International Journal on
Advanced Science
Engineering
Information Technology

Vol.3 (2013) No. 3
ISSN: 2088-5334

The Effects of Temperature and Length of Fermentation on Bioethanol Production from Arenga Plant (*Arenga pinnata* MERR)

Fahrizal, Yusya' Abubakar, Murna Muzaifa, Muslim

[#] *Agricultural Product Technology Department, Faculty of Agriculture, Syiah Kuala University, Banda Aceh*
E-mail: fahrizal_stp@yahoo.com

***Abstract*— Bioethanol is a fuel extracted from plant. Bioethanol can be extracted from cassava, sweet potato, sugarcane, corn, grain sorghum, sweet sorghum, sagoo, palms, coconut and rice. The aren palm is the most potential source of bioethanol, and as one of the most productive raw material of bioethanol. A research is needed to be able to produce bioethanol in a simple way so that it can be applayed by society. In this study, the effects of temperature (T) and length of fermentation (t) on ethanol production was examined. Temperature used is 27 ^{o}C and 32 ^{o}C. Samples from each treatment will be taken every 24 hours, starting from third days, which is 72 hours (H3), 96 hours (H4), 120 hours (H5), 144 hours (H6) and 168 hours (H7). Analysis performed includes changes in the sugar content, pH, total acid and ethanol content. The results showed that sugar content and pH decreased with increasing fermentation time, in both temperature, 27 ^{o}C and 32 ^{o}C. In contrast total acid was increased with increasing fermentation time. Increase in total acid is related to the formation of acids during fermentation. Ethanol content increased with increasing fermentation time in both 27 ^{o}C and 32 ^{o}C, though, the increase was higher at 32 ^{o}C. Highest ethanol content was obtained on day 5 in temperatures 32 ^{o}C.**

***Keywords*— A*renga Pinnata*; Bioethanol; Fermentation; Temperature.**

I. INTRODUCTION

Since the end of 2004, Indonesia is the only OPEC member country has become a net importer of crude oil. Decline in oil exports gradually been going on since 1991, while it is to meet the needs of the local oil refinery, Indonesia has to import crude oil higher volumes (Triwiyono, 2006). One alternative to fossil fuels with biofuels like bioethanol is. Bioethanol is a fuel derived from vegetable oils. Bioethanol can be a source of cassava, sweet potato, sugar cane, corn, grain sorghum, sweet sorghum, sago, palm, palm, palm, coconut and rice. The advantage of using bioethanol as a fuel is has a higher octane rating than gasoline, can be used in pure form and mixed with gasoline, biodegradable and environmentally friendly in the water, so it is a potential alternative fuels to be developed (Anonymous, 2005).

From several sources of bioethanol, sugar palm is a source of bioethanol plants with the most potential, and as one of the bioethanol feedstock most productive. Processed palm juice to produce bioethanol about 25,000 to 40,000 liter / hectare / year, other commodities are much lower (Yudiarto, 2008).

In the producing areas such as the palm juice like Minahasa North Sulawesi palm juice into ethanol processing is usually done by farmers aren results by tapping sap accommodate the tank for 2-3 days (at room temperature) without using the starter or yeast. Nira fermented then distilled to a simple distillation apparatus, and produce bioethanol yield of 25-35% ethanol (Lay et al., 2004). In the province of Aceh there are also many palm trees that had been used as a raw material in the manufacture of brown sugar and vinegar. The estimated total area of sugar crops in the province of Aceh has reached 4081 ha (Akuba, 2004). However, the potential to be a palm juice, palm sugar and vinegar increasingly displaced by the influx of commercial vinegar and palm sugar from the outside with better quality. Therefore, it is necessary to study the utilization of palm juice as a source of raw material in the manufacture of ethanol.

II. RESEARCH METHODOLOGY

This research has been carried out in the Laboratory of Industrial Microbiology and Food Analysis Laboratory Department of Agricultural Product Technology, Faculty of Agriculture, Syiah Kuala University. This study was conducted in March 2012.

A. Equipment and Materials

Materials to be used in this study are fresh palm juice were obtained from Lamsiteh, Montasik, distilled water,

KOH 4%, NaOH 0.1 N, an indicator of PP, acid anhydride, H2SO4, glucose and anthrone.

Equipment used in this study is a pipette, analytical scales, erlenmeyer 250 ml, 100 ml flask, beaker 100 ml, 100 ml measuring cup, biuret, autoclave, laminar flow, aluminum foil, incubators and UV-Vis spectrophotometer pharo 300 .

B. Research Design

This research will study the effect of temperature on the acquisition of ethanol during fermentation. Temperatures will be used are: T1 = 27 ° C and T2 = 32 oC. Samples from each treatment will be taken every 24 hours, starting from day three (t1 = 72 h, t2 = 96 h, t3 = 120 h, t4 = 144 h and t5 = 168 hours). Analyses in this study consist of sugar content, pH, total acid and ethanol content. All data collected were analyzed using ANOVA and Duncan`s multiple range test to determine the significant differences between means.

C. Research procedures

*1) Preparation of raw materials:*Palm juice obtained from farmers in Lamsiteh Montasik Aceh Besar district. The material is collected in 1500 ml aqua container for easy transport into the laboratory. The palm juice was analysed of sugar content and pH.

2) Fermentation of Palm Juice: Palm juice was placed into 250 ml erlenmeyer. Then fermented in an incubator for 7 days, at a temperature of 27 oC and 32 oC (appropriate treatment), with sampling every day starting from day 3. Samples were taken every 24 hours, for the measurement of glucose, pH, total acid and ethanol content.

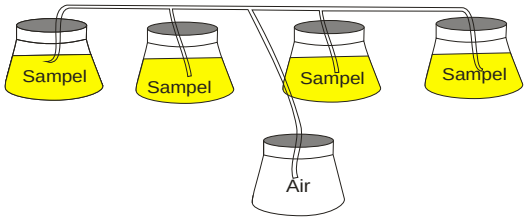

Figure 1. Design for Fermentor Networt

3) Analysis: Analysis was performed on fresh palm juice and palm juice fermented. Analysis of the fresh palm juice include measurement of sugar content and pH. While the analysis of the palm juice fermented includes analysis of sugar content, pH, total acid and ethanol content.

III. Results And Discussion

D. Measurement of Glucose

One of the factors that influence the involvement of microorganisms in fermentation is the availability of sugar that serves as a source of nutrients. Palm juice is sweet cause sugar content. The results showed that the initial sugar palm juice is 20.09%. Changes in the levels of sugar palm juice during fermentation are presented in Figure 2.

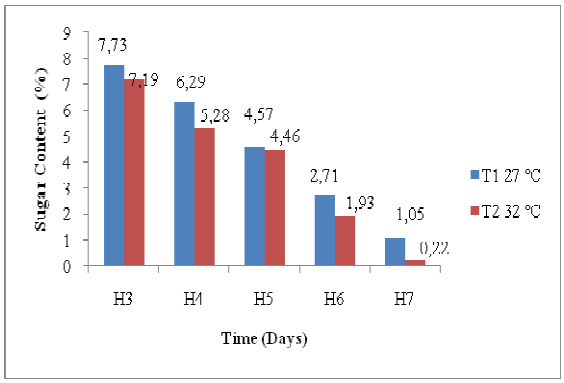

Fig. 2. Sugar Content Change during Fermentation

Based on Figure 2 above shows that the concentration of sugar in the palm jus at 27 ° C and at 32 ° C decreased with increasing fermentation time. Decrease sugar content looks bigger occurred at 32 ° C, presumably by increasing temperature causes the faster the decomposition of sugar. Decomposition of these sugars was related to the activity of microorganisms present in the palm juice to use as an energy source. Activity of yeast will elaborate sugars into ethanol so the sugar content has declined, other microorganisms also consumes sugar as an energy source (Legaz et al., 2000; Kusumanto, 2010).

E. pH Measurement

In fresh palm juice has a sweet taste and pleasant smell and has degrees of acidity with pH 5.5 to 6.0 (Dachlan, 1984). The results showed that the initial pH of the sugar palm sap is 5.29. pH changes during fermentation presented in Figure 3.

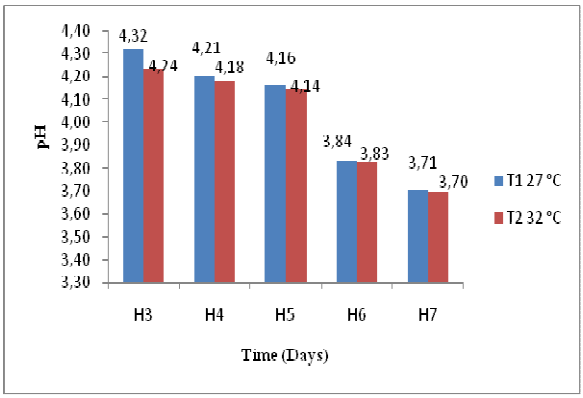

Fig. 3. PH changes during fermentation.

Based on Figure 3 shows that the longer the incubation time, the pH value during fermentation will decrease both the temperature of 27 ^{o}C and 32 ^{o}C. Decrease of pH is caused by the accumulation of the compounds of the acidic by some microorganisms present in palm juice (Judoamidjojo et al., 1989). Reed and Peepler (1973) mentions that during the fermentation process takes place will form acids such as acetic acid, lactic acid and pyruvic acid. Decrease in pH at the beginning of fermentation caused by the acid fermentation by microorganisms present in palm juice (both natural and contaminant).

F. *Measurement of Total Acid*

Acid is a chemical compound that when dissolved in water will produce a solution with a pH less than 7. Fermentation will produce acids such as acetic acid, lactic acid and pyruvic acid (Reed and Peepler. 1973). Changes in total acid during fermentation of the palm juice are presented in Figure 4.

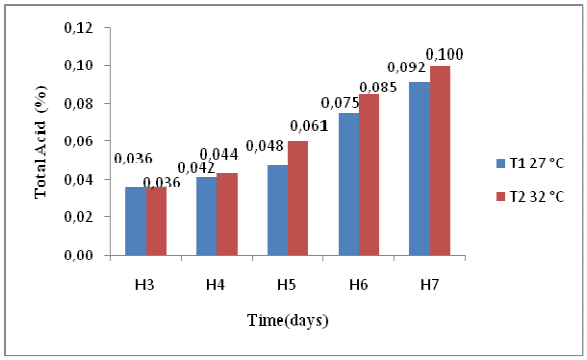

Fig 4. Measurement of total acid (%).

Based on Figure 4 shows that the longer the fermentation, the total acid increased both temperature 27 oC and 32 oC temperature. The increase is higher at 32 oC. The increase in total amino acid fermentation showed that occurs by microorganisms present in the sap (Legaz et al., 2000; Kusumanto, 2010).

The increase in Acid total at the beginning of fermentation thought to be due to acid fermentation by microorganisms such as Flavobacterium, Candida, Brevibacterium, Bacillus, Acetobacter and Klebsiela that produces a variety of organic acids. While in the next stages of fermentation, the yeasts are more dominant convert glucose into alcohol and then alcohol is further oxidized to acetic acid (Marzoeki, 1993), so the longer the incubation time increased total acid.

G. *Ethanol Content*

Ethanol content is a comparison between the total amount of ethanol solution and in (b / w) or (v / v). Ethanol is a parameter that indicates the quality of the ethanol. Alcohol produced from fermentation depending on the type of yeast used, sugar, and fermentation efficiency (Fardiaz, 1989). Ethanol research results presented in Figure 5.

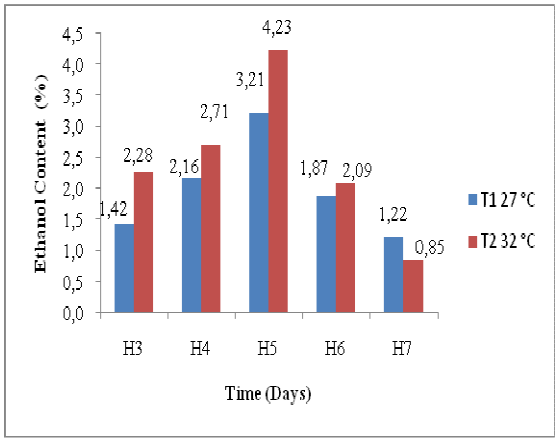

Figure 5. Measurement of ethanol (%).

According to Figure 5 shows that the highest levels of ethanol produced on day 5 in both temperature 27 ^{o}C and 32 ^{o}C, presumable on day 5 of fermentation runs with optimum levels that produced the highest of ethanol. On day 5 suspected of growth and activity of Saccharomyces cerevisiae is the logarithmic growth phase, where nutrients are consumed and produced both metabolic substances to the fullest. Logarithmic growth phase velocity is influenced by the availability of nutrients in the media (Fardiaz, 1989).

In the fermentation day 6 and 7 shows decreased levels of ethanol fermentation presumable been running slow because the content of nutrients in the media decrease besides diminishing other growth conditions that are not supported (such as a decrease in pH and accumulation of metabolites). And thus Saccharomyces cerevisiae thus no longer able to produce ethanol (Fardiaz, 1992). While existing metabolites further oxidized by other microorganisms (bacteria acetic acid) to acetic acid so that the ethanol content decreased. These results are in accordance with the statement Effendi (2009) and Mulja (2007), the longer the fermentation, the ethanol content produced will be optimum and will eventually decline.

IV. Conclusions And Recomendation

A. *Conclusion*

The longer the fermentation, the sugar content and decreasing of pH value while increasing total acid. Ethanol content will increase with increasing of ethanol incubation time. Highest ethanol content obtained on day 5 using a temperature 32 ^{o}C.

B. *Recommendation*

Experimental studies need to be done by sterilizing raw palm juice, and then followed by the addition of yeast (specific microorganisms) to obtain a higher ethanol recovery. In addition, further research needs to be done for ethanol purification.

REFERENCE

[1] Anonim. 2005. Bioetanol pengganti BBM yang kompetetif. Kompas, 14/02/2005.

[2] Anonim. 2010. Materi kimia asam basa.

[3] http://id.wikibooks.org/wiki/Subjek:Kimia/Materi:Asam,_Basa,_Garam.

[4] Akuba, R.H.2004. Profil Aren. Pengembangan Tanaman Aren. Prosiding Seminar Nasional Aren. Tondano. Balai Penelitian Tanaman Kelapa dan Palma Lain. , 9 Juni. hlm.1-9.

[5] Dachlan, M.A. 1984. Proses Pembuatan Gula Merah. Laporan Up Grading Tenaga Pembina Gula Merah. Balai Besar Penelitian dan Pengembangan Industri Hasil Pertanian, Departemen Perindustrian RI. Jakarta.

[6] Effendi, D.S. 2009. Aren Sumber Energi Alternatif. Warta Penelitian dan Pengembangan Pertanian. Tahun 2009. 31(2):1-3

[7] Fardiaz, S. 1989. Fisiologi Fermentasi. Bogor: Pusat Antar Universitas. Institut Pertanian Bogor.

[8] Fardiaz, S. 1992. Mikrobiologi Pangan I. Jakarta: P.T. Gramedia Pustaka Utama.

[9] Judoamidjojo, R.M., E.G. Said dan L. Hartono. 1989. Biokonversi. Bogor: Departemen Pendidikan dan Kebudayaan Direktorat Jenderal Pendidikan Tinggi, Pusat Antar Universitas Bioteknologi Institut Pertanian Bogor.

[10] Kusumanto, D. 2010. Mencari Cara Pengawetan Nira Aren Untuk Produksi Gula Organik. Aren Foundation Indonesia. http://arenfoundation.wordpress.com

[11] Lay A, Hutapea RTP, Tuyuwale J, Sondakh JO, Polakitan AL. 2004. Pengembangan komoditas aren di Daerah Minahasa Sulawesi Utara. Prosiding Seminar Nasional Pengembangan Tanaman Aren. Tondano, Juni 2004.
[12] Legaz, María-Estrella, Roberto de Armas, Eva Barriguete dan Carlos Vicente. 2000. Binding of Soluble Glycoproteins from Sugarcane Juice to Cells of Acetobacter diazotrophicus. J Internatl Microbiol 3: 177–182.
[13] Marzoeki, A. A. M. 1993. Studi Tentang Perubahan Kimia Nira Nipah Dari Hasil Penyadapan Sore Hari. Majalah Kimia. No. 50, Desember 1993. 27-31. Balai Industri Ujung Pandang.
[14] Reed, G. dan H.J. Peepler. 1973. Yeast Technologi:, The AVI Publishing Co., Inc., New York.
[15] Tjokro dan Adikoesoemo., PS. 1986. HFS dan industri ubi kayu lainnya. Penerbit Gramedia, Jakarta.
[16] Yudiarto, A. 2008. Memilih aren sebagai bahan baku bioetanol. http://kebunaren.blogspot.com/2008/10/memilih-aren-sebagai-bahan-baku.html [27 desember 2011].