

Utilization of Pineapple's (*Ananas comosus* L. Merr) Peel Waste as Raw Material in Cider Making

Melanie Cornelia* and Theda Kristyanti

Food Technology Department, Faculty of Science and Technology,
Universitas Pelita Harapan, UPH Tower, Karawaci-Tangerang 15811

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Abstract: Pineapples were known have about 60% peels, it was often seen as pineapple waste and under utilized resources. Currently, the skin represents waste issue to be thrown away as of no value lead to environmental pollution. The way to overcome those waste problem was by processing of pineapple skin to make an added value of it. The phytochemical components of pineapple fruit such as carbohydrate, vitamin, polyphenols, and minerals, were also found in pineapple skin. Therefore the pineapple skin could be used as a source of antioxidant compounds, dietary fiber, and nutrition for microbes, in making cider. There were 4 provinces in Indonesia that has the highest of pineapple fruit production, Palembang, Pematang, Subang and Lampung. In this research, cider was made using Palembang, Pematang, Subang, and Lampung pineapple's skin by adding sugar with 3 different concentrations such as 15%, 20% and 25%, and fermented for 3 days. From the analysis result of ciders, adding of 15% sugar was chosen as the best formulation in cider making. Ciders of Palembang, Pematang, Subang, and Lampung pineapple's skin could produced 7.56%; 7.56%; 7.59% and 7.91% alcohol; pH 3.73; 3.64; 3.54 and 3.57; total soluble solid of 9.60; 10.60; 8.37; and 9.93 °Brix respectively. These results showed that cider was made from Pematang pineapple's skin, has the highest antioxidant activity with IC₅₀ of 10,753.87 mg/L and phenolic compounds of 282.13 mg/L. But the highest dietary fiber 1.15% was found in Palembang pineapple's skin cider.

1 INTRODUCTION

Pineapple (*Ananas comosus* L. Merr) was one of the tropical fruits which contains high amount of water, sugar, vitamin, minerals and oftenly used for food products, because of produced sweet, sour flavor and taste. Pineapple's peel which had a harder texture and difficult to be eaten, would always ended up as waste. Some provinces in Indonesia i.e Lampung, Subang, Pematang and Palembang were well known as the largest pineapple producer. noted that production of pineapple in Indonesia on the last three years gain 0.22 kg/capita, and waste 60% from the total production of pineapple. Based on the research of, pineapple's peel almost has the same nutrient content with pineapple's flesh such as sugar, water, vitamins, polyphenols, caretenoid, and minerals. Therefore pineapple's peel could be utilized as a source of crude fiber, antioxidant and bioactives components, in both fermented and non-fermented food products. This was supported by research that pineapple's peel could produce fermented products such as nata,

vinegar, and non-fermentation such as syrup. This research was aimed to utilize waste of pineapple's peel from four different types of Indonesia pineapple (Palembang, Pematang, Subang and Lampung) as raw material in the making of cider, that has high carbohydrate content and potentially contain antioxidant activity and fiber. The research began by determining the best % sugar added, % alcohol produced, pH, total titratable acids, and total soluble solids. Hopefully, the further processing of pineapple's peel could be applied into food product that has more added value.

2 METHODOLOGY

2.1 Materials and Equipments

Materials used to make pineapple skin cider were pineapple skin from Palembang, Pematang, Subang (*Ananas comosus* (L). Merr) and sunpride from

“Rumah Buah All Fresh”, water, NaOH 0.1 N, DPPH (2,2 diphenyl picrylhydrazyl), ethanol, Na₂CO₃ 7,5% (w/v), FeCl 5%, *Folin Ciocalteu*, and galac acids. Equipment required during pineapple skin cider making were knife, blender, filter fabric, waterbath, picnometer, Bunsen, oven, micropipette, desiccator, crucible, volumetric flask, soxhlet, kjeldhal, bulp pump, spectrophotometer, cuvette, and thimble.

2.2 Research Method

The research were divided into two stages, the first stage and the second stage . The preliminary stage made of pineapple skin cider with variation of pineapple types and sugar added towards alcohol, pH, total titrated acids and total dissolved solids of ciders. The main stage analyzed the best pineapple skin cider from preliminary with parameter of antioxidant activity, total phenolic test, fiber test, scoring and hedonic test.

2.2.1 The Making of Pineapple Skin Cider

The making of pineapple skin cider were done based on and research. Pineapple skin has been sorted from other foreign things and then washed with clean running water. Added water to the skin that has been washed with a ratio 1:2, blended it using blender for 1 minute and filtered it, so the extracts were obtained. The pineapple skin extracts were pasteurized at 72 °C for 20 minutes. The next step was the addition of three different sugar concentrations 15%, 20%, and 30%, after being cooled to 38 °C. Instant yeast or “Fermipan” of 1 g/L were mixed into the juice. The juice were putted into a sterile bottle, gave a hose and closed it for 3 days. The observation for cider was done after 3 days based on predefined parameters.

3 RESULTS AND DISCUSSIONS

3.1 Carbohydrate Content

From the statistical analysis, the result showed significant difference ($p < 0.05$) of carbohydrate content on pineapple skin from Pematang 14.51±0.01%, Subang 11.93±0.01%, and Sunpride 5.00±0.01%. Pineapple skin commonly has a high carbohydrate content which can be used as a nutrition for microbes to grow during fermentation process.

3.2 Alcohol Intensity

From the statistical analysis, the result showed there was no interaction between % sugar and pineapple types, but it had significant effect ($p < 0.05$) on % alcohol produced. The 15% sugar added that produced cider 5%-8% alcohol. The function of sugar were as substrate that will be used by microbes (yeast) as a nutrients to be converted to alcohol. The range for sugar to be added into cider was 15%-25%.

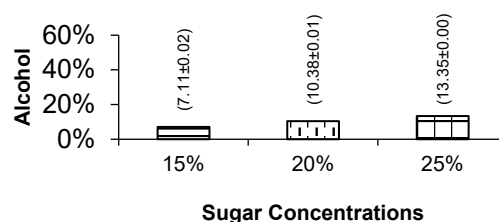


Figure 1. The Effect of Pineapple Types and % Sugar on Alcohol Produced

3.3 pH and Total Titrated Acid

Cider from pineapple skin sunpride has the lowest pH of 3.3-3.4 at 15% and 20% sugar concentrations, thus significantly different from Subang, Pematang and Palembang. pH could decrease drastically on day 3, because it was part of the new yeast phase actively converting glucose into alcohol and acid. The more acid that was formed, the more lower pH value. Total titrated acids represented the total of all types of acids present in pineapple fruit and skin which were the most dominant was 78% citric acid, 13% malic acid, and oxalic acid. Acetaldehyde derived from the decarboxylation of pyruvic acid due to glycolytic sugar changes, under anaerobic conditions will undergo a fermentation process that produces ethanol and acids.

3.4 Total Soluble Solids

The result showed that types of pineapple have significant effect and sugar concentration ($p < 0.05$) to total soluble solids on pineapple skin cider. Ending of cider fermentation with 15% sugar didn't have significantly different with 20% sugar on Sunpride and Palembang. The total dissolved solids in cider could be from precipitate of juice or microbe that has been dead or no longer active and also sugars (sucrose) was added in the beginning. However, there was still possibility of sugar content could be used to mask the sour taste that arises.

3.5 Best Formulation Determination

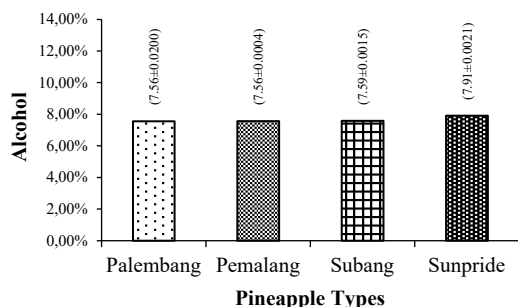


Figure 2. The Effect of Pineapple Types with the best choice of 15% Sugar on Alcohol Produced

The best formulation in the preliminary stage was taken on the alcohol intensity that meet the standards range alcohol in general. This showed that the addition of 15% sugar was enough to produce a pineapple skin cider with 5%-8% alcohol content.

3.6 Antioxidant Activity

Analysis of antioxidant activity on pineapple skin was done when pineapple skin has become pineapple skin juice and cider by using free radical of DPPH with IC₅₀ value. The data of pineapple types on antioxidant activity (IC₅₀) from pineapple skin juice were decreased significantly when pineapple skin became cider (p <0.05) could be seen in Table 1 below. The pineapple skin juice from Sunpride has the highest antioxidant activity (lowest in IC₅₀), but once it was made into a cider. The pineapple skin cider from Pemaalang has the highest antioxidant activity (lowest in IC₅₀). This fermentation has been shown to increase antioxidant activity in pineapple skin, in accordance with the theory written by.

Table 1. Antioxidant Activity (IC₅₀) of Pineapple Skin Juice (%) and Pineapple Skin Cider (%)

Pineapple Types	IC ₅₀ Pineapple Skin Juice (%)	IC ₅₀ Pineapple Skin Cider (%)
Palembang	8.27±0.89	3.36±0.04
Pemaalang	9.01±1.30	1.07±0.06
Subang	7.08±0.65	1.73±0.32
Sunpride	5.26±1.08	1.85±0.15

The determination of antioxidant activity against green tea cider also resulted decreasing IC₅₀ which indicates increasing antioxidant activity after fermentation process. Because yeasts were able to

produce enzymes that could increase antioxidant during fermentation in cider. As long as the sugar content were still available, antioxidant activity may continue to increase. It was also reinforced by and which stated that there was a positive correlation between antioxidant activity with phenolic compound.

3.7 Total Phenolics

From the statistical analysis, the result of total phenolic showed there was significant effect of pineapple types towards total phenolic content before and after the fermentation (p<0.05). From data in Table 2, pineapple skin cider from Pemaalang had the highest total phenolic content, while Sunpride had the lowest, but not significantly different from Palembang.

Table 2. Total Phenolic of Pineapple Skin Juice (%) and Pineapple Skin Cider (%)

Pineapple Types	Pineapple Skin Juice (ppm)	Pineapple Skin Cider (ppm)
Palembang	166.18±2.16	261.02±0.73
Pemaalang	183.96±1.50	282.13±0.55
Subang	175.39±0.80	280.70±1.38
Sunpride	165.65±0.54	251.00±0.25

Thus, the higher antioxidant activity, total phenolic compound in present will also increased. The fermentation process will cause the active enzyme to hydrolyze phenolic glucoside, thereby causing the concentration of free phenolic acid to increase.

3.8 Correlation of IC₅₀ with Total Phenolics

The correlation between IC₅₀ with total phenolics at coefficient value -0.453 (moderate). A positive correlation if one of the variable increase, then the other variable will also increase. However if its negative, one variable increase and the other decrease. The correlation produced by IC₅₀ with total phenolics was minus (-), indicating that the smaller the value of IC₅₀ obtained higher total phenolic value of pineapple skin cider.

3.9 Food Fiber

Food fiber analysis data showed that pineapple skin cider of Palembang has higher percentage of food fiber that is 1.15%, compared to the other three types of pineapple. This proved that pineapple skin cider contains fiber.

Table 3. Food Fiber Analysis

Pineapple Skin Cider from	Food Fiber (%)
Palembang	1.15
Pemalang	0.45
Subang	0.46
Sunpride	0.40

4 TOXICITY TEST

The results of toxicity testing of pineapple skin types Palembang, Pemalang, Subang and Sunpride showed that it was still classified as low toxic, with the value of LC_{50} successively was 755.21 ppm; 775.92 ppm; 403.83 ppm, and 616.23 ppm. If the toxicity test of a product or plant has a value of $LC_{50} < 1000$ ppm by BSLT method, then the plant or product could be re-developed as an anticancer potency.

4.1 Organoleptic Sensory Results

4.1.1 Hedonic Test

The hedonic test as a whole conducted aim to know consumer / panelist acceptance to pineapple skin cider products. Overall, panelist acceptance of pineapple skin cider suggests that Palembang's pineapple skin cider was more acceptable with a score of 4.74 ± 1.22 (scale 1: dislike - 7: like) in parameter of alcohol intensity, taste, color and clarity..

4.1.2 Scoring Test

Based on the alcohol intensity score, pineapple skin cider from Palembang, Pemalang, Subang and Sunpride were not significantly different from each others, all classified as having a slightly stronger alcohol intensity with successive scores of 3.83 ± 1.23 ; 4.27 ± 1.24 ; 4.17 ± 1.44 ; and 4.20 ± 1.16 respectively. In the parameters of pineapple aroma, Palembang pineapple skin cider and sunpride has the highest score of 4.33 ± 1.09 and 4.11 ± 1.36 . This score indicates that the aroma of pineapple was still a little wafting on the cider. Scores given by the

panelists on the acid showed that the skin of Subang's Pineapple has higher acid content than the other three ciders, with a score of 4.63 ± 1.21 . In the aspect of sweetness, there was no significant difference between the scores given by the panelists; each cider has a score of 4.13 ± 1.01 for Palembang's pineapple, 3.74 ± 1.21 Pemalang's pineapple, 3.73 ± 1.17 Subang's pineapple and 3.99 ± 0.97 sunpride's pineapple. This score was still classified into a little bit sweet. In the color grade, cider of pineapple Subang has the highest score of 4.96 ± 0.92 which indicated that the cider has a slightly yellow color. The last aspect of clarity has a score that was not significantly different in each cider was 3.67 ± 1.20 for pineapple skin Palembang, 3.51 ± 1.26 Pemalang, 3.64 ± 1.34 Subang and 3.50 ± 1.22 sunpride. The score showed that the four types ciders have the same clarity that was a bit clear.

4.2 Comparison of Pineapple Skin Ciders with Pineapple Flesh Ciders

This comparison was performed to see the comparison analysis data of the two cider making from pineapple flesh and pineapple skin, using pineapple from Palembang, Pemalang, Subang and Sunpride. The characteristics of best pineapple cider skin formulation were compared with the characteristics of cider from each flesh pineapple, with the same sugar added and fermentation time. Then the observation were done for the percentage of alcohol, pH, total titrated acids and total dissolved solids. This comparison aimed to see whether or not the differences of cider characteristics were made from pineapple skin and from pineapple flesh, based on the parameters of alcohol content (Fig 3), pH (Fig 4), and total dissolved solids (Fig. 5).

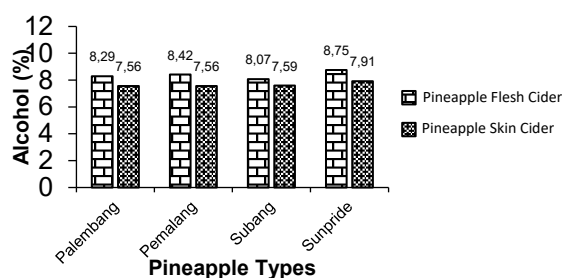


Figure 3. Comparison of Alcohol Cider of Pineapple Flesh Cider with Pineapple Skin Cider

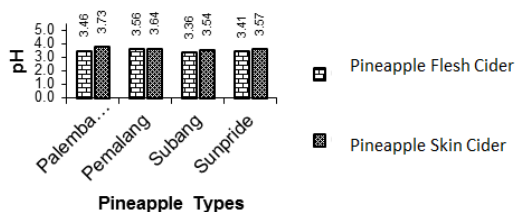


Figure 4. Comparison of pH of Pineapple Flesh Cider with Pineapple Skin Cider

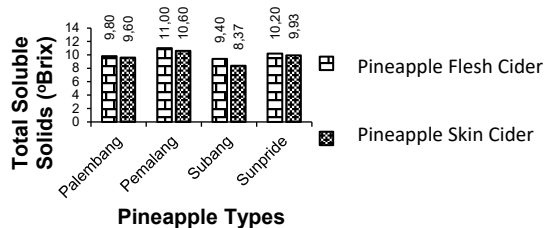


Figure 5. Comparison of Total Soluble Solids of Pineapple Flesh Cider with Pineapple Skin Cider

From the result above, it could be seen that cider from the pineapple flesh has a slightly higher alcohol content than pine pineapple skin, has pH lower, then the total acid produced from the fermentation process also increased, except sunpride. At the end of fermentation, total soluble solids in each cider could be seen in Fig 6. The pineapple flesh has a higher sugar content compare to the pineapple skin indicated the sweetness of the pineapple cider, so the total dissolved solids more remaining compared to the pineapple skin cider that has a slightly lower total soluble solid.

4.3 Determination of the Best Pineapple Skin Type

In the antioxidant activity test and total phenolic, the highest values were obtained from the pineapple skin husk with IC₅₀ value of 10753.87 mg / L and total phenolic 282.13 mg GAE / L. The food fiber test showed that Palembang's pineapple skin cider had the largest percentage of 1.15%. Palembang pineapple type also has the highest acceptance score of 4.74, on organoleptic test. Based on the results of some of these tests, Palembang and Pemalang pineapple can be considered as the best pineapple species in the manufacture of pineapple skin cider.

5 CONCLUSION

Waste of pineapple skin was potential to be proceed as a cider drink because it has a fairly high percentage of carbohydrates which produced alcohol according to cider's standard. The best of sugar concentration added was 15% sugar that produced cider 5%-8% alcohol. In the parameter of antioxidant activity, the best antioxidant activity (or the lowest IC₅₀ value) of pineapple skin juice was from Sunpride type 5.26±1.08 % and for the pineapple skin cider was from Pemalang type 1.07±0.06%. Cider has better antioxidant activity than it's juice for all types of pineapple. In term of total phenolic, the best total phenolic pineapple skin juice and also pineapple cider were come from Pemalang type. That was 183.96±1.50 ppm (juice) and 282.13±0.55 ppm (cider), so cider has better total phenolic content rather than it's juice for all types of pineapple. The food fiber analysis results showed that Palembang's pineapple skin cider had the largest 1.15% of food fiber compared to cider from Pemalang, Subang and Sunpride. Palembang pineapple skin cider also has the highest acceptance score of 4.74 on organoleptic test. Based on the results of food fiber and hedonic test, pineapple skin from Palembang could be considered as the best pineapple types in the making of pineapple skin ciders.

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