

Original Research Article

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Comparison Effect of Coconut Sap and Lime (*Citrus aurantifolia*) on the Chemical and Sensory Characteristics of Coconut Sap Beverages

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ABSTRACT

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Coconut sap is a liquid that has a sweet taste and has the potential to be developed as a beverage product. The combination of coconut sap and lime can produce a more attractive sensory and flavor combination in new product development efforts. The aim of this research is to examine the ratio effect of coconut sap and lime to develop coconut sap as a beverage product. The method in this research was a Completely Randomized Design (CRD) with comparison of coconut sap and lime consisting of 6 levels, such as F0 (100%: 0%), F1 (97.5%: 2.5%), F2 (95%: 5%), F3 (92, 5%; 7.5%), F4 (90%; 10%) and F5 (87.5%; 12.5%). Each treatment was repeated 3 times, so there were 18 experimental units obtained. The research data was then analyzed statistically using analysis of variance and if the treatment had a significant effect on the observed variables, it was continued with Duncan's Multiple Range Test (DMRT). The results of phase I showed the formulation of coconut sap and lime had a very significant effect ($P < 0.01$) on all parameters, with the best ratio is 95% coconut sap and 5% lime which has pH 4.03, total dissolved solids 9.5%, total sugar 36.4%, vitamin C 1.06 mg/g, sensory assessment of the color, aroma, taste and the overall acceptance was very preferred.

Introduction

Nira is a sweet liquid obtained from the juice of stems or the sap of flower bunches of plants such as sugar cane, beetroot, sorghum, maple, siwalan, dahlia flowers and plants from the palm family such as sugar palm, coconut, nipah, sago, date palm and so on (Baharuddin *et al.*, 2007). The amount of coconut sap production in Indonesia has increased along with the increase in coconut cultivation. Indonesia has the largest coconut plantation land in the world with an area of 3,892,434

hectares or 32.2% of the world's coconut land area, which is around 12 million hectares and is spread almost evenly throughout the territory of the Unitary State of the Republic of Indonesia (Dirjen Perkebunan, 2021). Coconut sap is generally used as a raw material for making brown sugar. Fresh coconut sap has a pH of 7.16 and is known to contain a water content of 88.40%; sugar content 9.3%; protein content 0.01%; fat content 0.3%; minerals 0.38%; polyphenols 0.05% and vitamins 0.04% (Femi *et al.*, 2020; Barh & Mazumdar, 2008). The nutritional and bioactive components in coconut sap have

the potential to be used as health drinks or functional drinks (Tulalo & Mawardi, 2018). According to Femi *et al.*, (2020) Consuming coconut sap regularly can prevent various diseases, such as jaundice, diabetes, cancer, electrolyte deficiencies, hair loss, and can maintain digestive health. Kusumawaty *et al.*, (2012) reported that coconut sap has greater economic value when processed into beverage or vinegar products.

Utilizing other sources of ingredients as a mixture in coconut sap drinks needs to be done to produce a more attractive and preferred sensory and flavor combination (Gunawardhana *et al.*, 2018) reported that the addition of lemon extract in making ready-to-drink coconut sap produced a taste that the panelists liked. However, lemons tend to be more difficult to obtain and expensive.

Another alternative ingredient that can be used is lime. Limes are easier to obtain and have a more affordable price. Based on data (Badan Pusat Statistik, 2023), lime production in Indonesia in 2021 will be 33,511 tons and will increase to 53,457 tons in 2022. Lime is known as a fruit that can be used as an electrolyte solution because of its high content of several types of minerals and citric acid (Salafa *et al.*, 2020). According to Angraini (2015), lemon and lime juice squeezed from the fruit contain quite high levels of citric acid (48 and 46 g/L respectively). Lime also contains many active compounds including vitamin C, alkaloids, phenols, flavonoids, terpenoids, steroids which act as antioxidants and essential oils which provide a distinctive aroma and flavor.

Therefore, the aim of this research is to determine the effect of the ratio of coconut and lime juice on the chemical and sensory characteristics of the drink produced and to determine the ratio of coconut and lime juice which produces the best chemical and most preferred sensory characteristics.

Materials and Methods

The raw materials used in this research consisted of coconut sap obtained from coconut farmers in the Sibang, Abiansemal area and lime obtained from Badung Market, Denpasar, Bali.

Research Methods

The research method used in this research is an experimental method Completely Randomized Design

(CRD) comparing coconut sap concentration and lime concentration consisting of 6 comparison combinations, each treatment was repeated 3 times to obtain 18 experimental units as follows (Nusi *et al.*, 2022) modified.

Making Coconut Juice and Lime Drink

The process of making this coconut sap and lime drink adopts research procedures (Gunawardhana *et al.*, 2018) by modifying the type of material used, namely in this study using lime. Fresh coconut sap obtained from farmers has its pH measured (7-7.4) then filtered using a filter cloth. The sap which has a neutral pH is then pasteurized at 70°C for 15 minutes. Limes are sorted to separate those that are suitable for processing and those that are not.

The limes that have been sorted are cleaned using running water. The lime is then split and squeezed. The comparison of coconut and lime juice was made in a volume of 100 ml (v/v). Coconut sap was then measured at 87.5%, 90%, 92.5%, 95%, 97.5% and 100%. Then lime juice was added to each coconut sap treatment, namely 12.5%, 10%, 7.5%, 5% and 2.5%.

Before the drink is put into bottles, the bottles are sterilized first. The drink is then filled in sterile bottles while hot (hot filling). Then it is closed (seal) and the drink is pasteurized again for 10 minutes at 100°C, then cooled. Next, the drink is stored in the refrigerator at a temperature of 4°C.

Test Parameters

The test parameter analyzed is pH (National Standardization Agency, 2022), total dissolved solids (AOAC, 2005) total sugars using the Nelson-Somogyi method (Dewi *et al.*, 2017), vitamin C using a spectrophotometer (Rantung *et al.*, 2022) and sensory evaluation (Ayustaningwarno *et al.*, 2020).

Data analysis

Experimental design in the research. Data obtained in phase I and phase II research were analyzed using variance (ANOVA) and if there was an effect of treatment on the observed variables, it was continued with the Duncan test (Gomez, 1995). The best treatment in phase I and phase II research is determined through the treatment that has the best criteria for each test variable.

Results and Discussion

Phase 1 Research Comparison of Coconut Juice and Lime in Liquid Drink Form

pH

The results of the diversity analysis showed that the ratio between coconut juice and lime had a very significant effect ($P < 0.01$) on the pH of the coconut juice and lime drink in liquid form. The results of the pH analysis of coconut sap and lime drinks ranged from 3.36 – 6.63. The average pH value of coconut sap and lime drinks in various comparisons can be seen in Table 2. Based on Table 2, the results show that the pH of coconut sap drinks is the highest, namely in the comparison of 100% coconut sap and 0% lime (F0) of 6.63 and the lowest was the ratio of 87.5% coconut sap and 12.5% lime (F5) of 3.36. The decrease in pH value is thought to be due to the high acid content in limes, one of which is citric acid (Gozali *et al.*, 2023). The decrease in pH is caused by the high acid content in limes.

According to Hamid *et al.*, (2016) lime is rich in citric acid and other organic acids. The total acid value is negatively correlated with pH, the higher the total acid value, the lower the pH value. Fresh coconut juice generally has a neutral pH ranging from 7-7.4, while lime is known to have a low pH ranging from 2.48-2.5 (Rochmah *et al.*, 2014). This is one of the causes of a decrease in the acidity level or pH of coconut and lime juice drinks. Fardiaz (1996) reported that the pH of food and drinks is influenced by the acid content naturally found in food ingredients. This is also supported by a statement from Saprian *et al.*, (2014) that the citric acid content in limes can lower the pH.

A high concentration of lime can give a sour taste which can affect product acceptability. On the other hand, the addition of a low concentration does not have a significant effect on reducing the pH, thereby affecting the criteria for the product to be produced. Similar research results occurred in research Hamidatun *et al.*, (2023) which states that the higher the concentration of lime and granulated sugar added to the tempe juice drink, the pH value decreases. Based on this, the pH of coconut sap and lime drinks is influenced by increasing the concentration of lime combined with coconut sap, resulting in a pH that tends to decrease. Research result Assalam *et al.*, (2023) Optimizing the lime drink formula showed that the pH value of 10 lime drink formulations

ranged from 2.76 to 2.9. The higher the concentration of lime added, the higher the acid produced and the measured pH value will be lower.

Total Dissolved Solids

The results of the diversity analysis showed that the ratio between coconut and lime juice had a very significant effect ($P < 0.01$) on the total dissolved solids of the coconut and lime juice drinks in liquid form. The results of the analysis of total dissolved solids of coconut and lime juice drinks ranged from 11.9 to 7.90Brix. The average value of total dissolved solids for coconut and lime juice drinks in various comparisons can be seen in Table 2. Total dissolved solids are organic and inorganic compounds dissolved in a liquid. Based on Table 2, the results show that the total dissolved solids of the coconut sap and lime drink were the highest, namely at a ratio of 100% coconut sap and 0% lime (F0) of 11.9 0Brix and the lowest was at a ratio of 87.5% coconut sap and 12.5% lime (F5) of 7.9 0Brix. Increasing the lime ratio can reduce the total dissolved fat significantly. The decrease in total marine solids was caused by a reduction in coconut juice in drinks. Coconut sap has a high sugar content which can increase total dissolved solids (Mela & Wijonarko, 2020). According to Yolandari (2021), total solids are positively correlated with total sugars as organic compounds.

The decrease in total soluble solids occurred along with the reduction in the percentage of formulated coconut sap. The total dissolved solids value can be caused by the total amount of sugar contained in a solution. According to research Nusi *et al.*, (2022) The higher the sugar concentration in the isotonic sugarcane juice drink, the higher the total dissolved solids. Nurfalia (2023) stated that the increase in total dissolved solids was related to the amount of solids added in the process of making processed lime drinks. The addition of sucrose (sugar) can increase the total dissolved solids. The higher the added sugar concentration, the greater the total dissolved solids value. According to Istianah (2019), sugar is hygroscopic so it dissolves easily in water. The total dissolved solids content of a food ingredient includes produced sugar, non-produced sugar, organic acids, pectin and protein.

Total Sugar

The results of the diversity analysis showed that the ratio between coconut juice and lime had a very significant

effect ($P < 0.01$) on the total sugar of the coconut juice and lime drink in liquid form. The results of the analysis of the total sugar of coconut sap and lime drinks ranged from 31,324 - 40,226%. The average total sugar value of coconut sap and lime drinks in various comparisons can be seen in Table 2. Based on Table 2, it can be seen that the highest total sugar in the combination of coconut sap and lime drinks was obtained in the F0 comparison, namely 15.771%. Comparison of F5 being the treatment with the lowest total sugar of 8.796%. Increasing the lime ratio can reduce total sugar. A significant decrease in total sugar occurred between the addition of 2.5% lime; 7.5%, and 12.5%. This is caused by the presence of high total sugar in coconut sap. Reducing the amount of coconut sap means the total sugar of the drink decreases. Coconut sap contains 13-17% total sugar (Muchtadi *et al.*, 2013).

Total sugar content is the total sugar content in a food ingredient which consists of reducing sugars and non-reducing sugars. The total types of sugar are monosaccharides, disaccharides, oligosaccharides and polysaccharides. The total sugar content is not only sugar that can reduce but non-reducing sugar will also be calculated (Rohman and Soemantri, 2007). The higher the sugar concentration in the ingredients used, the greater the amount of sugar measured will be because sucrose is a non-reducing sugar, reducing sugar and organic acids formed are counted as total sugar.

Vitamin C

The results of the diversity analysis showed that the ratio between coconut juice and lime juice had a very significant effect ($P < 0.01$) on vitamin C from coconut juice and lime drinks in liquid form. The results of the vitamin C analysis of coconut sap and lime drinks ranged from 9.85-11.77%. The average value of vitamin C for coconut sap and lime drinks in various comparisons can be seen in Table 2. Based on Table 2, it can be seen that the highest vitamin C in the combination of coconut sap and lime drinks was obtained in the F5 ratio, namely 11.77%. The F0 formulation was the treatment with the lowest vitamin C at 9.85%. This shows that, the higher the concentration of lime juice added, the greater the measured vitamin C levels will be. Increasing the ratio of lime shows a significant increase in vitamin C starting from the addition of 7.5% of lime. The highest addition of 12.5% did not experience a significant increase in vitamin C with 7.5%. Thus, the increase in vitamin C

occurred at a certain concentration of adding lime, namely at a concentration of 7.5%. This is because lime is known to be a source of vitamin C while coconut sap has a low vitamin C content. High concentrations of vitamin C in lime, starting from 7.5%, can contribute to increasing the vitamin C of coconut juice drinks. Coconut sap contains vitamin C but in relatively lower amounts compared to lime.

An increase in vitamin C can also be caused by lower levels of sugar or sucrose. This is because higher sugar levels can accelerate the rate of vitamin C degradation, so that vitamin C levels decrease. The sugar present can cause a lot of water to come out so that it can dissolve vitamin C.

Sensory Evaluation

Sensory evaluation is a subjective measurement because it is based on subjective human responses as a measuring tool (Ayustaningwarno *et al.*, 2020).

Color

The results of variance analysis showed that the ratio of coconut and lime juice had a very significant effect ($P < 0.01$) on the hedonic color of the coconut and lime juice drinks. Based on table 3, the average panelist gave a color liking level of 2.13 – 4.80 with the criteria of not liking it to liking it very much. Comparison of 95% coconut sap and 5% lime (F2) with the highest average value of 4.80 which is also not significantly different from the comparison of 92.5% coconut sap and 7.5% lime (F3) with the average 4.60. The lowest value was in the ratio of 87.5% coconut sap and 12.5% lime. This is because the lime color component when added at a high concentration, starting from 10%, can affect the color of the coconut sap drink. Color changes due to the addition of high amounts of lime can reduce the level of color preference for coconut sap drinks.

Aroma

The results of variance analysis showed that the ratio of coconut and lime juice had a very significant effect ($P < 0.01$) on the hedonic aroma of the coconut and lime juice drinks. The effect of the ratio of coconut juice and lime on the hedonic aroma of coconut and lime juice drinks can be seen in Table 3.

Table.1 Comparison of Coconut Nira and Lime Drinks

Code	% Coconut Palm	% Lime
F0	100%	0%
F1	97.5%	2.5%
F2	95%	5%
F3	92.5%	7.5%
F4	90%	10%
F5	87.5%	12.5%

Table.2 Average test values for pH, TPT, total sugar and vitamin C for coconut and lime juice drinks

Sample	pH	TPT	Total Sugar	Vitamin C
F0 (100%:0%)	6.63 ± 0.05a	11.9 ± 0.05a	15,771 ± 0.419a	9.85 ± 0.028c
F1 (97.5%:2.5%)	4.13 ± 0.05b	10.9 ± 0.05b	14,216 ± 0.358b	9.96 ± 0.080c
F2 (95%:5%)	4.03 ± 0.05b	9.5 ± 0.05c	13,241 ± 0.062b	10.56 ± 0.015bc
F3 (92.5%:7.5%)	3.67 ± 0.05c	8.7 ± 0.05d	11,057 ± 0.577c	11.10 ± 0.073ab
F4 (90%:10%)	3.56 ± 0.05d	8.4 ± 0.05e	9,749 ± 0.561cd	11.56 ± 0.040ab
F5 (87.5%:12.5%)	3.36 ± 0.05e	7.9 ± 0.05f	8,796 ± 0.994d	11.77 ± 0.066a

Note: different letters behind the average value in the same column indicate a significant difference (P≤0.05)

Table.3 Average value of hedonic test for color, aroma, taste and overall acceptability of coconut and lime juice drinks

Sample	Color	Aroma	Flavor	Overall Acceptance
F0 (100%:0%)	3.00±0.84 c	3.13±0.63 c	3.47±0.83 c	3.40±0.73 c
F1 (97.5%:2.5%)	3.93±0.25 b	4.00±0.63 b	4.13±0.51 b	4.07±0.45 b
F2 (95%:5%)	4.80±0.41 a	4.73±0.45 a	4.80±0.41 a	4.73±0.63 a
F3 (92.5%:7.5%)	4.60±0.63 a	4.07±0.45 b	4.73±0.59 a	4.67±0.61 a
F4 (90%:10%)	2.33±0.81 d	2.40±0.63 d	2.40±0.63 d	2.47±0.91 d
F5 (87.5%:12.5%)	2.13±0.35 d	2.27±0.45 d	2.33±0.61 d	2.33±0.72 d

Note: different letters behind the average value in the same column indicate a significant difference (P≤0.05)

Based on Table 3, four comparisons of coconut juice and lime on the aroma of the drink were acceptable to the panelists while the other two were not liked by the panelists.

On average, the panelists gave a score ranging from 2.27 – 4.73 with the criteria of not liking it to liking it very much. The ratio of 95% coconut sap and 5% lime is the hedonic aroma of the coconut sap and lime drink that the panelists like most with an average value of 4.73.

Flavor

The results of variance analysis showed that the ratio of coconut juice and lime juice had a very significant effect (P<0.01) on the hedonic taste of the coconut juice and

lime drink. The effect of the ratio of coconut juice and lime on the hedonic taste of the coconut juice and lime drink can be seen in Table 3. Based on Table 3, four comparisons of coconut juice and lime on the taste of the drink were acceptable to the panelists while the other two were not liked by the panelists. On average, the panelists gave a score ranging from 2.33 – 4.80 with the criteria of not liking it to liking it very much.

The ratio of 95% coconut sap and 5% lime (F2) is the hedonic taste of the coconut sap and lime drink with the highest average value of 4.80 which is also not significantly different from the comparison of 92.5% coconut sap and 7.5% lime (F3) with an average of 4.73 where the two comparisons were most liked by the panelists in terms of taste characteristics.

Overall Acceptance

The results of variance analysis show that the ratio of coconut and lime juice has a very significant effect ($P < 0.01$) on the overall hedonic acceptance of coconut and lime juice drinks.

The effect of the comparison of coconut juice and lime on the overall hedonic acceptance of the coconut juice and lime drink can be seen in Table 3. Based on Table 3, four comparisons of coconut juice and lime on the overall acceptance of the drink were acceptable to the panelists while the other two were not liked by the panelists.

On average, the panelists gave a score ranging from 2.27 – 4.73 with the criteria of not liking it to liking it very much. The comparison of 95% coconut sap and 5% lime produced hedonic overall acceptance of the coconut sap and lime drink which was most liked by the panelists with an average value of 4.73.

The results of the analysis of the acceptability of coconut and lime juice drinks showed that the comparison of the concentrations of coconut and lime juice had a very significant effect ($P < 0.01$) on pH, total dissolved solids, total sugar, vitamin C, hedonic color, aroma, taste and acceptability.

Overall as well as scoring color, aroma and taste. The best comparison results for the concentration of coconut and lime juice were obtained in a comparison of 95% coconut juice and 5% lime with characteristics of pH 4.03, total dissolved solids 9.5%, total sugar 36.4%, vitamin C 1.06 mg/ g, as well as sensory assessments of color, aroma, taste and overall reception was very favorable.

Author Contributions

Ni Komang Ayu Nila Ratna: Investigation, formal analysis, writing—original draft. Gusti Ayu Kadek Diah Puspawati: Validation, methodology, writing—reviewing. I. Nengah Kencana Putra:—Formal analysis, writing—review and editing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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