water aims to regulate the temperature of the cooling water in the condenser tube and is equipped with a thermocouple to read the water temperature so that the water temperature can be controlled.
- Measuring the percentage of alcohol levels. To get the alcohol content in the distillation tool using an alcohol measuring device, in this test using tuak fermentation for 6 hours, 8 hours and 12 hours with a heating temperature of 70°C, 75°C and 80° C and the heating holding time for the test is 10 minutes, 20 minutes and 30 minutes.



Fig. 1. Testing of distillation equipment.



Fig. 2. Test results draw.

D. Discussion

1) *Analysis of Nira fermentation for 6 hours:* From the results of checking the alcohol content of coconut nira fermentation for 6 hours at a heating temperature of 70°C, 75°C and 80°C with a heating time of 10 minutes, 20 minutes and 30 minutes using an alcoholmeter.

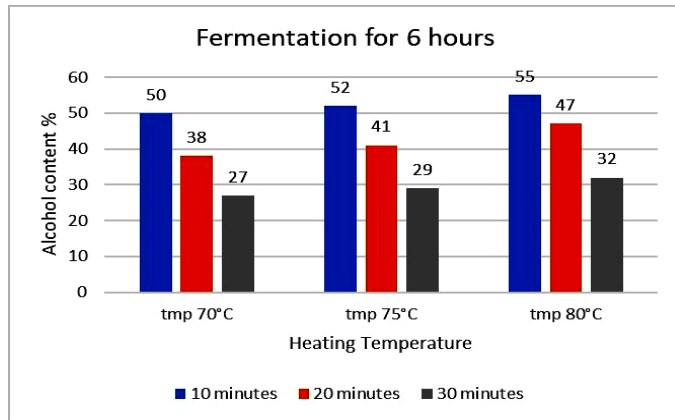


Fig. 3. Fermentation for 6 hours.

Based on the data in Figure 3, tuak fermentation time for 6 hours, the average value of sample alcohol content at heating temperature 70°C has 38% alcohol content, heating temperature 75°C has 41% alcohol content and heating temperature 80°C has 45% alcohol content. So that the higher the heating temperature in tuak, the alcohol content will increase

2) *Analysis of Nira fermentation for 8 hours:* Checking the alcohol content of the nira fermentation for 8 hours at a heating temperature of 70°C, 75°C and 80°C with a heating time of 10 minutes, 20 minutes and 30 minutes using an alcoholmeter.

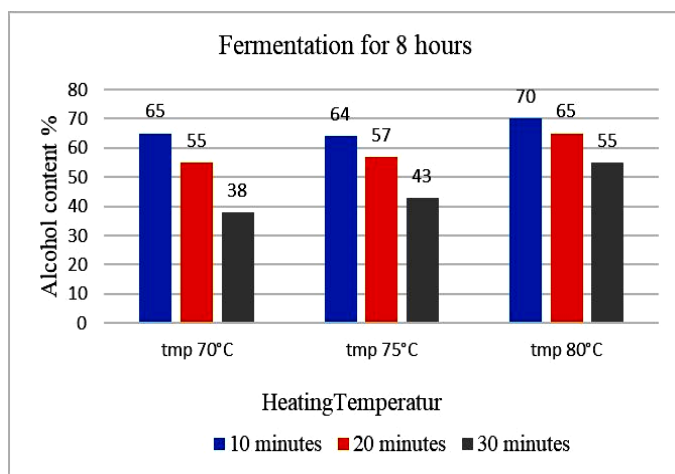


Fig. 4. Fermentation for 8 hours.

Based on the data in Figure 4, the fermentation time of nira for 8 hours showed that the average value of the sample alcohol content at a heating temperature of 70°C has an alcohol content of 53%, a heating temperature of 75°C has an alcohol content of 55% and a heating temperature of 80°C has an alcohol content of 63%. So that the higher the heating temperature of the nira, the alcohol content will increased.

3) *Analysis of Nira fermentation for 12 hours:* Checking the alcohol content of the juice fermentation for 12 hours at a heating temperature of 70°C, 75°C and 80°C with a heating time of 10 minutes, 20 minutes and 30 minutes using an alcoholmeter.

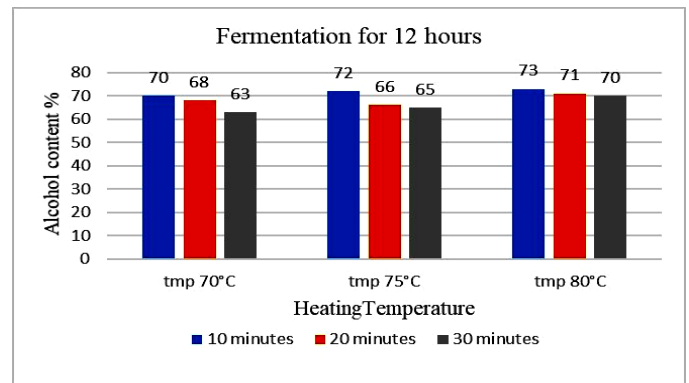


Fig. 5. Fermentation for 12 hours.

Based on the data in Fig. 5, the nira fermentation time for 12 hours showed that the average value of the sample alcohol content at a heating temperature of 70°C has an alcohol content of 67%, a heating temperature of 75°C has an alcohol content of 68% and a heating temperature of 80°C has an alcohol content of 71%. So that the higher the heating temperature of the nira, the alcohol content will increased.

4) *Analysis of the effect of duration of fermentation on alcohol content:* Based on the test results obtained data on the alcohol content of each nira fermentation for 6 hours, 8 hours and 12 hours with three heating temperatures taken, namely at a heating temperature of 70°C, 75°C and 80°C.

TABLE I. RESULTS OF AVERAGE PERCENTAGE OF ALCOHOL CONTENT

No	Heating Temperature (°C)	Average Percentage of Alcohol Content (%)		
		Fermentation 6 hr	Fermentation 8 hr	Fermentation 12 hr
1	70°C	38	53	63
2	75°C	41	55	65
3	80°C	45	63	70

From the data in Table 1 with controlled temperature of tuak fermentation, namely the average percentage of alcohol content at each heating temperature of nira fermentation tends to increase in alcohol content.

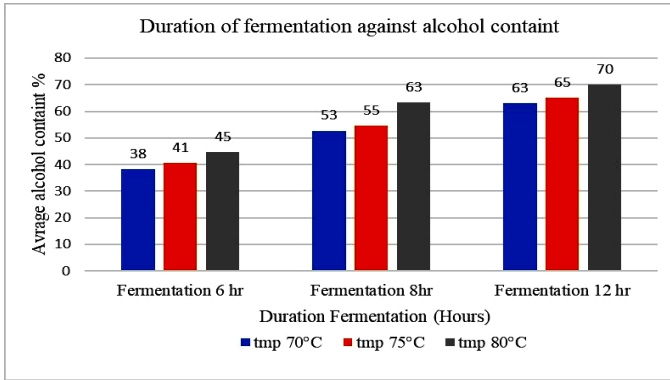


Fig. 6. Duration of fermentation.

After getting the results of the examination of the alcohol content in the nira fermentation, then proceed with the ANOVA test to determine the effect of the length of fermentation of the nira as the results of alcohol content in coconut nira.

TABLE II. EFFECT OF FERMENTATION ON ALCOHOL CONTENT

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1128,667	2	564,333	37,903	,000
Within Groups	89,333	6	14,889		
Total	1218	8			

Based on the ANOVA test output, it can be obtained a significance probability value of 0.000. Therefore, the significance probability value is $0.000 < 0.05$, so that the hypothesis is rejected, which means that there is a significant difference between the fermentation time and the alcohol content with the heating temperature in the reactor tube, namely 70°C, 75°C and 80°C and the temperature holding time for 10 minutes, 20 minutes and 30 minutes.

IV. CONCLUSION AND SUGGESTION

A. Conclusion

The average alcohol content of coconut nira in fermentation for 6 hours, heating temperature of 70°C is 38%, fermentation for 8 hours, heating temperature of 70°C is 53%, fermentation

for 12 hours, heating temperature of 70°C is 63%, fermentation for 6 hours, heating temperature 75°C is 41%, fermentation for 8 hours, heating temperature 75°C is 55%, fermentation for 12 hours, heating temperature 75°C is 65%, and fermentation for 6 hours, heating temperature 80°C is 45%, fermentation for 8 hours, heating temperature 80°C is 63%, fermentation for 12 hours, heating temperature 80°C is 70%.

Based on the ANOVA test output, it can be obtained a significance probability value of 0.000. Therefore, the significance probability value is $0.000 < 0.05$, so that the hypothesis is rejected, which means that there is a significant difference in fermentation time for 6 hours, 8 hours and 12 hours on the alcohol content with heating temperature in the reactor tube which is 70°C, 75°C and 80°C and temperature holding time for 10 minutes, 20 minutes and 30 minutes.

B. Suggestion

The suggestions for makers of arak drinks from coconut nira to pay more attention to the duration of fermentation in order to get the quality of alcohol (*arak*) and pay attention to the heating temperature of coconut nira (*tuak*).

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