COMPOSITIONAL CHARACTERISTICS OF NIRA - PALM JUICE OF HIGH SUGAR CONTENT FROM PALM TREE

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ABSTRACT

Composition of palm juices from *aren, siwalan (lontal)* and *nipah* were analyzed. Sugar is the major solid component of all juices and ranging about 10 to 13%. Ash is also found from 0.1 to 0.4%. On the paper chromatogram, sucrose was confirmed as a dominant sugar component of fresh palm juices, but glucose and fructose were formed as the decomposed products of sucrose according to the initiation of fermentation. Additional several oligosaccharides were observed in fermented palm juices as converted sugars by the enzymatic action.

Organic acid detected in fresh juices are citric, tartaric, malic, succinic, fumaric and pyroglutamic acids, but lactic acid was formed as a dominant organic acid in fermented juice. Sugar content of commercially sold palm juice and solid palm sugars produced by heat concentration of palm juices were also composed of sucrose, glucose and fructose.

INTRODUCTION

Palm juice is one of popular bevarage in Indonesia. It is exuded and collected from an incision of cutted inflorescence of palm tree, and called "nira". Four kind of palm trees of aren, siwalan (lontal), coconut (kelapa) and nipah are mainly used for this purpose.

The juices are very sweet by their high content of sugar. They are used, therefore, to produce solid palm sugars by heat concentration, and also used sometimes for production of alcoholic drinks by fermentation.

In this experiment, we intended to make clear the compositional characteristics of palm juices. The term of palm juice in this work signifies only the juices exuded from cutted inflorescence of palm trees, and does not include the juice contained in palm seed.

MATERIALS AND METHODS

Materials

Palm juices from aren and coconut were collected from Cianjur, West Java. Palm juices from siwalan were from Jeneponto (South Sulawesi) and nipah were from Manokwari (Irian Jaya).

Juices were collected from palm trees within one hour, then cooled immediately and kept in frozed until analysis was performed.

Methods

(1) *Analytical methods for general composition*

Moisture content was measured by heating. Ca. 3 g of sample accurately weighed into a flat-bottom glass dish of 3 cm diameter were heated on steam bath until approximately dry, then heated in an air oven at 110°C for 5 hours. After cooling in a desiccator for 30 min, the weight was measured.

Nitrogen content was determined by semi-micro Kjeldahl method. Ca. 1 g sample was digested by heating with sulfuric acid containing $CuSO_4$ and K_2SO_4 as catalyzers. The factor of 6.25 was used for conversion of nitrogen content to protein content.

Sugar content was measured by phenol-sulfuric acid method[1]. Two ml of diluted palm juice was mixed with 0.1 ml of 80% phenol solution followed by addition of concentrated sulfuric acid (5 ml). Intensity of developed colour was measured at 490 nm using a spectrophotometer. Calibration curve was prepared using standard sucrose solution.

Measurement of ash content was done by heating sample in an electric furnace at 600°C for 3 hours. The sample taken into crucible was well carbonated on a small gas flame before it was introduced into the furnace.

(2) *Paper chromatography (PC) of sugar composition*

PC of sugar was performed on Toyo No. 51 filter paper using a solvent system of n-butanol-pyridine-water (6 : 4 : 3, v/v). After three times repeated development at room temperature, the paper was stained with silver nitrate solution according to the method of Robyt and French[2].

(3) *Analytical method of organic acid and sugar by high performance liquid chromatography (HPLC)*

Ten grams of palm juice sample were acidified to pH 1—2 by 3 N HCl, then extracted with ethyl ether for 30 hours in Soxhlet apparatus modified for the extraction of liquid sample. The extract was alkalinized with 2 N NH_4OH, then the ether was evaporated off. Remaining water layer was collected in 10 ml volumetric flask and filled with water after acidification with 2 N phosphoric acid to about pH 2.

Analysis of organic acids by HPLC was performed using a Hitachi model 635 S apparatus attached with a 834—50 integrator. The extracted samples were introduced to the apparatus and eluted through the column packed with Hitachi custon ion exchange resin #2618 (0.4 × 50 cm) by 0.05% phosphoric acid at a flow rate of 0.3 ml/min and 50°C. The elution was monitored at 210 nm.

Analysis of sugar composition of palm juice was achieved using the same equipment. Palm juice samples were introduced directly into the equipment

and eluted with water at a flow rate of 0.2 ml/min and 40°C. The elution was monitored using a Shodex refractive integrator model SE - 11.

RESULTS AND DISCUSSION

Table 1 shows the general composition of palm juices from four kind of palm trees. The major component is sugar which is ranging from 10 to 13%. Ash and protein are also found as minor components. Sugar composition of the palm juices was analyzed by paper chromatography (Fig. 1). Fresh samples from aren, siwaran and coconut were composed only sucrose. No additional sugars were detected on the chromatogram. However, several minor components were observed in fresh juice from nipah. Those components were presumed as degradation products of sucrose by microbiological action while transportation of the sample. In this case, 0.1% of $HgCl_2$ was mixed as an antiseptic, but microorganismic growth could not be prevented completely. The naturally contaminated microorganisms start growth and produced enzymes degrade sucrose into glucose and fructose.

Table 1. General composition of palm juices.

		Moisture %	Sugar %	Ash %	Protein %
Aren	1	88.85	10.52	0.03	0.23
Aren	2	87.66	12.04	0.21	0.36
Siwalan (Lontal)		87.78	10.96	0.10	0.28
Nipah		86.30	13.28	0.43	0.21
Coconut (Kelapa)	1	87.78	10.88	0.37	0.21
Coconut	2	88.40	10.37	0.38	0.41

Sample No 5 to 8 in Fig. 1 are indicating the change in sugar composition as the function of time after harvest of aren palm juice kept at ambient temperature (25—32°C). Several minor components having lower Rf values were observed. Those components are oligosaccharides formed from glucose, fructose and sucrose by transglucosylation reaction of enzymes. The formation of different kind of oligosaccharides in palm juice from aren, siwalan and nipah shown in Fig. 1 is indicating the difference of contaminated microorganisms in such palm juices.

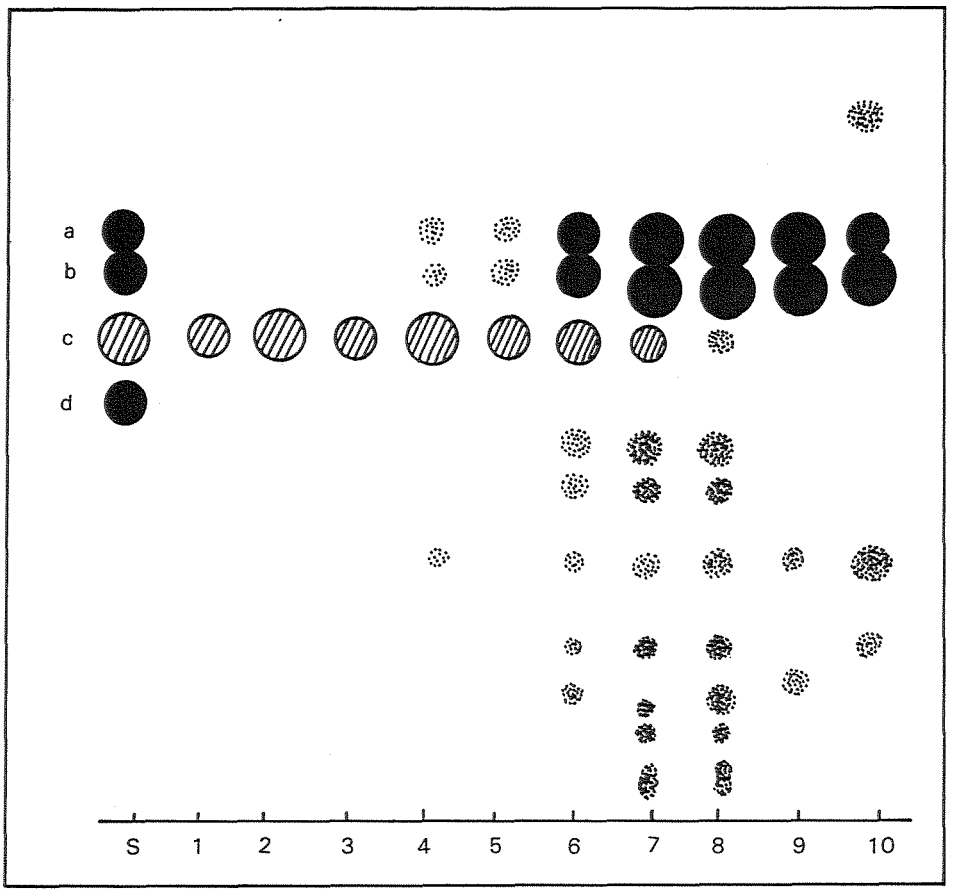

Fig. 1. Paper chromatogram of sugars in palm juices.
S: Standard sugars, a: Fructose, b; Glucose, c: Sucrose, d: Maltose, 1: Aren, fresh palm juice, 2: Siwalan, fresh, 3: Coconut, fresh, 4: Nipah, fresh, 5: Aren, 12 hours after harvest at ambient temperature, 6: Aren, one day after harvest, 7: Aren, two days after harvest, 8: Aren, three days after harvest, 9: Siwalan, fermented, 10: Nipah, fermented.

HPLC chromatograms of organic acids in fresh and partially fermented palm juice are shown in Fig. 2. Under a given set of operating conditions, each component was identified by compareing retention time with standard materials. Analytical data on organic acids in palm juice are also given in Table 2. Aren palm juice was relatively high in malic acid. Siwalan was characterized by high content of succinic. Nipah was the highest in succinic and also in

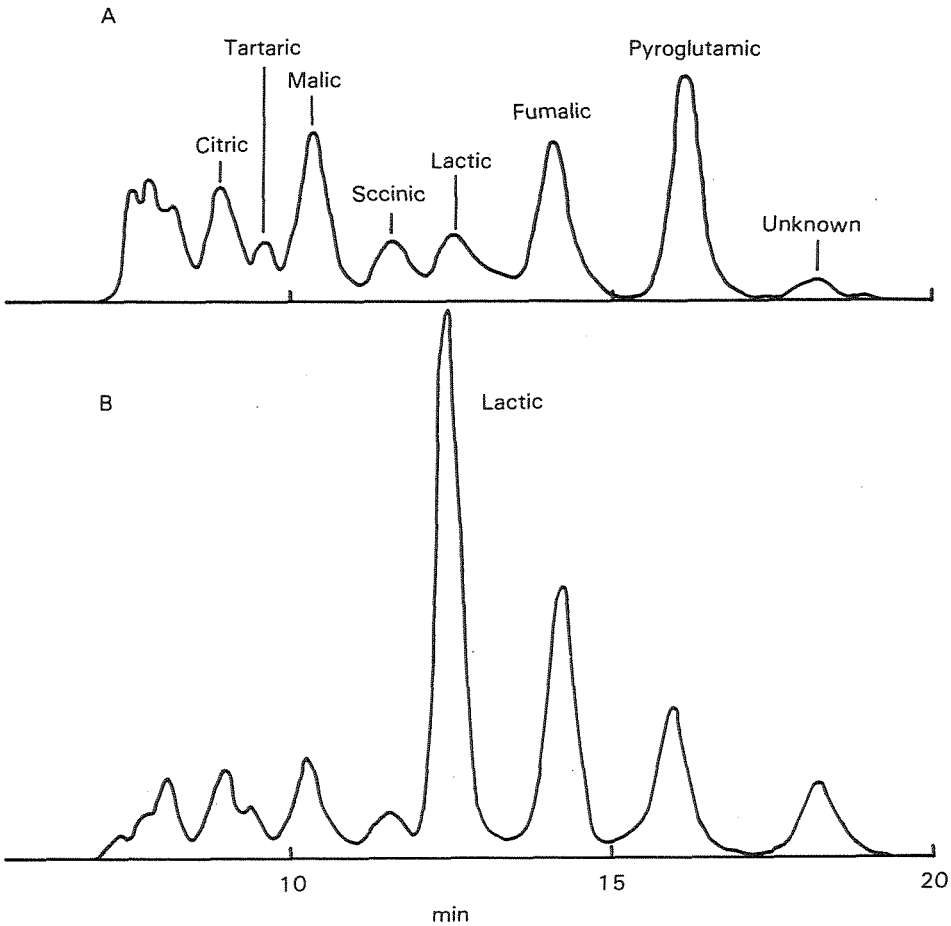

Fig. 2. HPLC chromatogram of organic acid in palm juice A: Fresh aren palm juice, B: Aren palm juice kept at ambient temperature for two days after harvest.

tartaric. Coconut contained high amounts of succinic, pyroglutamic and citric. These components appear to give characteristic sour taste and flavor to each palm juice. While the juice was allowed to stand at ambient temperature, lactic acid increased markedly as the result of fermentation progress.

Palm juices are usually sold on street or at market as a popular bevarage. Fig. 3 shows example of the sugar composition of such commercially sold palm juice. Sucrose was still major sugar component, however, relatively high content of fructose and glucose were detected as the degradation products of

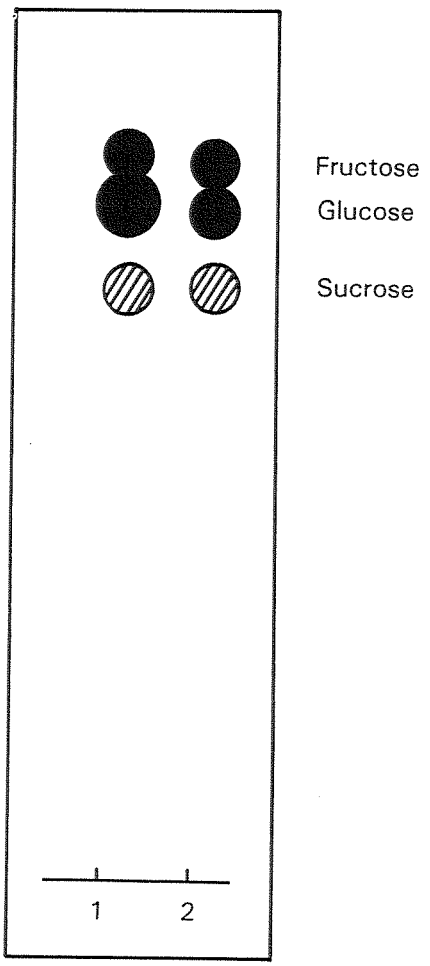

Fig. 3. Paper chromatogram of commercially sold palm juices.

Table 2. Composition of organic acids in palm juices (mg/100 g).

	Citric	Tartaric	Malic	Succinic	Lactic	Fumalic	Pyroglutamic
Fresh palm juice							
Aren 1	0.9	0.6	17.0	5.1	4.0	0.1	3.9
Siwalan	0.9	0.6	15.0	34.0	9.0	0.3	0.9
Nipah	6.4	30.0	21.0	78.0	2.4	0.1	8.6
Coconut 1	22.0	0.6	3.6	73.0	6.5	0.1	41.0
One day after harvest*							
Aren	2.3	0.5	19.1	7.8	272.0	0.4	5.5
Nipah	4.2	10.1	10.0	42.0	470.0	0.5	5.9

* At ambient temperature.

Table 3. Sugar composition of commercially sold palm juices and solid palm sugars (ratios in 100%).

	Sucrose	Glucose	Fructose	Others
Commercially sold				
Palm juice 1	57.7	21.1	19.1	2.2
Palm juice 2	58.6	19.2	18.4	3.8
Commercially sold solid palm sugar				
from aren 1	57.4	21.5	19.1	1.9
from aren 2	67.2	15.6	14.4	1.8
from coconut 1	57.1	20.4	19.3	3.2
from coconut 2	62.2	18.0	17.1	2.7
from siwalan	55.8	21.2	20.8	2.2

sucrose. The result indicate that the commercially sold palm juice was in the partially fermented state.

Palm juices are also used for production of solid brown coloured palm sugars, which is called gula merah in Indonesia. Palm juices are, in this case, concentrated by heating and solidified in cool. Fig. 4 is indicating paper chromatogram of sugar composition in commercially sold solid palm sugars from different source of palm juices. All solid palm sugars were composed mainly of sucrose, fructose and glucose. Additional minor few oligosaccharides were also detected as converted sugars. Profile of paper chromatogram of solid palm sugars from different source were almost the same.

Sugar composition of commercially sold palm juice and solid palm sugars analyzed by HPLC were shown in Table 3 as the ratios in 100%. Sugar ratios were almost the same in the commercially sold palm juice and solid palm

sugars, and composed around 60% of sucrose, 20% of each glucose and fructose, and few % of other sugars.

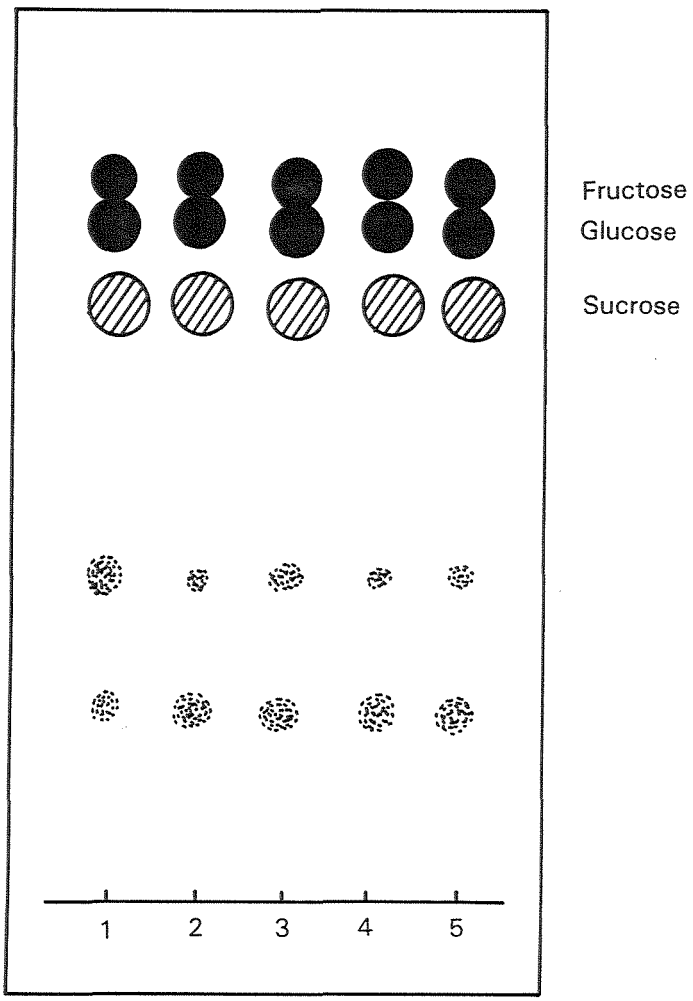

Fig. 4. Paper chromatogram of commercially sold solid palm sugars. 1 and 2 : from aren, 3 and 4 : from coconut, 5 : from siwalan.

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