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Sensory Qualities of Coconut Water Vinegar as Influenced by Maturity Indices and Sugar-Yeast Ratio: Product Packaging and Labeling Evaluation

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Abstract

Coconut water is the clear, naturally sweet liquid found inside young, green coconuts, known for being a refreshing, low-calorie, and electrolyte-rich beverage. It differs from coconut milk, which is a thicker product made from the grated flesh of mature coconuts.

This study assessed the influence of coconut maturity stages and sugar-to-yeast ratio on the sensory quality and commercial viability of coconut water vinegar. The research addresses the underutilization of coconut water by converting it into a high-value product through fermentation. A 3×4 factorial experiment arranged in a Randomized Complete Block Design (RCBD) was employed, testing three coconut maturity indices, young (3 to 4 months), rubber (5 to 6 months), and shaker (7 to 8 months), with four sugar-to-yeast ratio (from ½ cup sugar:1 teaspoon yeast to 2 cups sugar:4 teaspoon yeast). The vinegar was assessed through sensory evaluation (taste, aroma, color, appearance, texture, and general acceptability), physicochemical analyses (pH, Brix, and alcohol content), and preferential tests. Results revealed that both factors, including their interaction, significantly affected all sensory and chemical properties ($p < 0.001$). The combination of young coconut water with the highest sugar-to-yeast ratio (2 cups sugar:4 teaspoons yeast) produced the most favorable outcomes in terms of taste, aroma, clarity, acidity, and consumer acceptability. Treatments using shaker-stage coconut water also demonstrated high sensory scores due to its complex aromatic compounds. Furthermore, the return on investment (ROI) analysis indicated that the best-performing formulations are economically viable for small-scale production. The evaluation also revealed that coconut water vinegar exhibits excellent packaging and labeling quality, particularly in terms of container durability, environmental sustainability, and branding. However, minor improvements are recommended in container design, storage capacity, and the clarity of manufacturer and expiration date information. The findings presented the potential of converting leftover coconut water into a marketable, sustainable product with strong sensory appeal and economic value. This approach reduces agricultural waste and provides alternative livelihood opportunities for coconut farmers.

Keywords: *Coconut water, Commercial viability, Fermentation, Sensory evaluation, Sugar-yeast ratio*

1.0 Introduction

Coconut (Cocos nucifera) has thrived for millions of years across nearly all tropical regions, earning the eulogistic epithet "Tree of Life" among the people of the tropics (Henrietta et al., 2022). This title reflects the palm's remarkable ability to provide essential needs such as food, fuel, medicine, and shelter. The fruit of the coconut palm produces coconut meat, from which coconut oil, coconut milk, and copra meal are produced. It also contains coconut water, particularly prized from young coconuts, which serves as a refreshing and nutritious beverage (Balaji & Abinaya, 2024).

Large quantities of fruit are produced and wasted yearly because of overproduction or because they are classified as second or third quality. According to Luzón-Quintana et al. (2021), citing the Food and Agriculture Organization (FAO), approximately 21.6 percent of global fruits are wasted during postharvest distribution. Often, the fruit is rejected solely based on its perceived imperfection or insufficient size, even if it is perfectly edible. Although some surplus is processed into products such as fruit preserves, juices, or jams, a significant proportion is left in the field or immediately disposed of as waste. These practices contribute to environmental and economic problems, including pollution and rising market prices due to inefficient use of resources. Therefore, finding alternative ways of using surplus fruit is essential to mitigate the negative impact on the fruit sector. Some possible solutions, particularly relevant to the vinegar sector, include macerating fruit in vinegar, enriching the vinegar with fiber from fruit, or using the fruit directly in vinegar production (Quintana et al., 2021).

Coconut water vinegar is tasty and nourishing, which makes it an excellent way to reuse otherwise wasted mature coconut water. Vinegar is a sour liquid obtained by fermentation of alcohol and sugars. It is an essential condiment that enhances the taste of different dishes, particularly in Filipino cuisine. Vinegar is a staple ingredient in Filipino cuisine and has become a staple ingredient in everyday food preparation worldwide. According to Dolan (2016), vinegar has impressive functional and therapeutic properties. It works as an antibiotic and antioxidant, helps control blood pressure, and stimulates the growth of new blood vessels. Moreover, the Department of Science and Technology - Industrial Technology Development Institute (2018) emphasized that the yeast-to-sugar ratio significantly affects the quality of coconut juice vinegar fermented over 30 to 90 days.

Although coconut water is often considered a by-product, it is important to human health and economic development (Xu et. Al, 2022). Coconut water may be transformed into high-value vinegar through fermentation (Hasanuddin et al., 2012). The study aimed to contribute to the expanding literature on the safe and efficient production of coconut water vinegar for human consumption. It also aimed to support coconut farmers and processors in maximizing the utility of coconut water, particularly from mature fruits. The study examined the effects of different sugar-yeast ratio and coconut maturity stages that affect the quality of the vinegar and its potential for commercialization.

This study aims this study aimed to determine the effect of different coconut maturity stages and sugar-yeast ratio on sensory qualities of coconut water vinegar. Specifically, the study aimed to;determine coconut water vinegar's sensory quality and acceptability as influenced by coconut maturity stages, evaluate the sensory quality and acceptability of coconut water vinegar as influenced by the sugar-yeast ratio. Lastly determine the interaction effect of different maturity stages of coconut and sugar-yeast ratio on coconut water vinegar's sensory qualities and acceptability.

This study aimed to assist coconut farmers in maximizing the use of coconut water by transforming it into a valuable kitchen condiment, a widely demanded product, thereby providing an additional source of income by converting what is often considered waste into a profitable commodity. Furthermore, the study contributed to producing and supplying high-quality, chemical-free vinegar in the market, promoting better health outcomes for consumers.The results of this research also expanded the current knowledge base, especially on the impacts of varying maturity indices of coconut, the ratio of sugar and yeast, and their combination on the desired quality and value of coconut water vinegar. This information is useful for researchers and practitioners in the field.

2.0 Methodology

2.1 Research Design

The experimented design used in the study was Randomized Complete Block Design (RCBD) arranged in a factorial manner to assess the effects of two factors: the maturity indices of coconut (Factor A) and the sugar-yeast ratio (Factor B) on sensory qualities of coconut water vinegar. Factor A represents the various stages of coconut maturity, while Factor B corresponds to the different proportions of sugar and yeast used during fermentation. Each treatment combination received a sample volume of at least 3000 ml, replicated three times to ensure the reliability and accuracy of the results. The study evaluated the 12 treatment combinations (3 maturity stages × 4 sugar-yeast ratios) and measured their effect on the resulting coconut water vinegar's sensory quality, physicochemical properties, and commercial viability.

2.2 Research Locale

The study was conducted at Purok Pag-asa I, Barangay Cebuano, in the Municipality of Tupi, Province of South Cotabato. The research activities, which include preparing, fermentation, and evaluating coconut water vinegar, were conducted for two months, from February 22, 2025, to April 09, 2025.

2.3 Research Instrument

The materials and equipment used in this study ensured the proper collection, preparation, and analysis of coconut water vinegar. Coconut water was collected from coconuts at different maturity stages, namely the young, rubber, and shaker stages. These different stages of coconut maturity evaluate how the age of the coconut affects the quality of the coconut water vinegar. The sugar mixed was used as a fermentation substrate, providing the necessary sugars that yeast converts into alcohol during fermentation. Yeast, acting as the fermenting agent, converts the sugar in the coconut water into alcohol, which was later converted into vinegar through acetic acid fermentation.

Additionally, strainer separates solid particles from the coconut water during extraction, ensuring that only the liquid portion is used in fermentation. Accurate measurements maintain consistency throughout the experiment, and a measuring cup was used to measure precise quantities of coconut water, sugar, and yeast. The stainless basin serves as the vessel where coconut water, sugar, and yeast were combined and mixed, ensuring proper cleanliness during preparation.

Furthermore, for chemical analysis, the alcohol content of the coconut water vinegar was measured using a refractometer, which provides the refractive index of the liquid, correlating to the alcohol concentration. A pH meter measures the acidity or alkalinity of the vinegar, which was essential for understanding the

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fermentation process and evaluating the product's final quality. The refractometer also measured the Brix level, indicating the sugar content of the coconut water before fermentation. The sugar concentration determines the fermentation potential and evaluates the quality of the final product.

2.4 Production of Coconut Water Vinegar

The selection of coconuts for this study was based on the maturity indices specified under Factor A: young coconuts (3–4 months old), rubber meat stage coconuts (5–6 months old), and shaker stage coconuts (7–8 months old). All coconuts were sourced from a single farm planted with a common variety, Laguna Tall. Harvesting was conducted in one batch between 8:00 to 10:00 a.m. to maintain uniformity in raw material quality.

Immediately after harvesting, the coconuts were transported to the designated processing area. Coconut water was extracted individually according to each maturity group, ensuring that waters from different maturity stages do not mix and that contamination was avoided. A bolo was used to open the coconuts, and the extracted water was filtered using a stainless basin and strainer to remove any impurities. The filtered coconut water was then placed into 555 stainless steel containers, properly labelled according to their maturity group, and prepared for the following processing stage

Mixing sugar follows the treatment levels outlined in Factor B (sugar-yeast ratio). Twenty cups of coconut water from each maturity group were measured using a measuring cup, and sugar was added based on the assigned treatment: 1/2 cup, 1 cup, 1 1/2 cups, or 2 cups of white sugar per liter of coconut water, respectively. The sugar was stirred thoroughly to ensure complete dissolution.

Pasteurization was performed immediately after mixing the sugar. The coconut water mixture was heated to a temperature of 60–65°C for 10–15 minutes to kill unwanted microorganisms without extensively altering the coconut water’s natural properties.

After pasteurization and cooling to ambient temperature, yeast was added according to the treatment specifications in Factor B: one teaspoon, two teaspoons, three teaspoons, or four teaspoons. The yeast was stirred gently and thoroughly until fully dissolved into the solution.

The prepared mixture was then transferred into sterilized 5-liter plastic containers or pails. Each container was covered with a cheesecloth or clean paper and secured tightly using a rubber band and tape to prevent contamination by airborne microorganisms while allowing airflow necessary for fermentation.

The containers were placed in a cool, clean, dry area away from direct sunlight. Special attention was given to preventing contamination by pests; thus, a screen was installed on doors and windows of the storage area to restrict the entry of insects, rodents, and other contaminants. The fermentation process was allowed to proceed for 45 days.

Mother vinegar was added to each container between the fourth and seventh day of fermentation. The addition of mother vinegar accelerates the fermentation process and promotes the formation of acetic acid, which is essential for high-quality vinegar production.

After 45 days, the coconut vinegar was harvested and subjected to final pasteurization. The vinegar was heated gently over low heat for 15–20 minutes using a slow-boiling method. This step aims to eliminate any residual harmful microorganisms that may cause spoilage, ensuring the stability and shelf life of the product.

2.5 Data Gathering Procedure

2.5.1 Chemical Analysis

Chemical analyses were conducted to evaluate the quality of the coconut vinegar. The alcohol content was measured using a refractometer to assess the residual alcohol levels produced during fermentation. The pH level, which indicates the vinegar's acidity, was determined using a pH meter. Additionally, the sugar content, expressed in degrees Brix (°Brix), was measured using a refractometer to determine the residual sugar levels remaining in the vinegar after fermentation. These chemical parameters provide the final product's fermentation completeness, taste balance, and quality attributes.

2.5.2 Sensory Evaluation

Sensory evaluation was conducted with fifty (50) participants, comprising male and female respondents from diverse occupational sectors, to ensure a balanced representation of potential consumers.

2.5.3 Preferential Analysis

Preferential analysis was also conducted to determine the most preferred or favored coconut vinegar treatment based on the participants' overall preferences. Frequency counts of the participants' rankings for each treatment were tabulated, and preference percentages were computed. The treatment that received the highest frequency and percentage of first-choice rankings was considered the most preferred. This analysis supplemented the sensory evaluation by providing a clearer understanding of consumer choice behavior and highlights which product formulation holds the strongest market potential based on consumer preference.

2.5.4 Product Packaging and Labeling Evaluation

The coconut vinegar product packaging and labeling evaluation involved fifty (50) participants. These respondents were carefully selected to represent a broad and balanced demographic, consisting of 20 teachers, 20 students, and 10 individuals directly involved in vinegar production, such as processors, producers, and carinderia cooks. Note that these fifty (50) were the same participants in the sensory evaluation. This purposive and stratified sampling approach ensured diverse consumer insights across different occupational sectors, thereby enhancing the validity and relevance of the data collected.

2.6 Data Analysis

Data collected from the sensory evaluations were subjected to statistical analysis. Mean values were computed for all treatments to determine the central tendencies of the sensory parameters. Analysis of Variance (ANOVA) in Factorial Randomized Complete Block Design (RCBD) was employed to identify whether significant differences exist among treatments. If significant differences were observed, the Least Significant Difference (LSD) test was employed to pinpoint which specific treatments differ significantly. In addition to sensory evaluation analysis, a market viability analysis was performed through a projected cost and return analysis, including the computation of the Return on Investment (ROI), providing insights into the potential

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profitability of coconut vinegar production. The market analysis was based on actual production costs and prevailing market prices to evaluate the feasibility of commercial-scale production.

3.0 Results and Discussion

3.1 Taste Scores of Coconut Water Vinegar as Influenced by Maturity Indices and Sugar-Yeast Ratio in Sensory Evaluation

The sensory evaluation results for the taste of coconut water vinegar as affected by the interaction between coconut maturity indices (Factor A) and sugar-yeast ratios (Factor B).

Table 1. Taste Scores of Coconut Water Vinegar as Influenced by Maturity Stages and Sugar-Yeast Ratio in Sensory Evaluation.

Treatments	Different Maturity Indices of Coconut			Mean (Factor B)
	Young coconut	Rubber Meat	Shakers	
Different Sugar-Yeast Ratio				
1/2 cup sugar:1 tsp yeast	4.51[d]	5.03[c]	5.07[c]	**4.87**[d]
1 cup sugar:2 tsp yeast	5.03[c]	5.02[c]	5.25[b]	**5.10**[c]
1 1/2 cups sugar:3 tsp yeast	5.25[b]	5.07[c]	5.25[b]	**5.19**[b]
2 cups sugar:4 tsp yeast	5.89[a]	4.87[e]	5.29[b]	**5.35**[a]
Mean (Factor A)	**5.17**[b]	**5.00**[c]	**5.21**[a]	

C.V.(%)=0.33

[1]/ Treatment means with the same letter are not significantly different at a 5% level of significance using LSD

Table 1 presents across treatments, B4 combined with young coconut (A1) yielded the highest taste score (5.89), significantly outperforming other combinations. On the other hand, B1 with young coconut (A1) received the lowest score (4.51). The results indicate a significant interaction between maturity index and sugar-yeast ratio, with taste scores varying across both factors. Among the maturity stages, vinegar produced from shaker coconuts (A3) recorded the highest overall mean taste score (5.21), followed closely by young coconut (A1) at (5.17), while rubber meat coconuts (A2) yielded the lowest (5.00). Regarding sugar-yeast ratio, B4 (2 cups sugar:4 tsp yeast) achieved the highest overall mean score (5.35), indicating that a higher sugar and yeast concentration enhances the flavor profile of the vinegar. Means followed by the same letter are not significantly different, and all differences are highly significant at the 0.05 level.The coefficient of variation (CV) is low at 0.33%, indicating high precision and reliability of the sensory scores.

The sensory evaluation results for taste revealed how combining coconut maturity stages and sugar-yeast ratio influenced the coconut water vinegar's overall flavor profile and palatability. Taste, one of the most defining attributes of any vinegar product, was a primary determinant of consumer satisfaction and acceptability. The data demonstrated a statistically significant effect ($p < 0.001$) for all sources of variation, maturity stage (Factor A), sugar-yeast ratio (Factor B), and their interaction (A × B) on the taste scores, with mean values ranging from 4.51 to 5.89 on a 7-point hedonic scale. The sensory quality improvements observed under these conditions align with findings from Ngoc et al. (2016), who reported that coconut water vinegar produced using baker's yeast and Acetobacter aceti starter culture was rated positively across key sensory attributes, including odor, taste, and overall acceptability. Their results support the notion that precise control of fermentation inputs, especially sugar and yeast, is significant to flavor development. Additionally, Gunathilake et al. (2011) found that both coconut toddy and coconut water vinegar were rated highly in sensory evaluations for attributes such as aroma, color, and taste. These findings reinforce that fermentation conditions, including substrate composition and microbial activity, significantly affect sensory outcomes. In the A1B4 treatment, the elevated sugar-to-yeast ratio facilitated dynamic microbial metabolism, enhancing the conversion process while avoiding the accumulation of undesirable metabolites that could lead to bitterness or residual sweetness.

From a product development perspective, modifying fermentation strategies to the specific characteristics of the raw material is crucial for optimizing vinegar quality and ensuring consumer satisfaction. Young or mature coconut water, characterized by lower natural sugar content, often requires the addition of higher sugar and yeast concentrations to achieve complete fermentation and desirable flavor profiles (Jamaludin et al., 2018). For instance, Ngoc et al. (2016) demonstrated that fermenting coconut water with 12% sugar and 0.4% baker's yeast resulted in approximately 6% ethanol within one day, which was then efficiently converted to acetic acid, yielding vinegar with favorable sensory attributes.

3.2 Aroma Scores of Coconut Water Vinegar as Influenced by Maturity Stages and Sugar-Yeast Ratio in Sensory Evaluation

Aroma is a sensory attribute in vinegar quality evaluation, directly influencing consumer preference and marketability. It encompasses a complex interplay of volatile compounds derived from fermentation, contributing to perceptions of freshness, acidity, and pungency. In this study, highly significant differences ($p < 0.001$) were observed for the main effects of coconut maturity indices (Factor A), sugar-yeast ratios (Factor B), and their interaction (A × B), signifying that each factor, individually and in combination, substantially influenced the aromatic profile of the coconut water vinegar.

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Table 2. Aroma Scores of Coconut Water Vinegar as Influenced by Maturity Stages and Sugar-Yeast Ratio in Sensory Evaluation

Treatments	Different Maturity Stages of Coconut			Mean
	Young coconut	Rubber Meat	Shakers	(Factor B)
Different Sugar-Yeast Ratio				
1/2 cup sugar:1 tsp yeast	4.49[h]	5.01[d]	5.03[d]	**4.97**[c]
1 cup sugar:2 tsp yeast	4.89[f]	4.85[e]	5.19[c]	**4.97**[c]
1 1/2 cups sugar:3 tsp yeast	5.23[b]	4.94[e]	5.29[b]	**5.15**[a]
2 cups sugar:4 tsp yeast	5.22[b]	4.77[g]	5.33[a]	**5.11**[b]
Mean (Factor A)	**5.05**[b]	**4.89**[c]	**5.21**[a]	

C.V.(%)=0.25

[1]/ Treatment means with the same letter are not significantly different at a 5% level of significance using LSD

As shown in Table 3 the aroma scores varied between 4.49 and 5.33 on the 7-point Just About Right (JAR) hedonic scale, indicating a general range from moderate to high aroma acceptability. Among the treatments, A3B4 (shaker coconut with 2 cups sugar: 4 tsp yeast) received the highest aroma score of 5.33, suggesting that mature coconuts combined with a higher sugar-yeast ratio yield more desirable aromatic qualities. Conversely, A1B1 (young coconut with 1/2 cup sugar: 1 tsp yeast) registered the lowest score of 4.49, possibly due to underdeveloped fermentation volatiles or weaker substrate conversion.

The highest aroma rating was observed in treatment A3B4 (shaker-stage coconut with 2 cups sugar and 4 teaspoons yeast), which achieved a mean score of 5.33. This combination yielded a vinegar with a rich, clean, and pleasantly tangy aroma that likely stemmed from complete fermentation and the generation of desirable esters and volatile acids. Mature coconuts, especially at the shaker stage, are known to contain elevated levels of complex organic compounds, including amino acids, peptides, fatty acids, and various sugars. These components are essential not only as carbon and nitrogen sources for microbial growth but also important in flavor development during fermentation. For instance, amino acids such as phenylalanine and glutamate serve as precursors in metabolic pathways that lead to the formation of aroma-active compounds, including alcohols and esters. During fermentation, these constituents undergo biochemical transformations that significantly enhance the aromatic and sensory profiles of the final product, such as coconut water vinegar. Studies have shown that fermenting matured coconut water with appropriate microbial strains results in a product rich in volatile compounds and essential nutrients, underlining the importance of raw material composition in product development (Zhang et al., 2018; Xu et al., 2022).

The aroma results affirm that the coconut water's chemical composition and the fermentation intensity are critical for developing appealing vinegar aromas. Treatments A3B4 and A1B4 stand out for their ability to generate vinegar with clean, attractive, and consumer-acceptable aromatic profiles. These findings have clear commercial implications, as aroma is closely tied to the perception of freshness, quality, and safety in food products. A vinegar that smells too acidic, musty, or dull is unlikely to gain consumer approval, even if its taste is acceptable. Hence, optimizing aroma through proper maturity selection and sugar-yeast calibration is essential for developing coconut vinegar products that meet both technical standards and market expectations

3.3 Color Scores of Coconut Water Vinegar as Influenced by Maturity Stages and Sugar-Yeast Ratio in Sensory Evaluation

Color is an important visual attribute in vinegar evaluation, as it influences first impressions and overall product appeal. In fermented products such as coconut water vinegar, color development is affected by raw material composition, microbial activity, and the extent of fermentation, which are in turn influenced by the maturity of the coconut and the sugar-yeast concentration used during processing.

Table 3. Color Scores of Coconut Water Vinegar as Influenced by Maturity Stages and Sugar-Yeast Ratio in Sensory Evaluation

Treatments	Different Maturity Stages of Coconut			Mean
	Young coconut	Rubber Meat	Shakers	(Factor B)
Different Sugar-Yeast Ratio				
1/2 cup sugar:1 tsp yeast	4.69[g]	5.03[f]	5.13[e]	**4.95**[d]
1 cup sugar:2 tsp yeast	5.21[d]	5.35[c]	5.25[d]	**5.27**[a]
1 1/2 cups sugar:3 tsp yeast	5.14[e]	5.17[e]	5.33[c]	**5.21**[c]
2 cups sugar:4 tsp yeast	5.61[a]	5.21[d]	5.43[b]	**5.42**[b]
Mean (Factor A)	**5.16**[c]	**5.19**[b]	**5.28**[a]	

C.V.(%) = 0.35

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1/ Treatment means with the same letter are not significantly different at a 5% level of significance using LSD

Table 3 presents the sensory scores for color as influenced by the interaction between coconut maturity stages (Factor A) and sugar-yeast ratio (Factor B). The analysis revealed highly significant differences ($p < 0.05$) for the main effects of maturity index, sugar-yeast ratio, and their interaction, confirming that each factor significantly contributed to the visual quality of the vinegar..

The color and appearance of coconut water vinegar, as revealed in the study, were significantly influenced by both the maturity stage of the coconut and the sugar-yeast ratio used during fermentation. Treatments with higher sugar-yeast concentrations, particularly A1B4 (young coconut with 2 cups sugar and 4 teaspoons yeast) and A3B4 (shaker-stage coconut with the same sugar-yeast ratio), demonstrated higher visual qualities. These samples consistently exhibited a clear, vibrant, golden-yellow hue, which is an attribute that is not only indicative of successful acetic acid fermentation but also of consumer acceptance. The visual quality of coconut water vinegar, particularly its color and clarity, is significantly influenced by both the maturity stage of the coconut and the sugar-to-yeast ratio used during fermentation. Treatments such as A1B4 (young coconut with high sugar and yeast) and A3B4 (shaker-stage coconut with the same conditions) consistently produced vinegar with a vibrant, golden-yellow hue and high clarity. This appearance indicates not only successful fermentation but also consumer appeal. High sugar concentrations combined with adequate yeast inoculum enhance microbial metabolism, particularly by Saccharomyces cerevisiae and Acetobacter species (Gunathilake, 2011). With that, it ensures a complete conversion of sugars to ethanol and then to acetic acid, minimizing the accumulation of turbidity-causing intermediates such as dead yeast cells and polysaccharides. As a result, the final product exhibits brilliance and purity as key indicators of vinegar quality and market readiness (Ngoc et al., 2016).

In contrast, treatments such as A_1B_1 and A_2B_1, which involved lower sugar-yeast ratios (½ cup sugar and 1 tsp yeast), yielded vinegar with less favorable color and appearance. These samples were reported to be lighter, less uniform in hue, and sometimes cloudy, indicating incomplete fermentation or poor microbial activity. Insufficient sugar in vinegar production limits the availability of fermentable substrates, directly reducing the metabolic activity of both yeast (for ethanol production) and acetic acid bacteria (for acetic acid conversion). With that, it can lead to slow or incomplete fermentation, negatively impacting the development of flavor and aroma compounds such as esters and organic acids. Additionally, active microbial metabolism during fermentation aids in the breakdown and settling of suspended solids. When microbial activity is low, residual proteins and polysaccharides may remain in suspension, causing cloudiness and visual defects in the final product (Zhou et al., 2018).

3.4 Appearance Scores of Coconut Water Vinegar as Influenced by Maturity Stages and Sugar-Yeast Ratio in Sensory Evaluation

Appearance directly influences consumer expectations and perceived product quality, particularly in fermented beverages like coconut water vinegar. It encompasses clarity, absence of sediment, color uniformity, and visual appeal, all of which can be affected by raw material characteristics and fermentation dynamics.

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Table 4 Appearance Scores of Coconut Water Vinegar as Influenced by Coconut Maturity Stages and Sugar-Yeast Ratio in Sensory

Evaluation

Treatments	Different Maturity Indices of Coconut			Mean
	Young coconut	Rubber Meat	Shakers	(Factor B)
Different Sugar-Yeast Ratio				
1/2 cup sugar:1 tsp yeast	4.78[g]	5.13[e]	5.11[d]	**5.00**[c]
1 cup sugar:2 tsp yeast	5.15[e]	5.28[c]	5.29[c]	**5.24**[b]
1 1/2 cups sugar:3 tsp yeast	5.09[f]	5.14[e]	5.35[b]	**5.19**[d]
2 cups sugar:4 tsp yeast	5.51[a]	5.21[c]	5.32[b]	**5.34**[a]
Mean (Factor A)	**5.13**[c]	**5.19**[b]	**5.2**[a]	

C.V.(%) = 0.35

[1]/ Treatment means with the same letter are not significantly different at a 5% level of significance using LSD

Table 4 illustrates the interaction effects of coconut maturity stages (Factor A) and sugar-yeast ratio (Factor B) on the appearance scores of coconut water vinegar. Statistical analysis revealed highly significant differences ($p < 0.05$) in the main effects and interaction, highlighting that both coconut maturity and fermentation substrate levels substantially impact the product's visual quality.

Scores ranged from 4.78 to 5.51 on the 7-point Just About Right (JAR) scale, reflecting moderate to high consumer acceptability in terms of visual appeal. The highest score (5.51) was observed for treatment A1B4 (2 cups sugar: 4 tsp yeast with young coconut), indicating that a higher sugar-yeast ratio promotes a clearer and more appealing vinegar appearance even when using less mature coconuts. The lowest score (4.78) was recorded for A1B1 (1/2 cup sugar: 1 tsp yeast with young coconut), suggesting that minimal sugar and yeast result in suboptimal appearance due to possible turbidity or insufficient fermentation clarity.

Among sugar-yeast treatments, B_4 (2 cups sugar:4 tsp yeast) registered the highest overall mean appearance score (5.34), followed by B2 (5.24), B3 (5.19), and B1 (5.00). This consistent trend reinforces the notion that increased substrate levels enhance microbial fermentation performance, thereby improving the appearance of the final product (Zannini et al., 2022).

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The results imply that color and appearance are closely linked to fermentation efficiency and should be considered key quality indicators in the production of coconut water vinegar. The ability to consistently produce visually appealing vinegar enhances consumer confidence, supports premium product positioning, and facilitates entry into value-added and health-conscious market segments. In value-added and health-conscious markets, such as those for artisanal and organic vinegar, clarity and coloration are often interpreted as signs of natural processing, purity, and high quality (Mas et al., 2014). Visually attractive products like those from A1B4 and A3B4 can thus help position a product within premium segments, enhancing brand credibility and consumer trust. These visual cues, coupled with superior flavor and aroma, significantly increase market viability and consumer acceptance (Lyons and Wien, 2018) .

3.5 Texture Scores of Coconut Water Vinegar as Influenced by Maturity Stages and Sugar-Yeast Ratio

Texture scores ranged from 4.75 to 5.52 on the 7-point Just About Right (JAR) scale, indicating moderate to high acceptability among panelists. The highest score (5.52) was recorded for A1B4 (2 cups sugar:4 tsp yeast with young coconut), suggesting that higher sugar-yeast ratios positively influence the texture, likely by enhancing fermentation processes that reduce the presence of undesirable particles or increase product viscosity. The lowest score (4.75) was observed for A1B1 (1/2 cup sugar: 1 tsp yeast with young coconut), indicating that minimal sugar and yeast may result in a thinner or more acidic texture that is less favored by consumers.

Table 5.Texture Scores of Coconut Water Vinegar as Influenced by Coconut Maturity Stages and Sugar-Yeast Ratio in Sensory

Treatments	Different Maturity Indices of Coconut			Mean
	Young coconut	Rubber Meat	Shakers	(Factor B)
Different Sugar-Yeast Ratio				
1/2 cup sugar:1 tsp yeast	4.75[g]	5.11[d]	5.19[d]	**5.02**[c]
1 cup sugar:2 tsp yeast	4.97[f]	5.03[e]	5.35[b]	**5.12**[b]
1 1/2 cups sugar:3 tsp yeast	5.15[d]	4.97[f]	5.25[c]	**5.12**[b]
2 cups sugar:4 tsp yeast	5.52[a]	4.95[f]	5.39[b]	**5.28**[a]
Mean (Factor A)	**5.10**[b]	**5.01**[c]	**5.30**[a]	

C.V.(%) = 0.25

[1]/ Treatment means with the same letter are not significantly different at a 5% level of significance using LSD

Evaluation

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Table 5 presents the sensory scores for texture, showing the influence of coconut maturity stages (Factor A) and sugar-yeast ratio (Factor B). The results indicate highly significant differences ($p < 0.05$) for the main effects of both factors and their interaction, suggesting that these variables significantly contribute to the texture profile of the coconut water vinegar.Among the sugar-yeast treatments, B4 (2 cups sugar:4 tsp yeast) consistently produced the highest texture mean (5.28), followed by B2 (5.12) and B3 (5.12), while B1 (5.02) scored the lowest. Increasing the sugar-yeast ratio enhances the vinegar's texture by contributing to more robust fermentation and smoother consistency (Ge et al., 2025). The findings suggest that optimal fermentation enhances taste and aroma and significantly improves the vinegar's physical characteristics during consumption. Enhanced microbial activity leads to the breakdown of coarse particulates and residual proteins, resulting in a more refined and uniform liquid texture (Solieri & Giudici, 2009).

Conversely, treatments such as A1B1 and A2B1, which used minimal sugar and yeast, scored lower in texture. These samples likely underwent incomplete fermentation, resulting in coarser textures due to retained particulates or inconsistent acetic acid production. The presence of residual sugars and less effective yeast activity may have also contributed to a duller or heavier mouthfeel, which is generally less desirable in vinegar products (Matsunaga et al., 2016).

3.6 General Acceptability Scores of Coconut Water Vinegar as Influenced by Maturity Stages and Sugar-Yeast Ratio in Sensory Evaluation

The analysis revealed highly significant differences ($p < 0.05$) for both main effects and their interaction, indicating that the coconut maturity and sugar-yeast ratio significantly impact overall consumer acceptability.

Table 6. General Acceptability Scores of Coconut Water Vinegar as Influenced by Coconut Maturity Stages and Sugar-Yeast Ratio in Sensory Evaluation

Treatments	Different Maturity Indices of Coconut			Mean
	Young coconut	Rubber Meat	Shakers	(Factor B)
Different Sugar-Yeast Ratio				
1/2 cup sugar:1 tsp yeast	4.99^{h}	5.30^{d}	5.35^{d}	**5.21**^{d}
1 cup sugar:2 tsp yeast	5.08^{g}	5.28^{e}	5.49^{c}	**5.28**^{c}
1 1/2 cups sugar:3 tsp yeast	5.21^{e}	5.38^{d}	5.45^{c}	**5.35**^{b}
2 cups sugar:4 tsp yeast	5.81^{a}	5.13^{f}	5.55^{b}	**5.50**^{a}
Mean (Factor A)	**5.27**^{b}	**5.27**^{b}	**5.46**^{a}	

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C.V.%=0.26

[1]/ Treatment means with the same letter are not significantly different at a 5% level of significance using LSD

Table 6.General Acceptability Scores of Coconut Water Vinegar as Influenced by Coconut Maturity Stages and Sugar-Yeast Ratio

in Sensory Evaluation

Table 7 presents the general acceptability scores of coconut water vinegar, influenced by coconut maturity indices (Factor A) and sugar-yeast ratio (Factor B).The general acceptability scores ranged from 4.99 to 5.81 on the 7-point Just About Right (JAR) scale, indicating moderate to high overall acceptability across the treatments. The highest score (5.81) was observed for A1B4 (2 cups sugar:4 tsp yeast with young coconut), highlighting that a higher sugar-yeast ratio combined with young coconuts resulted in the most preferred vinegar. The lowest score (4.99) was recorded for A1B1 (1/2 cup sugar: 1 tsp yeast with young coconut), which suggests that lower sugar-yeast ratio with young coconuts were less favored by the panelists. Scores ranged from 4.99 to 5.82, indicating overall moderate to high consumer satisfaction. The data clearly illustrated that both the maturity stage of the coconut (Factor A) and the sugar-yeast ratio (Factor B) had statistically significant effects ($p < 0.001$) on acceptability, with the highest ratings consistently associated with the highest sugar-yeast concentration (B4). Treatments with lower sugar and yeast levels, particularly those combined with suboptimal raw materials like the rubber meat stage (A2), demonstrated poor fermentation performance, leading to lower sensory scores. The results reflect incomplete or imbalanced fermentation, where insufficient substrate availability and weaker microbial activity hinder the full development of flavor, aroma, and clarity (Zhou et al., 2018).

The significant interaction between coconut maturity and sugar-yeast ratio further reinforced that optimal vinegar quality cannot be achieved by adjusting one factor alone; both must be aligned to produce a product that meets consumer expectations. Treatments such as A2B4 and A1B1, despite either a favorable maturity or sugar input, fell short due to the mismatch between substrate composition and fermentation dynamics.

3.7 Chemical Analysis

The sensory evaluation findings of the coconut water vinegar, covering taste, aroma, color, appearance, texture, and general acceptability, are supported and explained by the chemical analysis parameters: pH, alcohol content, and Brix (°Bx). These chemical metrics directly influence fermentation dynamics and the development of desirable sensory qualities in vinegar..

Table 7. Summary Table for the Chemical Analysis of the Coconut Water Vinegar as Influenced by Maturity Indices and Sugar-Yeast Ratio in Sensory Evaluation

Treatment	**pH**	**Alcohol**	**Brix (20^0C)**
Young Coconut & ½ cup sugar:1 tsp yeast	4.0	2.3	5.0

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Young Coconut & 1 cup sugar:2 tsp yeast	3.9	4.2	9.0
Young Coconut & 1½ cups sugar:3 tsp yeast	3.78	4.0	8.0
Young Coconut & 2 cups sugar:4 tsp yeast	3.72	5.0	11.0
Rubber Meat Coconut & ½ cup sugar:1 tsp yeast	3.91	5.0	10.0
Rubber Meat Coconut & 1 cup sugar:2 tsp yeast	3.77	5.0	10.0
Rubber Meat Coconut & 1½ cups sugar:3 tsp yeast	4.30	2.0	4.0
Rubber Meat Coconut & 2 cups sugar:4 tsp yeast	4.05	2.2	8.0
Shakers Coconut & ½ cup sugar:1 tsp yeast	3.76	5.0	9.0
Shakers Coconut & 1 cup sugar:2 tsp yeast	4.33	2.0	4.0
Shakers Coconut & 1½ cups sugar:3 tsp yeast	4.30	1.9	4.0
Shakers Coconut & 2 cups sugar:4 tsp yeast	3.99	3.8	7.0

Table 7 presents the summary of chemical properties such as pH, alcohol content (% v/v), and Brix (°Bx at 20°C) of coconut water vinegar samples produced under varying coconut maturity indices (Factor A) and sugar-yeast ratio (Factor B). These parameters are essential in evaluating the fermentation efficiency and the quality of the resulting vinegar.The taste was significantly influenced by the combined effects of acidity (pH), residual sugar (Brix), and alcohol content, which collectively define the flavor balance and mouthfeel of the vinegar. The treatment A1B4, which achieved the highest taste rating (5.89), exhibited a low pH (3.72), high alcohol content (5%), and the highest Brix value (11°Bx). The chemical composition reflects a complete and active fermentation process where sufficient ethanol is produced and converted to acetic acid, imparting a bright, tangy acidity. Meanwhile, residual sugars enhanced the vinegar's smoothness and sweetness, creating a palatable and well-rounded flavor profile. In contrast, treatments such as A2B3 and A3B3, which recorded the lowest alcohol content (2% and 1.9%), high pH values (both at 4.3), and very low Brix levels (4°Bx), were rated poorly in taste. These values suggest incomplete fermentation, resulting in insufficient acetic acid production, minimal ester or volatile formation, and an overall bland or flat taste. The absence of both residual sugar and fermentation by-products likely contributed to the poor flavor complexity and low acceptability among evaluators, affirming that the chemical balance is a significant factor in determining taste quality.

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Aroma is influenced by alcohol content and the metabolic activity of yeast and acetic acid bacteria. Treatments such as A1B4, with 5% alcohol, exhibited strong aromatic appeal, as confirmed by the highest aroma preference score (0.20), likely due to enhanced ester formation and balanced volatile acid development during fermentation. In contrast, treatments like A3B2 (2%) and A3B3 (1.9%), which had low alcohol content and high pH values (above 4.3), showed weak aroma perception, pointing to insufficient fermentation and reduced microbial activity. However, A3B1, despite having 5% alcohol, received a low aroma score (–0.02), suggesting that aroma development is multifactorial, affected not only by ethanol presence but also by substrate composition, coconut maturity, and the types of volatiles produced (Stoffel et al., 2024). Thus, while higher alcohol levels generally favor aroma, the overall sensory impact depends on the complex interaction of fermentation conditions and raw material quality (Peng et al., 2015)

Sugar levels and the completeness of the fermentation process closely influence the color and appearance of coconut vinegar. Treatments with higher Brix values, particularly A1B4 (11°Bx) and A2B1 (10°Bx), produced vinegar with golden-yellow hues and clear, bright visual appeal, which were highly favored in both the sensory evaluation and preferential analysis. These visual qualities reflect successful fermentation, where high sugar availability supports active microbial metabolism, leading to stable pigment development and the prevention of haze formation. A1B4, in particular, was consistently described as “presentable” and “natural-looking,” while A2B1 was noted as “pleasant to the eyes.” In contrast, treatments such as A2B3 and A3B3, which recorded the lowest Brix levels (4°Bx), exhibited poor clarity and dull coloration, receiving low appearance scores and remarks such as “light yellow” and “unpresentable.” The relationship between sugar content, fermentation quality, and the visual attribute of vinegar is well established. Insufficient sugar substrates during vinegar fermentation can impair microbial metabolism, particularly of yeasts and acetic acid bacteria, leading to incomplete biochemical conversion. This often results in the accumulation of suspended solids like dead cells and unconverted organics, causing cloudiness and visual instability. Kasemsumran et al. (2023) demonstrate this in their study on pineapple vinegar, where reduced sugar levels were associated with murky broth and turbidity, negatively impacting both clarity and color vibrancy.

Moreover, the fermentation process is not only needed for acetic acid production but also for ensuring visual clarity. For example, Zhang et al. (2024) showed that the presence of sufficient sugars helped regulate microbial succession and metabolite profiles, enhancing the clarity of persimmon vinegar during bioaugmented fermentation. Clarity and color are tightly linked to fermentation completeness, as incomplete metabolism leaves residual sugars and particles in suspension. Ma et al. (2021) further affirm that higher sugar content early in the fermentation of pear vinegar led to both better flavor profiles and visual clarity.

Clarity and visual appeal are also influenced by acid-sugar balance. Studies by Dai et al. (2024) illustrate that proper sugar adjustment not only affected ethanol and acetic acid levels but also directly influenced the transparency and aesthetic characteristics of fruit wines and vinegar. A high sugar concentration supports stronger microbial activity and pigment preservation, which is key in colored vinegar made from fruits such as blueberries or pomegranates. Ezeora et al. (2024) note that sugar concentration during fermentation significantly affects pigment retention and color evolution, contributing to the brightness and appeal of fermented beverages.

Treatments with high Brix values, particularly A1B4 (11°Bx), exhibited a rich body and smooth consistency, which was confirmed by its top texture preference score (0.17) and panelist feedback describing it as having a “tangy taste on the tongue.” This favorable mouthfeel likely stems from adequate residual sugars that reduce astringency and prevent a thin or watery sensation. While A1B2 (9°Bx) and A1B3 (8°Bx) also had relatively

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high sugar content, they received low texture scores (–0.07 and –0.03, respectively), suggesting that high Brix alone does not guarantee good mouthfeel; other factors, such as acid balance or volatile content, may also contribute. Conversely, treatments with low Brix values, such as A3B3 and A2B3 (both 4°Bx), exhibited thin, less viscous mouthfeel and were rated poorly, with panelists describing them as unpleasant or watery. These results highlight that while sugar content contributes to the mouthfeel, the overall fermentation quality, including acid, ethanol, and solute profile, must be optimized to achieve a desirable vinegar texture.

3.8 Preferential Analysis

The preferential analysis of coconut water vinegar, when interpreted alongside both sensory evaluation and chemical analysis results, provides deeper insights into what drives consumer preferences.

Table 8. Summary Table for the Preferential Analysis of the Coconut Water Vinegar as Influenced by Maturity Indices and Sugar-Yeast Ratio in Sensory Evaluation

Treatment	*Total Preference Score*	*Rank*	*Remarks*
Young coconut & 2 cups sugar:4 tsp yeast	***0.1567***	***1st***	***Most preferred; described as very delightful, with intense aroma, tangy texture, and natural vinegar appearance***
Rubber meat coconut & 1½ cups sugar:3 tsp yeast	***0.0167***	***2nd***	***Liked for vinegar aroma and soft texture; moderate preference***
Rubber meat coconut & ½ cup sugar:1 tsp yeast	***0.0050***	***3rd***	***Balanced taste and pleasant appearance; described as a "natural vinegar."***
Rubber meat coconut & 2 cups sugar:4 tsp yeast	***-0.0050***	***4th***	***Mixed reactions: appreciated by some for-vinegar traits but criticized for color***

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Rubber meat coconut & 1 cup sugar:2 tsp yeast	*-0.0100*	*5th*	*Low preference: aroma and taste are not well-received*
Young coconut & 1½ cups sugar:3 tsp yeast	*-0.0150*	*6th*	*Weak preference; slightly better than others in texture, but lacking aroma and taste*
Rubber meat coconut & 1 cup sugar:2 tsp yeast	*-0.0150*	*6th (tie)*	*Not preferred due to bland taste and pale appearance*
Young coconut & ½cup sugar:1 tsp yeast	*-0.0167*	*7th*	*Taste and texture are described as alcoholic and harsh*
Shakers coconut & ½ cup sugar:1 tsp yeast	*-0.0167*	*7th (tie)*	*Lacked appeal in taste, aroma, and appearance*
Young coconut & 1 cup sugar:2 tsp yeast	*-0.0150*	*8th*	*Least preferred: weak flavor and aroma, unpleasant texture*
Shakers coconut & 1½cups sugar:3 tsp yeast	*-0.0267*	*8th (tie)*	*Criticized for bitterness, alcohol-like taste, and pale-yellow appearance*
Shakers coconut & 2 cups sugar:4 tsp yeast	*-0.0467*	*9th*	*Lowest ranked; disliked for color, aftertaste, and lacking vinegar character*

Table 8 presents the total preference scores, rankings, and qualitative remarks of coconut water vinegar treatments derived from different combinations of coconut maturity stages and sugar-yeast ratio. This analysis integrates consumer perception of aroma, taste, texture, and visual appearance, offering a holistic assessment of market acceptability.The top-performing treatment, A1B4 (Young Coconut with 2 cups sugar: 4 tsp yeast), emerged as the most preferred in the preferential analysis with a score of 0.1567. This preference correlates strongly with its outstanding sensory evaluation scores, particularly in taste (5.89), aroma (5.22), texture (5.52), color (5.61), appearance (5.51), and general acceptability (5.81). Chemically, A1B4 had the highest alcohol content (5%) and Brix level (11), indicating a higher residual sugar content and vigorous fermentation activity. Its relatively low pH (3.72) also signifies firm acidity, likely contributing to its tangy, vinegar-like appeal.

These results suggest that young coconut maturity and a high sugar-yeast ratio produce a product with enhanced sensory and chemical attributes, aligning well with consumer preferences (Appaiah et al., 2015).

The second most preferred treatment, A2B3 (Rubber Meat with 1 1/2 cups sugar: 3 tsp yeast), with a preference score of 0.0167, also supports the pattern that moderate-to-high sugar-yeast ratios yield favorable results. Its high pH (4.3) and low alcohol (2%), and Brix (4) values suggest a milder acidity and sweetness profile, which some panelists favored for its softer texture and aroma. Although it did not score the highest in individual sensory parameters, its overall balance appealed to a segment of consumers who preferred subtler vinegar profiles.

Meanwhile, A2B1 (Rubber Meat with 1/2 cup sugar: 1 tsp yeast), ranked third, had moderate chemical readings (pH 3.91, alcohol 5%, Brix 10) but was still appreciated for its balance in taste and appearance. This treatment's alignment with a "natural vinegar" profile points to consumer sensitivity toward flavor, aroma, visual appeal, and acidity.

In contrast, the least preferred treatment, A3B4 (Shakers with 2 cups sugar: 4 tsp yeast), had a negative preference score (-0.0467) and was widely criticized for its off-color, aftertaste, and weak vinegar character. Its pH (3.99), alcohol content (3.8%), and Brix (7) suggest an incomplete or less effective fermentation. Despite its relatively strong performance in sensory parameters like general acceptability (5.55) and texture (5.39), its lower preference ranking highlights that chemical markers such as acidity and alcohol balance must align with visual and taste expectations to secure consumer appeal.

The preferential analysis confirms that younger coconut maturity (A1) combined with higher sugar-yeast ratio (B4) enhances both chemical properties and sensory qualities, leading to superior consumer acceptance. It also illustrates that sensory attributes like taste, aroma, and appearance are deeply influenced by underlying chemical profiles such as pH, alcohol, and Brix, which collectively determine product desirability in vinegar production.

3.9 Profit & ROI At Different Selling Prices

Table 9. Profit & ROI At Different Selling Prices

Selling Price (₱)	Revenue (₱)	Net Profit (₱)	ROI (%)
90	9,000	-505.20	**Negative (-5.3%)**
100	10,000	494.80	5.21%
110	11,000	1,494.80	15.7%

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120	12,000	2,494.80	26.2%

Break-Even Price Per Bottle

To break even: ₱9,505.20 / 100 bottles = ₱95.05

The price of the product needs to be above ₱95.05 per bottle to gain profit.

Table 9 illustrates the financial performance of coconut vinegar production under varying selling price scenarios. The analysis focuses on four different price points, such as ₱90, ₱100, ₱110, and ₱120 per bottle, and highlights their corresponding revenue, net profit, and return on investment (ROI). These figures are derived from a standard production cycle that yields 100 bottles at a total cost of ₱9,505.20.At the lowest price point of ₱90 per bottle, total revenue amounts to ₱9,000, resulting in a net loss of ₱505.20. This translates to a negative ROI of -5.3%, showing that this price is unsustainable for the business. It fails to cover production costs and would result in financial losses if maintained.Selling at ₱100 per bottle, which is just slightly above the break-even point of ₱95.05, yields a modest net profit of ₱494.80 and an ROI of 5.21%. Although profitable, this return is relatively low, presenting minimal financial cushion or room for reinvestment and unexpected cost increases.Increasing the price to ₱110 per bottle significantly improves profitability, generating a net profit of ₱1,494.80 and an ROI of 15.7%. This level of return is more sustainable and reflects a healthier margin that supports operational resilience and business growth.

The most favorable scenario in the table is at ₱120 per bottle, producing a net profit of ₱2,494.80 and an ROI of 26.02%..

3.10 Product Packaging and Labelling Evaluation

Evaluating the packaging and labeling of coconut water vinegar provides essential feedback on how consumers perceive its market readiness, usability, and visal appeal.

Table 10. Evaluation of Product Packaging and Labeling of Coconut Water Vinegar

Product Packaging	**Rating/Mean**
1. Container used	4
2. Design of the container	3
3. Material used as primary container	4
4. Handiness	4
5. Storage Capacity	3
6. Environmental care/issue	4
Product Labeling	
1. Detailed information presentation **1.1 Address/Manufacturer**	3
1.2 Expiration Date	3

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1.3 Brand Name	3
1.4 Net Content	3
2. Originality of logo design	4
3. Originality of the Brand Name	3
4. Attractiveness of the trademark	3
5. Overall presentation/package	3

Rating Scale for Product Packaging and Labeling Evaluation: 4.00 (Excellent Quality): Indicates that the attribute is of a superior standard and exceeds expectations. 3.00 – 3.99 (Good Quality): Reflects a satisfactory level of quality that meets consumer expectations. 2.00 – 2.99 (Fair Quality): Suggests that the attribute is below ideal standards and may require improvement. 1.00 – 1.99 (Poor Quality): Denotes a low-quality attribute that is unacceptable or needs significant enhancement.

Table 10 presents the evaluation scores for various aspects of the product packaging and labeling of coconut water vinegar. The table is divided into two main sections: Product Packaging and Product Labeling.

Based on the results, the container used, material used as the primary container, handiness, and environmental consideration each received a mean rating of 4, indicating that the respondents consider these aspects quality. This finding suggests that the container is durable, easy to handle, and likely made from materials that are either recyclable or reusable, factors that are increasingly important to environmentally conscious consumers (Ampuero & Vila, 2006). In line with consumer standards, functional packaging protects the product and influences consumer satisfaction and repurchase intentions (Silayoi & Speece, 2004).The design of the container and storage capacity received a slightly lower score of 3, which reflects an acceptable or standard level of quality, but not exceptional. These ratings suggest that while the packaging design is adequate, it may lack distinctiveness or aesthetic appeal. Consumers may find the shape or visual layout functional but not attractive or innovative. Similarly, a rating of 3 for storage capacity implies that the container size may not fully meet the expectations of the end users regarding convenience or volume for extended use. The product's physical design and capacity directly influence its perceived value and usability (Underwood & Klein, 2002), so improvements in these areas may enhance the competitiveness of the product, especially when displayed alongside more visually engaging competitors on retail shelves.

For product labeling, most of the evaluated criteria received a rating of 3, including brand name, net content information, trademark attractiveness, address, expiration date of the manufacturer, and overall presentation which implies that this information is present but may not be visible, prominently placed, or sufficiently detailed. According to the Food and Drug Administration (FDA) labeling guidelines (FDA Philippines, 2014), key product information, including manufacturing origin and shelf life, must be printed and legible to ensure consumer safety and informed purchasing. Consumers use these details to verify product freshness and traceability. A rating of 3 suggests an opportunity to enhance clarity by adjusting font size, layout, or label design to highlight these details better. Only originality of logo design received 4 rating in labeling evaluation.

Overall, the results indicate that the coconut water vinegar packaging and labeling are well-received and functional, but with areas for improvement in design and information clarity. High-quality packaging materials and visually appealing labels support consumer trust and convey professionalism. At the same time, clear labeling of expiration dates and origin ensures compliance and promotes safety. Addressing the moderately rated aspects can elevate the overall image of the product and strengthen its market appeal, especially in a competitive retail environment where packaging often serves as the first point of contact between product and consumer (Wells, Farley, & Armstrong, 2007).

4.0 Conclusion

This study confirmed that the maturity of coconut water and the sugar-yeast ratio used during fermentation significantly affect the quality and acceptability of coconut water vinegar. The best results were obtained from young coconut water (3 to 4 months old) and the highest sugar-yeast ratio (2 cups sugar: 4 tsp yeast). This treatment produced a pleasant taste and aroma of vinegar, an appealing color, and a smooth texture, resulting in the highest overall acceptability. The natural sweetness and low fat of young coconut water made it ideal for fermentation.

These findings also showed that coconut water vinegar has good commercial potential, especially the A1B4 treatment, which was most preferred by consumers and had the highest return on investment. The study highlights how coconut water, often treated as waste, can be turned into a profitable and healthy product, supporting both sustainability and income generation for coconut farmers. Incorporating microbial enrichment techniques like standardized “mother vinegar” inoculation and investigating biodegradable or eco-friendly packaging could further refine the product's market readiness. This study provided a strong foundation for future innovations in coconut-based fermentation products, advancing food technology, supporting smallholder agribusiness, and promoting sustainable agriculture.

Use Young Coconut Water (3–4 Months Old).Based on the sensory evaluation, young coconut water consistently yielded vinegar with superior taste, aroma, and overall acceptability. It is therefore highly recommended as the primary raw material for producing high-quality coconut water vinegar.Apply a Higher Sugar-to-Yeast Ratio (2 Cups Sugar: 4 tsp Yeast).Treatments with higher sugar and yeast concentrations demonstrated significantly better fermentation outcomes, improving flavor, clarity, and texture. This ratio is recommended to ensure efficient fermentation and desirable sensory characteristics.

Conduct Extended Fermentation Studies.This study focused on a 45-day fermentation period; however, additional research is recommended to explore how different fermentation durations influence the flavor complexity, acidity levels, and shelf stability of the vinegar. This could provide a deeper understanding of how time affects the final quality of preservation.Validate Findings Through Expanded-Scale Trials

To strengthen the reliability of the findings, it is important to conduct larger-scale trials. Expanding the scope of the study can help confirm the results and ensure they apply to a broader range of conditions or production scales. This approach will provide more reliable, generalized findings, potentially revealing additional factors influencing the outcome.

5.0 Contributions of Authors

All the authors were responsible for the conceptualization of the study. July Ann V. Dela Cruz conducted and collected the necessary data, analyzed the study, and drafted the manuscript. Junito P. Marcelino provided technical guidance, supervised the research process, and reviewed and edited the manuscript.

6.0 Conflict of Interest

The author declares no conflicts of interest, financial or otherwise, that could have influenced the study's findings or conclusions.

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9.0 References

Adebo, O. A., & Niobe, P. B. (2017). Phytochemical analysis and antimicrobial activity of coconut (Cocos nucifera) husk extract. Journal of Pharmaceutical and Pharmacological Research, 5(2), 111–123. https://doi.org/10.33140/jpppr.05.02.04

Aguilar, E. A., Lozada, E. P., & Aragon, C. T. (2022). The Philippine coconut industry roadmap, 2021–2040. Philippine Coconut Authority, Department of Agriculture.

Ampuero, O., & Vila, N. (2006). Consumer perceptions of product packaging. Journal of Consumer Marketing, 23(2), 100–112. https://doi.org/10.1108/07363760610655032

Appaiah, P., Sunil, L., Kumar, P.K., & Krishna, A.G. (2015). Physico-chemical characteristics and stability aspects of coconut water and kernel at different stages of maturity. Journal of Food Science and Technology, 52(8), 5196–5203. https://doi.org/10.1007/s13197-014-1559-4

Aragon, C. (2000). Coconut program area research planning and prioritization (PIDS Discussion Paper Series No. 2000-31). Philippine Institute for Development Studies. https://pidswebs.pids.gov.ph/cdn/publications/pidsdps0031.pdf

Balaji, C. D., & Abinaya, C. (2024). Coconut: A versatile and multipurpose crop. KRISHI Science – eMagazine for Agricultural Sciences, 5(6), 26–30. https://www.researchgate.net/publication/381550813

Beigbeder, J.-B., de Medeiros Dantas, J. M., & Lavoie, J.-M. (2021). Optimization of yeast, sugar and nutrient concentrations for high ethanol production rate using industrial sugar beet molasses and response surface methodology. Fermentation, 7(2), 86. https://doi.org/10.3390/fermentation7020086

Bekatorou, A. (2020). Advances in vinegar production. CRC Press.

Buda, N. H., Aykin, E., Seydim, A. C., & Annel, K. (2014). Functions and properties of vinegar. Journal of Food Science, 79(5). https://doi.org/10.1111/1750-3841.12434

Chanivet, M., Es-sbata, I., Astola, A., Durán-Guerrero, E., & Castro, R. (2024). Thermotolerant acetic acid bacteria in the production of red wine vinegar by surface culture at different temperatures: Volatile and polyphenolic composition. European Food Research and Technology, 250(11), 2849–2862. https://doi.org/10.1007/s00217-024-04580-2

Chen, F., Ma, Y., Corradini, G., & Giudici, P. (2025). The theory and practice of sensory evaluation of vinegar: A case of Italian traditional balsamic vinegar. Foods, 14(5), 893. https://doi.org/10.3390/foods14050893

Chen, G.-L., Zheng, F.-J., Sun, J., Li, Z.-C., Lin, B., & Li, Y.-R. (2014). Production and characteristics of high-quality vinegar from sugarcane juice. Sugar Tech, 17(1), 89–93. https://doi.org/10.1007/s12355-014-0352-z

Dai, Y., Chen, Y., Lin, X., & Zhang, S. (2024). Recent applications and prospects of enzymes in quality and safety control of fermented foods. Foods, 13(23), 3804. https://doi.org/10.3390/foods13233804

de Morais, F. P. R., Pessato, T. B., Rodrigues, E., Peixoto Mallmann, L., Mariutti, L. R. B., & Netto, F. M. (2020). Whey protein and phenolic compound complexation: Effects on antioxidant capacity before and after in vitro digestion. Food Research International, 133, 109104. https://doi.org/10.1016/j.foodres.20 20.109104

Department of Science and Technology – Industrial Technology Development Institute. (2018). Optimizing of fermentation conditions for coconut vinegar production.

Didier, R. C., & Montet, R. (2016). Fermented foods, part I: Biochemistry and biotechnology. Taylor & Francis. https://www.taylorfrancis.com/books/edit/10.1201/b19872

Dolan, R. S. (2016). Optimizing of pasteurization conditions for coconut vinegar. Journal of Food Science and Technology, 53(4), 1030–1038. https://doi.org/10.1007/s13394-0160-01748

DOST–PCAARRD. (n.d.). Coconut industry profile. Industry Strategic S&T Plans (ISPs) Platform. https://ispweb.pcaarrd.dost.gov.ph/isp-commodities/coconut/

Dutra, J. M. (2021). Produção e caracterização físico-química e microbiológica do vinagre de jambolão (Syzygium cumini) [Bachelor's thesis, Instituto Federal Goiano]. Repositório Institucional do IF Goiano. https://repositorio.ifgoiano.edu.br/handle/prefix/1883

Ezeora, K. C., Setati, M. E., Fawole, O. A., & Opara, U. L. (2024). Pomegranate wine production and quality: A comprehensive review. Fermentation, 10(7), 348. https://doi.org/10.3390/fermentation10070348

FDA Philippines. (2014). Food labeling guide for prepackaged processed food products. Retrieved from https://www.fda.gov.ph

Food and Agriculture Organization. (2019). The state of food and agriculture 2019: Moving forward on food loss and waste reduction. https://www.fao.org/3/ca6030en/ca6030en.pdf

Food and Agriculture Organization. (n.d.). Restoring coconut farmers' livelihoods in the Philippines. https://www.fao.org/in-action/restoring-coconut-farmers-livelihoods-in-the-philippines/en/

Garde-Cerdán, T., Lorenzo, C., Carot, J. M., Esteve, M. D., Climent, M. D., & Salinas, M. R. (2009). Differentiation of barrel-aged wines according to their origin, variety, storage time and enological parameters using fermentation products. Food Control, 20(3), 269–276. https://doi.org/10.1016/j.foodcont.2008.05.003

Ge, Y., Wu, Y., Aihaiti, A., Wang, L., Wang, Y., Xing, J., Zhu, M., & Hong, J. (2025). The metabolic pathways of yeast and acetic acid bacteria during fruit vinegar fermentation and their influence on flavor development. Microorganisms, 13(3), 477. https://www.mdpi.com/2076-2607/13/3/477

Gunathilake, K. D. P. P. (2011). Development of a low-cost coconut water vinegar-making process and evaluation of the "generator process" to accelerate the acetification. CORD, 27(1), 6–11. https://doi.org/10.37833/cord.v27i1.122

Gunathilake, K. D. P. P., Fernando, J. A. K. M., & Jayawickrama, D. S. (2011). Development of low-cost coconut water vinegar making process and evaluation of "generator process" to accelerate the acetification. CORD, 27(1), 42–47. https://doi.org/10.37833/cord.v27i1.122

Habiba, U., Alam, A. N. M. I., Aunsary, L., Jubayer, M. F., Karmoker, P., Alim, M. A., & Mazumder, M. A. R. (2024). Exploring the potential of wild date palm (Phoenix sylvestris L. Roxb) fruits for vinegar production in Bangladesh. Applied Food Research, 4(2), 100628. https://doi.org/10.1016/j.afres.2024.100628

Hah, D. (2012). Coconut (Cocos nucifera L.): A review of its uses, chemical composition, and health benefits.

Hasanuddin, H., Dewi, K. H., & Wulandra, O. (2012). The use of coconut water for raw material of vinegar. Jurnal Agroindustri, 2(2), 53–61. https://doi.org/10.31186/j.agroindustri.2.2.53-61

Henrietta, H. M., Kalaiyarasi, K., & Raj, A. S. (2022). Coconut tree (Cocos nucifera) products: A review of global cultivation and its benefits. Journal of Sustainability and Environmental Management, 1(2), 257–264. https://doi.org/10.3126/josem.v1i2.45377

Hernani, Mangunwardoyo, W., Hidayati, M. D., & Miskiyah. (2020). Influence of sucrose and Acetobacter aceti in addition to acetic acid content on coconut water vinegar. IOP Conference Series: Earth and Environmental Science, 458, 012015. https://doi.org/10.1088/1755-1315/458/1/012015

Ho, C. W., Lazim, A. M., Fazry, S., Zaki, U. K. H. H., & Lim, S. J. (2017). Varieties, production, composition, and health benefits of vinegars: A review. Food Chemistry, 221, 1621–1630. https://doi.org/10.1016/j.foodchem.2016.10.128

Hutkins, R. W. (2008). Microbiology and technology of fermented foods. Wiley-Blackwell.

Jamaludin, M., Amin, A., Othman, R., Ahmad Fadzillah, N., & Muflih, B. (2018). Technical Review on Vinegar Fermentation Process and Physiochemical Properties of Vinegar Product Based on Shariah and Scientific Perspectives. In Advances in Science, Technology & Innovation (pp. 543–550). Springer. https://doi.org/10.1007/978-981-10-7257-4_43.

Karmowski, J., Enke, K., Killenberg, M., & Böhm, V. (2015). Interactions between lipophilic antioxidants measured by photo chemiluminescence assay and α-tocopherol equivalent antioxidant capacity assay, as well as the influence of matrix compounds on the lipophilic antioxidant capacity. LWT – Food Science and Technology, 64(2), 817–823. https://doi.org/10.1016/j.lwt.2015.06.057

Kasemsumran, S., Boondaeng, A., Jungtheerapanich, S., Ngowsuwan, K., Apiwatanapiwat, W., Janchai, P., & Vaithanomsat, P. (2023). Assessing fermentation broth quality of pineapple vinegar production with a near-infrared fiber-optic probe coupled with stability competitive adaptive reweighted sampling. Molecules, 28(17), 6239. https://doi.org/10.3390/molecules28176239

Online ISSN: 3082-5121
Aloysian Interdisciplinary Journal of Social Sciences, Education, and Allied Fields
https://journals.aloysianpublications.com
Volume 1 Issue 5 (2025)

Keller, K.L. (2003). Strategic brand management: Building, measuring, and managing brand equity. New Jersey, United States: Prentice Hall.

Kocher, G. S., Dhillon, H. K., & Joshi, N. (2012). Scale up of sugarcane vinegar production by recycling successive fermentation batches and its organoleptic evaluation. Journal of Food Processing and Preservation, 38(3), 955–963. https://doi.org/10.1111/jfpp.12050

Lawless, H. T., & Heymann, H. (2010). Sensory evaluation of food: Principles and practices (2nd ed.). Springer.

Li, W.-L., Tong, S.-G., Yang, Z.-Y., Xiao, Y.-Q., Lv, X.-C., Weng, Q., Yu, K., Liu, G.-R., Luo, X.-Q., Wei, T., Han, J.-Z., Ai, L.-Z., & Ni, L. (2022). The dynamics of microbial community and flavor metabolites during the acetic acid fermentation of Hongqu aromatic vinegar. Current Research in Food Science, 5, 1720–1731. https://doi.org/10.1016/j.crfs.2022.10.002

Liu, Q., Tang, G. Y., Zhao, C. N., Gan, R. Y., & Li, H. B. (2019). Antioxidant activities, phenolic profiles, and organic acid contents of fruit vinegars. Antioxidants, 8(4), 78. https://doi.org/10.3390/antiox8040078

Luzón-Quintana, L. M., Castro, R., & Durán-Guerrero, E. (2021). Biotechnological processes in fruit vinegar production. Foods, 10(5), 945. https://doi.org/10.3390/foods10050945

Lyons, S.J., & Wien, A.H. (2018). Evoking premiumness: How color-product congruency influences premium evaluations. Food Quality and Preference, 64, 103–110. https://doi.org/10.1016/j.foodqual.2017.10.006

Ma, X., Yuan, H., Wang, H., & Yu, H. (2021). Coproduction of bacterial cellulose and pear vinegar by fermentation of pear peel and pomace. Bioprocess and Biosystems Engineering, 44(11), 2231–2244. https://doi.org/10.1007/s00449-021-02596-4

Maina, S., Papadaki, A., Kachrimanidou, V., Eriotou, E., & Kopsahelis, N. (2019). Raw materials and pretreatment methods for vinegar production. In A. Bekatorou (Ed.), Advances in vinegar production (pp. 115–136). CRC Press. https://doi.org/10.1201/9781351208475-5

Manikantan, M. R., Pandiselvam, R., Beegum, S., & Mathew, A. C. (2018). Harvest and postharvest technology. In K. S. Hebbar, M. R. Manikantan, & R. Pandiselvam (Eds.), The coconut palm (Cocos nucifera L.): Research and development perspectives (pp. 635–722). Springer. https://doi.org/10.1007/978-981-13-2754-4_13

Mas, A., Torija, M. J., García-Parrilla, M. del, & Troncoso, A. M. (2014). Acetic acid bacteria and the production and quality of wine vinegar. The Scientific World Journal, 2014, Article 394671. https://doi.org/10.1155/2014/394671

Matsunaga, K., Setoguchi, S., Shimono, K., Kamesawa, H., Nakamura, T., & Funane, K. (2016). Identification of turbid compounds generated in sugarcane vinegar. Journal of Applied Glycoscience, 63(1), 23–26. https://doi.org/10.5458/jag.jag.JAG-2015_020

Mihafu, F. D., Issa, J. Y., & Kamiyango, M. W. (2020). Implication of sensory evaluation and quality assessment in food product development: A review. Current Research in Nutrition and Food Science, 8(3). https://bit.ly/2UmXtmd

Mishra, A. A., & Fatima, B. (2015). Optimization of process parameters for the production of vinegar from banana peel and coconut water. International Journal of Science, Engineering and Technology, 3(3), 817–823. https://www.ijset.in/wp-content/uploads/2015/07/10.2348.ijset06150817.pdf

Mizzi, J., Gaggìa, F., Bozzi Cionci, N., Di Gioia, D., & Attard, E. (2022). Selection of acetic acid bacterial strains and vinegar production from local Maltese food sources. Frontiers in Microbiology, 13, Article 897825. https://doi.org/10.3389/fmicb.2022.897825

Molleno, G. L., & Ongy, E. E. (2024). Optimizing profit from coconut sap-based products at different investment levels. Science and Humanities Journal, 20, 30–56. https://doi.org/10.47773/shj.1998.201.3

Moreira, L. de P. D., Porcellato, D., Marangon, M., Nadai, C., Duarte, V. da S., Devold, T. G., Giacomini, A., & Corich, V. (2024). Interactions between Starmerella bacillaris and Saccharomyces cerevisiae during sequential fermentations influence the release of yeast mannoproteins and impact the protein stability of an unstable wine. Food Chemistry, 440, Article 138311. https://doi.org/10.1016/j.foodchem.2023.138311

Mota, J., & Vilela, A. (2024). Exploring microbial dynamics: The interaction between yeasts and acetic acid bacteria in port wine vinegar and its implications on chemical composition and sensory acceptance. Fermentation, 10(8), Article 421. https://doi.org/10.3390/fermentation10080421

Ngoc, T. N. T., Masniyom, P., & Maneesri, J. (2016). Preparation of vinegar from coconut water using baker's yeast and Acetobacter aceti TISTR 102 starter powder. Asia-Pacific Journal of Science and Technology, 21(2), 385–396. https://doi.org/10.14456/kkurj.2016.42

Ngoc, T., Thinh, P., Mui, D., Uyen, L., Ngan, N., Tran, N., Khang, P., Huy, L., Minh, T., & Trung, N. (2024). Influences of fermentation conditions on the chemical composition of Red Dragon Fruit (Hylocereus polyrhizus) wine. Beverages, 10(3), 61. https://doi.org/10.3390/beverages10030061

Ouattara, A., Somda, M. K., Ouattara, C. A., Dabiré, Y., Nikiéma, M., Traoré, A. S., & Ouattara, A. S. (2023). Production of mango vinegar using Acetobacter tropicalis CRSBAN-BVA1 and CRSBAN-BVK2 isolated from Burkina Faso. Food and Nutrition Sciences, 14(1), 26–37. https://doi.org/10.4236/fns.2023.141003

Peng, B., Li, F., Cui, L., & Guo, Y. (2015). Effects of fermentation temperature on key aroma compounds and sensory properties of apple wine. Journal of Food Science, 80(12), S2937–S2943. https://doi.org/10.1111/1750-3841.13111

Philippine Coconut Authority (PCA). (2019). Coconut vinegar, coconut processing technologies (FPDD Guide No. 8-Revise 3 Series of 2019). Albay Research Center.

Qian, M., Ruan, F., Zhao, W., Dong, H., Bai, W., Li, X., Huang, X., & Li, Y. (2023). The dynamics of physicochemical properties, microbial community, and flavor metabolites during the fermentation of semi-dry Hakka rice wine and traditional sweet rice wine. Food Chemistry, 416, 135844. https://doi.org/10.1016/j.foodchem.2023.135844

Rethinam, P., & Krishnakumar, V. (2022). Value addition in coconut water. In Coconut Water (pp. 287–384). https://doi.org/10.1007/978-3-031-10713-9_8

Roda, J. B., Pereira, L. C., & da Silva, A. P. (2017). Coconut (Cocos nucifera L.) water: A review of its chemical composition, nutritional value and potential health benefits. Journal of Food Science, 82(5), S14378–S1486. https://doi.org/10.1111/1750-3841.13734

Rodman, A. D., & Gerogiorgis, D. I. (2016). Dynamic simulation and visualization of fermentation: Effect of process conditions on beer quality. IFAC-PapersOnLine, 49(7), 615–620. https://doi.org/10.1016/j.ifacol.2016.07.236

Román-Camacho, J. J., García-García, I., Santos-Dueñas, I. M., García-Martínez, T., & Mauricio, J. C. (2023). Latest trends in industrial vinegar production and the role of acetic acid bacteria: Classification, metabolism, and applications—A comprehensive review. Foods, 12(19), 3705. https://doi.org/10.3390/foods12193705

Rutala, W. A., Weber, D. J., & The Healthcare Infection Control Practices Advisory Committee (HICPAC). (2000). Guidelines for disinfection and sterilization in healthcare facilities. Infection Control and Hospital Epidemiology, 21(4), 1–150. https://doi.org/10.1086/501435

Saelee, N., Cheong, L.-Z., & Chaijan, M. (2023). Optimized acetic acid production by mixed culture of Saccharomyces cerevisiae TISTR 5279 and Gluconobacter oxydans TBRC 4013 for mangosteen vinegar fermentation using Taguchi design and its physicochemical properties. Foods, 12(17), 3256. https://doi.org/10.3390/foods12173256

Saha, D., & Kumar Das, P. (2024a). Perspective chapter: Bioconversion of agricultural and food wastes to vinegar. Food Science and Nutrition. https://doi.org/10.5772/intechopen.109546

Saha, D., & Kumar Das, P. (2024b). Perspective chapter: Bioconversion of agricultural and food wastes to vinegar. Food Science and Nutrition. https://doi.org/10.5772/intechopen.109546

Santiago, M. M. B. R., de Ramos, J. D., Organo, M. V. M., Santiago, M. V. R., Aquino, M. C. P., & Rala, N. B. (2024). Technical evaluation of coconut sugar production methods and quality of selected processors in the Philippines. Philippine Journal of Agricultural and Biosystems Engineering, 20(2), 23–36. https://doi.org/10.48196/020.02.2024.02

Secretaria, M. I., Ebuna, R. M., & Magat, S. S. (2003). On-farm production and processing of selected coconut sap-based natural and nutritious food products from the SCTNP scheme. Coconut Research & Development Journal, 19(2), 34–46. https://doi.org/10.37833/cord.v19i02.375

Shanika, H. K. V., & Wansapala, M. A. J. (2018). Optimization of submerged batch fermented coconut water vinegar production process. International Journal of Science and Research (IJSR). https://www.ijsr.net/archive/v7i1/ART20179668.pdf https://doi.org/10.21275/ART20179668

Silayoi, P., & Speece, M. (2004). Packaging and purchase decisions: An exploratory study on the impact of involvement level and time pressure. British Food Journal, 106(8), 607–628.

Solieri, L., & Giudici, P. (2009). Vinegars of the World. Springer. https://doi.org/10.1007/978-88-470-0866-3

Stanco, M., Lerro, M., & Marotta, G. (2020). Consumers' preferences for wine attributes: A best-worst scaling analysis. Sustainability, 12(7), 2819. https://doi.org/10.3390/su12072819

Online ISSN: 3082-5121
https://journals.aloysianpublications.com
Volume 1 Issue 5 (2025)

Stoffel, E.S., Robertson, T.M., Catania, A.A., Castro, L.F., & Casassa, L.F. (2024). Descriptive temporal sensory properties and volatile composition of Pinot noir wines produced with contrasting alcoholic fermentation temperatures and cap management regimes. OENO One, 58(1). https://doi.org/10.20870/oeno-one.2024.58.1.7736

Tabago, M. K., Marmeto, M. C., Posadas, G. D., Laserna, A. K., & Garcia, J. (2024). Multi-platform metabolic profiling of the stages of production of locally made Lambanog, a traditional Philippine alcoholic beverage. Discover Chemistry, 1(1). https://doi.org/10.1007/s44371-024-00029-3

Tong, W., Chen, G., Yu, H., Wang, X., Xue, R., Yang, Y., Luo, H., & Huang, D. (2024). Dynamic changes and correlation of organic acids, physicochemical properties, and microbial communities during fermentation of Sichuan bran vinegar. Journal of Food Composition and Analysis, 132, 106355. https://doi.org/10.1016/j.jfca.2024.106355

Tuyekar, S. N., Tawade, B. S., Singh, K. S., Wagh, V. S., Vidhate, P. K., Yevale, R. P., Gaikwad, S., & Kale, M. (2021). An overview on coconut water: As a multipurpose nutrition. International Journal of Pharmaceutical Sciences Review and Research, 68(2). https://doi.org/10.47583/ijpsrr.2021.v68i02.010

Underwood, R.L., & Klein, N.M. (2002). Packaging as brand communication: Effects of product pictures on consumer responses to the package and brand. Journal of Marketing Theory and Practice, 10(4), 58–68.

United Coconut Association of the Philippines, Inc. (2022, December 15). Local coconut hybrid best for sap production. Retrieved from https://ucap.org.ph/news-manager/2022/12/local-coconut-hybrid-best-for-sap-production/

Viana, R. O., Magalhães-Guedes, K. T., Braga, R. A., Dias, D. R., & Schwan, R. F. (2017). The fermentation process for production of apple-based kefir vinegar: Microbiological, chemical and sensory analysis. Brazilian Journal of Microbiology, 48(3), 592–601. https://doi.org/10.1016/j.bjm.2016.11.006

Weilack, I., Mehren, L., & Weber, F. (2024). Pectic polysaccharides modulate colloidal stability and astringency perception of bottle-aged Cabernet Sauvignon wines. Food Hydrocolloids, 157, 110402. https://doi.org/10.1016/j.foodhyd.2024.110402

Wells, L.E., Farley, H., & Armstrong, G.A. (2007). The importance of packaging design for own-label food brands. International Journal of Retail & Distribution Management, 35(9), 677–690.

Xie, Z., Koysomboon, C., Zhang, H., Lu, Z., Zhang, X., & Chen, F. (2022). Vinegar volatile organic compounds: Analytical methods, constituents, and formation processes. Frontiers in Microbiology, 13, 907883. https://doi.org/10.3389/fmicb.2022.907883

Xu, S., Ma, Z., Chen, Y., Li, J., Jiang, H., Qu, T., Zhang, W., Li, C., & Liu, S. (2022). Characterization of the flavor and nutritional value of coconut water vinegar based on metabolomics. Food Chemistry, 369, 130872. https://doi.org/10.1016/j.foodchem.2021.130872

Zabed, H., Faruq, G., Sahu, J. N., Azirun, M. S., Hashim, R., & Nasrulhaq Boyce, A. (2014). Bioethanol production from fermentable sugar juice. The Scientific World Journal, 2014, 957102. https://doi.org/10.1155/2014/957102

Zannini, E., Lynch, K.M., Nyhan, L., Sahin, A.W., Luk, D., & Arendt, E.K. (2022). Influence of substrate on the fermentation characteristics and culture-dependent microbial composition of water kefir. Fermentation, 9(1), 28. https://doi.org/10.3390/fermentation9010028

Zhang, G., Chen, W., Chen, W., & Chen, H. (2018). Improving the quality of matured coconut (Cocos nucifera Linn.) water by low alcoholic fermentation with Saccharomyces cerevisiae: Antioxidant and volatile profiles. Journal of Food Science and Technology, 55(3), 964–976. https://doi.org/10.1007/s13197-017-3004-y

Zhang, L., Wang, M., Song, H., Liang, W., Wang, X., Sun, J., & Wang, D. (2024a). Changes of microbial communities and metabolites in the fermentation of persimmon vinegar by bioaugmentation fermentation. Food Microbiology, 122, 104565. https://doi.org/10.1016/j.fm.2024.104565

Zhang, Y., Kan, J., Liu, X., Song, F., Zhu, K., Li, N., & Zhang, Y. (2023). Chemical Components, Nutritional Value, Volatile Organic Compounds and Biological Activities In Vitro of Coconut (Cocos nucifera L.) Water with Different Maturities. Foods, 13(6), 863. https://doi.org/10.3390/foods13060863

Zhao, G.-q., Yao, Y., & Guan, J.-f. (2014). Influence of fermentation conditions on organic acids during brewing process of pear vinegar. Science and Technology of Food Industry, (03), 146–150. https://doi.org/10.13386/j.issn1002-0306.2014.03.052