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Characterization of Physical Properties and Sensory Evaluation of Pletok Bir Enriched with Apple Juice

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Abstract
This study aimed to determine the optimal concentration of apple juice as a flavor enhancer in pletok bir, a traditional Betawi drink, through evaluation of three ratio treatments (0:1/control, 1:1, and 3:1 v/v). Analysis of physical properties (pH, viscosity) and sensory attributes (color, aroma, taste, acceptability) using a 5-point hedonic scale showed that increasing apple juice concentration decreased pH from 7.33 to 4.31 and increased viscosity (0.107-0.125 mPa-s). A 3:1 ratio achieved the highest taste preference (score of 3.76) with an optimal viscosity balance (0.125 mPa-s), reducing bitterness and providing subtle sweetness without obscuring the characteristic spicy aroma. In contrast, the 1:1 ratio resulted in lower acceptability (score 3.08) due to flavor imbalance. Overall acceptability scores ranged from 3.2-3.64 (neutral-moderately like), reflecting moderate consumer preference. These findings indicate that the addition of apple juice at a 3:1 ratio can enhance the sensory appeal of pletok bir while maintaining its traditional essence, offering an innovation to expand the market through flavor diversification.

Keywords:
apple juice; physical properties; pletok bir; sensory evaluation

1. Introduction

Apple is one of the plants that can be cultivated in Indonesia and is an annual crop originating from the subtropics [1]. Apples are fruits from apple trees and belong to the Rosaceae family. People from various backgrounds widely favor this fruit due to its delicious taste and easy availability. Apples contain antioxidant activity, such as polyphenols, which have the potential to fight free radicals and maintain the health of body cells because they contain chlorogenic acid, epicatechins, and floridzine [2]. The antioxidant activity of phenolic compounds can provide potential benefits for human health, such as helping to prevent various diseases and slow down aging through their effects in the body [3]. In the food and beverage industry, apples have numerous uses, whether consumed fresh or processed into juice, sauce, jam, and various other products. Apples' distinctive taste and aroma are also frequently used as flavoring agents in various beverages, including juice, soda, and alcoholic drinks. According to [4] apple juice is one of the most favored juices among the public based on sensory testing.

Consistent consumption of apples has been shown to exert significant positive effects on the body, particularly when compared to other natural sources of antioxidants [5].

In addition to apples, which are recognized as a natural source of antioxidants, Indonesia also boasts traditional spice-based beverages with comparable health benefits. One of them is Pletok Bir, a Betawi specialty drink that originated during the Dutch colonial period and has been preserved for generations [6]. This beverage is made from a combination of various spices, including white ginger, lemongrass, cinnamons, nutmeg, sappan wood, pandan leaves, granulated sugar, water, and cloves. Despite its name, 'beer,' this drink does not contain alcohol. The term "beer" is used 21uet o the shaking process during its preparation, which resembles techniques used in beer-making. Pletok bir has significant potential as a traditional drink with functional health benefits. Its spice content has been scientifically proven to possess antioxidant, antibacterial, and anti-inflammatory properties. With these characteristics, Pletok bir serves as a promising alternative to healthy beverages that can support public health [7].

The addition of apple juice as a flavoring in pletok bir is an innovative effort to expand flavor variations and enhance consumer appeal toward this traditional beverage. This is in line with the statement of [8],that it is more appropriate to consume apple juice as a nutraceutical drink by adding other parts of the apple or enriching it with fruit, vegetables, or spices, rather than consuming it as pure fruit juice. The high phenolic content in apples and their by-products enables the development of final products with enhanced antioxidant properties while preserving sensory characteristics such as taste, aroma, texture, and appearance [9]. According to [10], the addition of inulin, ginger extract, and cardamom essential oil to apple juice significantly improve sensory quality and increase health benefits through increasing antioxidant capacity, total phenol content, flavonoid optimal functional drinks. Pletok bir, which features the distinctive taste of spices, has become an integral part of Indonesian culinary culture. With the increasing consumer interest in exploring diverse flavors, the combination of pletok bir with apple juice introduces an intriguing blend of tradition and innovation. The fresh and sweet taste of apple juice adds a new dimension to this drink, creating a more complex and appealing sensory experience. Furthermore, Apple juice contains nutrients such as vitamin C, fiber, and antioxidants, which may prevent oxidative stress and other biomarkers associated with cardiovascular disease risk [11]. From a business perspective, this innovation has the potential to offer a competitive advantage and expand the market by attracting consumers seeking fresh, unique, and diverse beverages.

This study aims to identify the optimal concentration of apple juice as a flavor in pletok bir, so as to produce drinks with the desired physical and sensory properties. The main focus of this study is to determine the concentration of apple juice that is able to provide the best physical characteristics, such as pH and viscosity, as well as superior sensory characteristics, such as color, taste, aroma, and texture. The results of this study are expected to expand the variation of flavors while increasing consumer attractiveness towards pletok bir as a traditional Indonesian drink. Pletok bir, known as the taste of spices, has a significant cultural value in local communities. The addition of apple juice provides an opportunity to combine traditional elements with a touch of innovation. The fresh and sweet taste that is typical of apple juice creates a new dimension in the sensory experience of pletok bir, making it more diverse and attractive. In addition, the antioxidant content in apple juice offers additional health

benefits, so that the pletok bir has the potential to become a typical Betawi functional drink that is more relevant to the needs of modern consumers.

2. Materials and Methods

2.1 Materials

The materials used in this study are based on [12] with modifications, namely white ginger, apples 'Royal Gala' variety, lemongrass, cinnamons, nutmeg, secang wood, pandan leaves, granulated sugar, water and clove obtained at UD. Ayu. Tools used in the manufacture of apple juice and pletok bir are pan, stove, knives, talenan, spoon, filtering, measuring cup, Philips blender, apple Peeler, digital scales (Fuji), basin, pan, gas stove (Rinnai), plastic gloves (STP), container, analytical balance (Shimadzu), aluminum cup, pH meter, beaker (Pyrex), volumetric flask (Pyrex), volume pipette (Pyrex), tissue (Paseo). This research was conducted in November 2024 at the Food Processing Laboratory and Food Analysis Laboratory, Faculty of Agricultural Technology, Udayana University.

2.2 Design and Data Analysis

The experimental design used in this study was a simple Randomised Group Design (RBD) with the treatment of the addition of apple juice at different concentrations and each treatment was replicated four times, resulting in a total of 12 experimental units. Data obtained from the observations will be statistically analysed using variance analysis with the help of Minitab 19. If there is an effect of treatment on the variable $P < 0.05$, then the test is continued with the Tukey Difference Test. The ratio of apple juice to pletok bir in this study was adapted from the method by [13], with several modifications. The selected ratios 1:1 (P1) and 3:1 (P2) was designed to test the incremental effects of apple juice addition. The 1:1 ratio represents an equilibrium between apple juice and pletok bir, while the 3:1 ratio intentionally prioritizes apple juice to evaluate the limits of sensory acceptance (taste, aroma) and physical stability (pH, viscosity) without obscuring the traditional identity of pletok bir. The treatments in this design are:

- P0: Control (Original Bir Pletok)
- P1: Ratio of apple juice to bir pletok = 1:1
- P2: Ratio of apple juice to bir pletok = 3:1

2.3 Pletok Bir Preparation

The process of making apple juice refers to the method developed by [14], with several modifications. The first step is to wash the apple using running water thoroughly to remove the dirt. After that, the apples are peeled to ensure cleanliness and remove residues that may be on the skin. Apples that have been peeled are then cut into small parts to facilitate the refining process. Furthermore, 500 grams of apples are weighed, then mashed using a blender with an additional 250 ml of water. Apple juice produced from this process is then filtered using a fine filter to separate the pulp, so that pure apple juice is ready for use.

The process of making pletok bir refers to [15], with several modifications. The initial stage starts from the sorting of raw materials, namely spices such as lemongrass, cinnamon, nutmeg, sappan wood, and pandan leaves are washed thoroughly to remove dirt, and the rotten parts are eliminated. White ginger is cut into small pieces, peeled, and washed clean using running water. After that, weigh 50 grams of white ginger, 16.3 grams of cinnamon, 3.1 grams of nutmeg, and 1.1 grams of clove. White ginger and lemongrass are crushed to release the maximum aroma. Water is heated in a pan to boil at 95°C - 105°C, then add 16 grams of lemongrass, 12 grams of pandan leaves, and the previously weighed materials,. This stew is cooked with the lid closed for 30 minutes. Furthermore, 12 grams of sappan wood and 100 grams of sugar are added to the stew and cooked for 3-5 minutes until the color of the water turns red. After that, the pletok bir is filtered to separate the spice pulp. Pletok bir that has been

filtered is divided according to the research treatment. Apple juice with a ratio of 1: 1 and 3: 1 is put into a pletok bir according to the volume of each treatment, then boiled briefly using low heat for 10 minutes. Package each treatment of pletok bir separately for further analyzes.

2.4 Physical Characteristics

PH testing refers to the method done by [16]. PH testing is carried out using a pH meter. The pH meter is dipped in the sample then wait until the indicator number appears on the pH meter screen which shows the sample pH value.

Viscosity testing refers to the method carried out by [17]. The viscosity value is determined by means of the sample inserted in the Ostwald pipe then the sample is sucked until it reaches the top of the tera sign on the Ostwald pipe. After that, open the pipe hole simultaneously and activate the time to calculate the length of time needed until the sample drops and reaches the lower terra sign.

2.5 Sensory Evaluation

The evaluation is referred to as a hedonic test. Pletok bir samples were presented in a randomized order and code-labelled to 30 untrained panelists to minimize bias. Panelists evaluated the quality of the Pletok bir samples in the organoleptic test which included color, aroma, taste, and overall acceptance. The scales used in the evaluation were in numbers ranging from 1 to 5, with 1 = not liked; 2 = slightly not liked; 3 = neutral; 4 = slightly liked; and 5 = liked. Each sample was then tested according to the parameters observed and then continued with the data analysis process.

3. Results and Discussion

3.1 Physical Properties

Based on the pH test result, pletok bir (control treatment) has a pH of 7.33. The addition of apple juice can reduce the pH of pletok bir to 4.26 and 4.31. This shows that the natural acid content in apples can contribute to a decrease in the pH of pletok bir. The acidity of apple juice is attributed to acid polyphenols and the release of natural acids from the fruit, which is enhanced by high pressure-induced cell structure damage during the destruction process [18]. According to [19], the pH value in apple juice ranges from 3.04 in the 'Bobovec' variety to 3.69 in the 'Fuji' variety. The pH test results in this study are in line with the findings [20], which shows that the pH of apple juice without the addition of sugar is 4.86 and has decreased in line with the addition of sugar. This supports the conclusion that the addition of certain materials, such as apple juice, can reduce the pH of pletok bir due to the acid content of apples, as seen in the treatment variations in this study. The release of polyphenols due to the breakdown of cell membranes and walls can increase the acidity of freshly squeezed apple juice [21], The pH and viscosity of pletok bir enriched with apple juice can be seen in Table 1.

Table 1.
The pH and viscosity of Pletok bir enriched with apple juice

Treatment	pH	Viscosity
Control	7,33	0,107
Ratio 1:1	4,26	0,238
Ratio 3:1	4,31	0,125

According to Table 1, the viscosity of Pletok bir increased from 0.107 in the control treatment to 0.125 (P2) and 0.238 (P1). Viscosity is one of the physical properties that can be measured in food testing, including in apple fruit juice. Although the addition of apple juice increased the viscosity of Pletok bir, the viscosity value of P2 was lower compared to P1. This phenomenon likely occurs because,

in P1, pectin forms a gel network more effectively, thereby increasing the final mixture's viscosity. The interaction between polysaccharide components in apples (pectin) and the solid content in apple juice is suspected to be the main cause. Pectin in apple juice plays a role in forming gels when binding with sugar at a specific pH, thereby increasing viscosity [22], [23]. The most significant factors are the degree of esterification of the pectin in the juice and the presence of calcium ions [24]. The solid content in apples, such as sugars and organic acids, plays a crucial role in increasing the viscosity (thickness) of processed apple Moreover, besides being a sweetener, sugar helps raise the solid content in the product, thereby enhancing the viscosity of pletok bir.

3.2 Sensory Evaluation

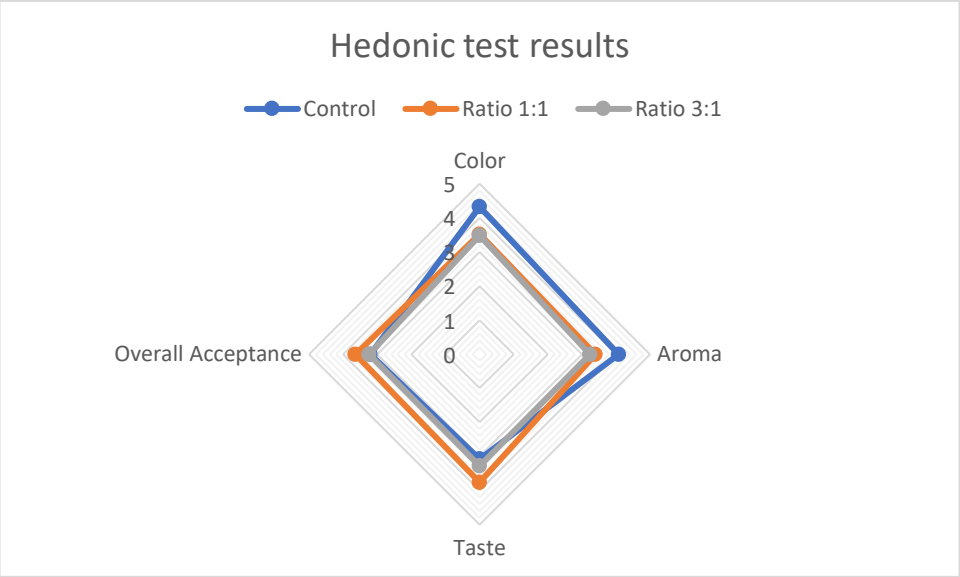

Figure 1.
Hedonic test Pletok Bir Enriched with Apple Juice

Color

Color is one of the quality factors that can attract the attention of consumers because colors give the impression whether the food is liked or not. Based on Figure 1. Hedonic test results, the addition of apple juice to the pletok bir has a very significant effect on the color of the pletok bir ($p < 0.01$). Treatment for the addition of apple juice to the pletok bir with a ratio of 3:1 is not significantly different from the addition of apple juice to the pletok bir with an additional 1: 1. The addition of apple juice to the pletok bir produces a brown color so it is less liked by consumers because it deviates from the color of the brownish red pletok bir. Similar results were also reported by [25] that apples in the formulation of apple juice affect the orange color of the carrot where the apples are browning caused by the enzyme polyphenol oxidase to cause color differences in the juice. Enzymatic and non-enzymatic browning are two different mechanisms that cause color changes in various food products. In apples, enzymatic browning is mainly caused by the activity of the Polyphenol Oxidase (PPO) enzyme, which catalyzes the oxidation of phenolic compounds and produces a dark colored pigment called melanin [26]. Browning in apple juice is likely to occur due to mild heat exposure during the process of blending apples in to apple juice [27]. The blending process can generate a small amount of heat, which may trigger enzymatic or non-enzymatic reactions, leading to color changes in the apple juice.

Aroma

Aroma is crucial for product acceptance; unpleasant smells can lower consumer ratings. Adding apple juice significantly affects the aroma ($P<0.05$). However, the 3:1 and 1:1 ratios of apple juice don't differ significantly in their effect on aroma. The control group (no apple juice) scored highest at 4.08 (liked). According to research [28], apple juice has increased levels of acetate and furfural esters during the browning reaction, which can potentially increase the product's sweet aroma. However, in making pletok bir, adding apple juice involves thermal treatment (heating). This can affect the stability of volatile compounds in apple juice, including aroma-giving compounds. Previous research [29] stated that thermal treatment of apple juice affects consumer perception of apple juice due to the loss of several components of aroma in juice. The loss of several volatile components in this apple juice results in the aroma of apple juice no longer typical of apples. According to the study by [30], apple juice contains 37 volatile compounds, the majority of which are esters (20 compounds), followed by alcohols (7 compounds), aldehydes (4 compounds), phenols (4 compounds), one terpenoid, and one acid. The key compounds responsible for generating the apple juice's aroma are hexyl acetate and hexanol.

Taste

The hedonic taste test aims to evaluate the flavor characteristics of the product, including strength, intensity, quality, and harmony. Based on the hedonic test results, the addition of apple juice to pletok bir had a significant effect on its taste profile ($P < 0.01$). The optimal ratio of 3:1 (P2) successfully neutralized the spicy taste of ginger without compromising the drink's distinctive identity, leading to higher acceptability among panelists. On the other hand, the 1:1 ratio resulted in a flavor that retained some natural bitterness of pletok bir, while the dominance of apple juice created an imbalance between the fruit's sweetness and the drink's characteristic profile. This disrupted flavor harmony, ultimately reducing panelist acceptance. Additionally, increasing the apple juice quantity further reduced natural bitterness, achieving a more harmonious flavor balance. These findings align with [13], which reported that adding pineapple to herbal spice drinks (e.g., those containing cinnamon bark, star anise, coriander, clove, white cumin, and cumin) can reduce sharp acidity and enhance balanced sweetness, improving overall sensory appeal. Similarly, [31] found that cucumber juice formulations enriched with polyphenol-rich clove extract received the highest sensory ratings for both taste and aroma.

Overall Acceptance

The acceptance test aims to evaluate the panelists' assessment of a product's properties or qualities that influence its likability. According to Figure 1, the addition of apple juice to pletok bir did not significantly affect overall acceptance ($P>0.05$), with average hedonic scores ranging from 3.2 to 3.64 (neutral to somewhat liked). Among the formulations tested, the 3:1 ratio achieved the highest score (3.64), followed by the 1:1 ratio, while the control treatment registered the lowest value. Visually, the pletok beer with the 3:1 ratio exhibited a brownish hue due to the apple juice, with an aroma that combined spices with a hint of apple and a taste similar to the control but with a slightly acidic note from the apple juice. Overall, the addition of apple juice did not significantly change the panelists' acceptance of the pletok bird's taste. Similar results were reported by [10], stating that apple juice enriched with dietary fiber, ginger extract, and cardamom essential oil can enhance mouthfeel and improve the product's color, thereby increasing overall product acceptance. [32] demonstrated that apple juices fortified with aqueous herbal extracts namely lemon balm, oregano, and salvia exhibited superior sensory attributes as evaluated by panelists when compared to conventional apple juice. The release of polyphenols due to the breakdown of cell membranes and walls boosts the acidity in freshly squeezed apple juice. This acidity is crucial as it defines the juice's taste, brightness, appearance, aroma, and overall sensory enjoyment, ensuring a more delightful drinking experience [20].

4. Conclusion

Based on the test results, a 3:1 apple juice ratio was identified as the optimal concentration to enhance the flavor of pletok bir. Although panelists tended to prefer the traditional aroma and criticized the brownish discoloration caused by apple juice, the 3:1 ratio achieved the highest taste preference (somewhat liked) compared to the control. This ratio also maintained acceptable physical properties, with a controlled decrease in pH (from 7.33 to 4.31) and a moderate increase in viscosity (0.107 to 0.125), ensuring minimal deviation from the drink's original characteristics. Despite neutral overall acceptability (hedonic score of 3.64), the 3:1 formulation successfully balanced innovation and tradition enhancing sweetness, reducing bitterness, and preserving the identity of pletok bir. Future research should focus on integrating natural color stabilizers to address panelists' rejection of the brownish discoloration while retaining the flavor-enhancing benefits of apple juice.

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