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Chemical Characteristics of Legen Drinks from Street Vendors in Surabaya

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A B S T R A C T

Legen is a traditional drink made of siwalan sap and it is very popular in East Java. This research aims to identify chemical characteristics of legen drinks sold by 10 local street vendors in Surabaya. This study is an exploratory and descriptive survey employing a cross-sectional approach. Data were collected by observation, interviews, and questionnaires regarding vendor characteristics, involving 10 street vendors selling legen drinks in Surabaya who operate throughout the year. The observed parameters include pH, total sugar, total acidity, and alcohol content. The observations showed that the vendors were predominantly male (90%), with the remaining 10% is female. The vendors' ages ranged from 26 to 55 years, with most having completed junior high school (40%) and senior high school (40%). Only one vendor had been selling for more than 20 years. The selling price of the product ranged from IDR 13,000 to 15,000 per 1,500 mL bottle, with most of the legen (80%) sourced from Tuban. The chemical analysis showed that the average pH was 2.85, the average total acidity was 0.22, the average total sugar content was 10.60, and the average alcohol content was 1.02.

Contribution to Sustainable Development Goals (SDGs):

SDG 3 – Good Health and Well-being

SDG 8 – Decent Work and Economic Growth

SDG 11 – Sustainable Cities and Communities

SDG 12 – Responsible Consumption and Production

1. INTRODUCTION

1.1. Research Background

Legen is a traditional drink from Indonesia made from sap of the siwalan plant (*Borassus flabellifer*), which is mainly found in East Java, especially in Tuban [1]. Legen drink is one of the most popular drinks, especially in Surabaya, and has been designated as a national culinary heritage. Legen drink is mainly sold by street vendors (*pedagang kaki lima*), who are small-scale entrepreneurs that provide goods or services to specific community segments. Fresh palm sap (*nira*) is often characterised by its sweet taste, distinct aroma, and pH of around 5.5-6. The sweet taste comes from the presence of simple sugars such as sucrose, glucose, and fructose, as well as other carbohydrates. This high sugar concentration is facilitating spontaneous

fermentation at room temperature. Initially, natural microorganism activity in sap converts sugar into alcohol, then creates a subsequent acidic taste [2,3]. Specifically, the legen drink, made from siwalan sap, contains a significant sugar concentration of around 10-15g.100ml [4].

The chemical characteristics of legen beverages, particularly those circulated in Surabaya, have not been extensively studied. According to Drug and Food Control Agency of Indonesia (BPOM RI) Regulation number 13 of 2019 [5] concerning on Processed Food Supervision and BPOM Regulation number 5 of 2021 [6] concerning on Food Categories, fermented beverages like legen drink must meet certain quality standards, including an alcohol content limit of <1% to be classified as non-alcoholic. Furthermore, from a halal perspective, Indonesian Ulama Council (MUI) Fatwa number 11 of 2009 [7] stipulates that beverages containing >1% alcohol and having intoxicating properties are prohibited for consumption. The relevance of this research is



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further pushed by the high consumption rate of legen in Surabaya, where it's distributed by street vendors operating under varying sanitation and hygiene conditions.

1.2. Literature Review

1.2.1 Legen

Legen is made of palm sap extracted from lontar trees by tapping the flower stalk. Typically, male flower stalks are chosen for tapping, while female stalks are left untapped to allow for fruit production. Palm sap tapping from lontar trees begins when this plant has flowered and the flower spadix turns yellowish. Lontar palms are highly productive, capable of being tapped for 6-8 months annually, yielding 3-5 litres of palm sap per spadix per day. Generally, legen is distributed in 1.5-liter plastic bottles.

However, the shelf life of legen from siwalan sap is very limited. This is because there is a risk of alcohol accumulated in legen drink up to addictive level caused by spontaneous fermentation. The degradation of legen drink is indicated by organoleptic changes, including an acidic taste, foam formation, and a slimy consistency, all resulting from microbial activity that is fermenting the sugars [8].

1.2.2 Alcohol

Alcohol is a substance found in a substrate that can be obtained through the fermentation of carbohydrates with the aid of yeast (Fathnur, 2019). Fermentation is a metabolic process involving the breakdown of organic substrates [9]. Specifically, the conversion of sugar into ethanol (alcohol) is a result of this fermentation process. The three main types of microorganisms responsible for this transformation are molds, yeasts, and bacteria [10].

Initially, the sugar contained in the solution is converted into alcohol and CO₂ in an anaerobic conditions. Following alcohol production, acetic acid fermentation promptly occurs. This process involves acetic acid bacteria aerobically oxidizing alcohol into acetic acid [11].

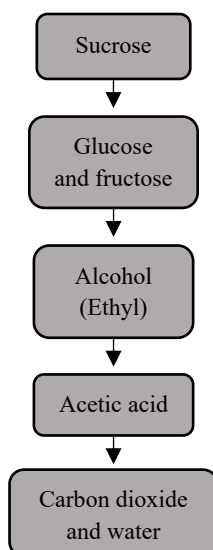


Fig. 1. Alcohol fermentation process (Santoso, 1993)

Palm sap is highly susceptible to fermentation due to its rich and active microbial content. Delays in the heating process lead to changes in the sap's colour, turning it cloudy and yellowish, accompanied by an acidic taste and pungent odour. These alterations are attributed to the conversion of sucrose into alcohol

by yeast activity, followed by the oxidation of alcohol into acetic acid by bacteria, which ultimately yields a sour-tasting vinegar. The pH of the substrate is also a crucial factor influencing the viability and activity of *Saccharomyces cerevisiae* [12].

1.3. Research Objective

This research aims to analyse the chemical characteristics of legen drinks distributed by local street vendors in Surabaya.

2. MATERIALS AND METHODS

This research conducted in April-May 2025. Initially, primary data were collected through direct observation, interviews, and questionnaires aimed at local street vendors who sold legen drinks. Then, the research continued by analysing chemical characteristics, including pH, total acidity, total sugar, and alcohol content, in the Analisa Pangan laboratory of Food Technology at Universitas Pembangunan "Veteran" Jawa Timur.

Alcohol content determined by evaporative distillation method. Distillation was carried out up to 80°C, according to the alcohol's boiling point, which is around 78°-80°C (Azizah et al., 2012). Total acidity determined by the titration method, total sugar determined by anthrone method, and pH levels determined by digital pH-meter.

3. RESULT AND DISCUSSION

3.1. Vendors Characteristics

3.1.1 Gender

A field survey revealed that male street vendors predominantly sell siwalan legen in East Surabaya, accounting for 90% (9 out of 10 vendors), while female vendors constitute only 10% (1 out of 10 vendors). This indicates that socioeconomic and cultural factors influence the gender distribution in the informal labour sector. As described before, the nature of street vending demands intensive physical activity, including lifting, carrying, and direct selling of goods. The majority of legen vendors frequently handle heavy loads, such as jerry cans filled with legen or other sales equipment, likely contributing to the higher proportion of male vendors in this trade [13].

3.1.2 Age

A survey indicates that 100% (10 out of 10 vendors) of street vendors on Legen Street in East Surabaya fall within the productive age category (15-63 years old). Age significantly influences individual productivity. Individuals within the productive age range generally possess superior physical strength compared to those in non-productive age groups [14].

3.1.3 Educational Background

A survey reveals that street vendors have varied educational backgrounds. About 20% (2 out of 10 vendors) are elementary school graduates, 40% (4 out of 10 vendors) are junior high school graduates, and 40% (4 out of 10 vendors) are senior high school graduates.

3.1.4 Years in business

60% (6 out of 10 vendors) of the legen vendors have been operating for 6-10 years. The duration of selling significantly impacts a vendor's entrepreneurial experience. Vendors with the longest trading experience tend to possess more extensive informal knowledge and a greater ability to make informed decisions across various circumstances [15].

3.1.5 Selling price

Surveys indicate that the selling price of Legend drink is around 10,000-15,000 IDR per 1.5-litre packaging. The availability and accessibility of raw materials in residential areas or near production sources significantly contribute to the quality of the legend. Legen products sold in these areas are typically not mixed or diluted, resulting in a more authentic flavor. Consumers accustomed to the taste of pure legen tend to demonstrate a higher willingness to pay for guaranteed quality.

3.1.6 Source of legen

80% of respondents indicated that the legen they consume originates from Tuban, while the remaining 20% procure it from Gresik. Tuban is identified as the largest production center for legen in East Java. This prominence is supported by the region's high potential for cultivating the siwalan palm (*Borassus flabellifer*), the primary raw material for legen [16].

3.2. Chemical Characteristics

3.2.1 pH levels

pH value plays a crucial role in determining a product's shelf life and the activity of microorganisms within it. **Table 1** indicates that the average pH of legen from 10 vendors is 2.85. *Saccharomyces cerevisiae* exhibits optimal growth within a pH range of 3 to 6. Furthermore, yeast, specifically *Saccharomyces cerevisiae*, is a microorganism that actively converts glucose into ethanol [17].

Table 1. pH levels of legen drink that different street vendors sell

Sampels	pH levels
P1	3.17
P2	2.89
P3	2.44
P4	2.68
P5	2.67
P6	2.63
P7	3.08
P8	2.55
P9	2.91
P10	3.00
Average	2.85±0.23

3.2.2 Total acidity

Total acidity is a crucial parameter in evaluating the chemical quality of fermented beverages, such as legen, as it directly reflects the metabolic byproducts of microorganisms during fermentation and storage. **Table 2** shows that the average total acid content from 10 legen vendors is 0.22%. The natural microbial composition of legen, particularly *Saccharomyces cerevisiae* and Lactic Acid Bacteria (LAB), significantly contributes to the production of these organic acids. Acetic acid bacteria are known to convert alcohol into acetic acid [18] aerobically.

Table 2. The total acidity of legen drink is sold by different street vendors

Sampels	Total Acidity
P1	0.37
P2	0.12
P3	0.10
P4	0.09
P5	0.16
P6	0.21
P7	0.13
P8	0.36
P9	0.30
P10	0.25
Average	0.22±0.11

3.2.3 Total sugar

Table 3 indicates that the average total sugar content from 10 legen vendors is 10.60%. Total sugar measurement in traditional beverages, such as legen, is crucial for understanding their initial quality and anticipating potential chemical changes that may occur during fermentation. Total sugar levels are directly impacted by the fermentation process, where sugar serves as a substrate for fermentative microorganisms, primarily *Saccharomyces cerevisiae*. This yeast consumes glucose and fructose via the glycolysis pathway (Embden-Meyerhof-Parnas), yielding ethanol and carbon dioxide as the main fermentation products [19].

Table 3. Total sugar of legen drink that different street vendors sell

Sampels	Total Sugar
P1	10.44
P2	11.22
P3	11.46
P4	11.06
P5	11.56
P6	11.08
P7	10.52
P8	9.56
P9	11.09
P10	8.55
Average	10.60±0.84

3.2.4 Alcohol content

Alcoholic fermentation generally occurs due to the activity of microorganisms, primarily yeast, which convert sugars into ethanol and other byproducts [20]. In traditional beverages like legen, the presence of natural yeast from both the environment and the siwalan sap itself plays a significant role in alcohol formation. As shown in **Table 4**, the average alcohol content from 10 vendors in Surabaya is 1.02%. According to BPOM Regulation No. 14 of 2016 concerning safety and quality standards for alcoholic beverages, this level falls into Category A, which includes beverages with an alcohol content of 1% or less.

Table 4. Alcohol content of legen drink that different street vendors sell

Sampels	Alcohol content
P1	1.00
P2	0.98
P3	1.10
P4	1.15
P5	0.95
P6	1.07
P7	1.13
P8	1.04
P9	0.96
P10	1.03
Rata-rata	1.02±0.02

4. CONCLUSION

The collected data of the researches reveal that male street vendors predominantly sell siwalan legen in East Surabaya, accounting for 90%, compared to 10% female vendors. The vendors' ages range from 26 to 55 years, with the majority (40% each) having an education level of junior high school or senior high school. Additionally, one vendor has been selling legen for over 20 years. Legen products are generally sold at prices ranging from Rp 10,000 to Rp 15,000 per 1,500 ml packaging. A significant portion of the legen (80%) distributed in the area originates from Tuban. Furthermore, analyses of the legen's pH, total acid, total sugar, and alcohol content indicate that spontaneous fermentation has not fully progressed. Consequently, the legen distributed in East Surabaya is classified as a Category A for alcoholic beverages.

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