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Sensory Attributes and Quality Control Properties of Pasteurized Coconut Water from Malita, Davao Occidental, Philippines

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ABSTRACT

This study examined the sensory attributes and quality control properties of pasteurized coconut water. The study utilizes a quantitative research design. It presented five formulations corresponding to five treatments: Treatment 1 consists of 100% mature coconut water; Treatment 2 is a 75:25% blend of mature and young coconut water; Treatment 3 is a 50:50% blend of mature and young coconut water; Treatment 4 is a 75:25% blend of young and mature coconut water; and Treatment 5 is composed of 100% young coconut water. Sensory attributes were assessed using a research questionnaire adopted for this purpose. The quality control parameters were determined using an 1800-UV spectrophotometer for absorbance, a pH meter to measure pH levels, and a refractometer to determine total soluble solids. Additionally, titratable acidity was measured using a titration technique. The results indicated that treatment 5 received the highest rating for appearance. Treatment 2 garnered the highest ratings for odor, while treatment 2 also achieved the highest score for taste. Treatment 3 received the highest rating for general acceptability. Significant differences were observed between treatments in terms of appearance, taste, and general acceptability, highlighting consumer acceptability for different coconut water blends. In terms of quality control properties, treatment 3, with the highest acceptability, had a pH of 5.2, a total soluble solid content of 25° Brix, a titratable acidity of 0.18, and an absorbance of 0.04 (A.U.). All treatments demonstrated excellent sensory attributes.

Keywords: Coconut water, Pasteurized, Sensory attributes, Quality control

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INTRODUCTION

Coconut water (*Cocos nucifera L.*) is an increasingly popular tropical beverage recognized for its potential health benefits and functional properties. This clear liquid, derived from coconut fruit, is being embraced as a natural sports drink and has gained global attention for its nutritional value. Firstly, coconut water may contribute to health improvements, including the reduction of kidney stone formation by decreasing crystal and stone development. Preliminary evidence also suggests benefits for heart health, although further research involving human subjects is necessary (Prades, 2012).

Its natural therapeutic properties have made coconut water a valuable resource in many regions for treating conditions like intestinal flu, cholera, and dehydration (Sunil, 2020). In the Philippines, the coconut industry plays a crucial economic role. It represents the country's primary agricultural export, with the Philippines being the world's second-largest producer of coconut products. Approximately 3.6 million hectares of coconut trees are cultivated across 68 of the 81 provinces (Moreno et al., 2020; Tacio, 2019).

Specifically, Davao Occidental is a hub for coconut and hardwood trees, with a focus on copra production, while the husk is processed for ethanol (NEDA Region 11, 2022). Despite the popularity of young coconut water, which is favored for its refreshing taste, mature coconut water remains underutilized in the beverage market. Currently, only a limited number of manufacturers, such as Franklin Baker and Century Pacific Agricultural Ventures, use mature coconut water as raw material, employing advanced processing methods like ultra-high temperature (UHT) and pasteurization (Costales, 2020). The nutrient composition of coconut drinks varies significantly based on the maturity of the coconut. Mature coconut water boasts a higher phenolic content and lower levels of monounsaturated fatty acids, with an increasing proportion of medium-chain fatty acids at each maturity stage (Appaiah et al., 2015). Research has shown that coconut drinks differ in pH, viscosity, titratable acidity, and water activity depending on their formulation (Azra et al., 2021).

To enhance the marketability of coconut water beyond local production areas, a processing method that preserves its chemical and sensory characteristics is essential. Fresh coconut water is sterile; however, exposure to air can lead to rapid oxidation and microbial contamination, thereby compromising its nutrient content (Matsui et al., 2008). Pasteurization, a mild thermal process conducted at temperatures below 100 ºC, effectively inactivates enzymes and destroys heat-sensitive microorganisms, thereby extending shelf life with minimal impact on sensory and nutritional qualities (Matsui et al., 2008).

To address the current shortage of young coconut water, developing a blended formulation that combines mature and young coconut water can add value to the coconut industry. This study aims to assess the sensory attributes and quality control properties of a blend of young and mature coconut water from Malita, Davao Occidental, Philippines. Ultimately, these findings will aid in identifying the optimal formulation of coconut water for commercialization.

MATERIALS AND METHODS

Research locale

The study was conducted at the Southern Philippines Agri-Business and Marine and Aquatic School of Technology (SPAMAST) (6025'05'' North, 125036'30'' East) located at Poblacion Malita, Davao Occidental, Philippines (shown in Figure 1). The most common coconut variety, which is the tall variety, used to prepare the prototype, was purchased from the public market in Poblacion Malita. The five (5) treatments were prepared at the food processing laboratory of SPAMAST. Moreover, the quality control parameters were analyzed at the research and laboratory services center of SPAMAST. The respondents for sensory evaluation are the currently enrolled BTLED students, faculty, and staff of the Southern Philippines Agri-business and Marine and Aquatic School of Technology (SPAMAST). The age of the BTLED students ranges from 19 to 21 years Old, while the faculty and staff range from 25 to 45 years old.

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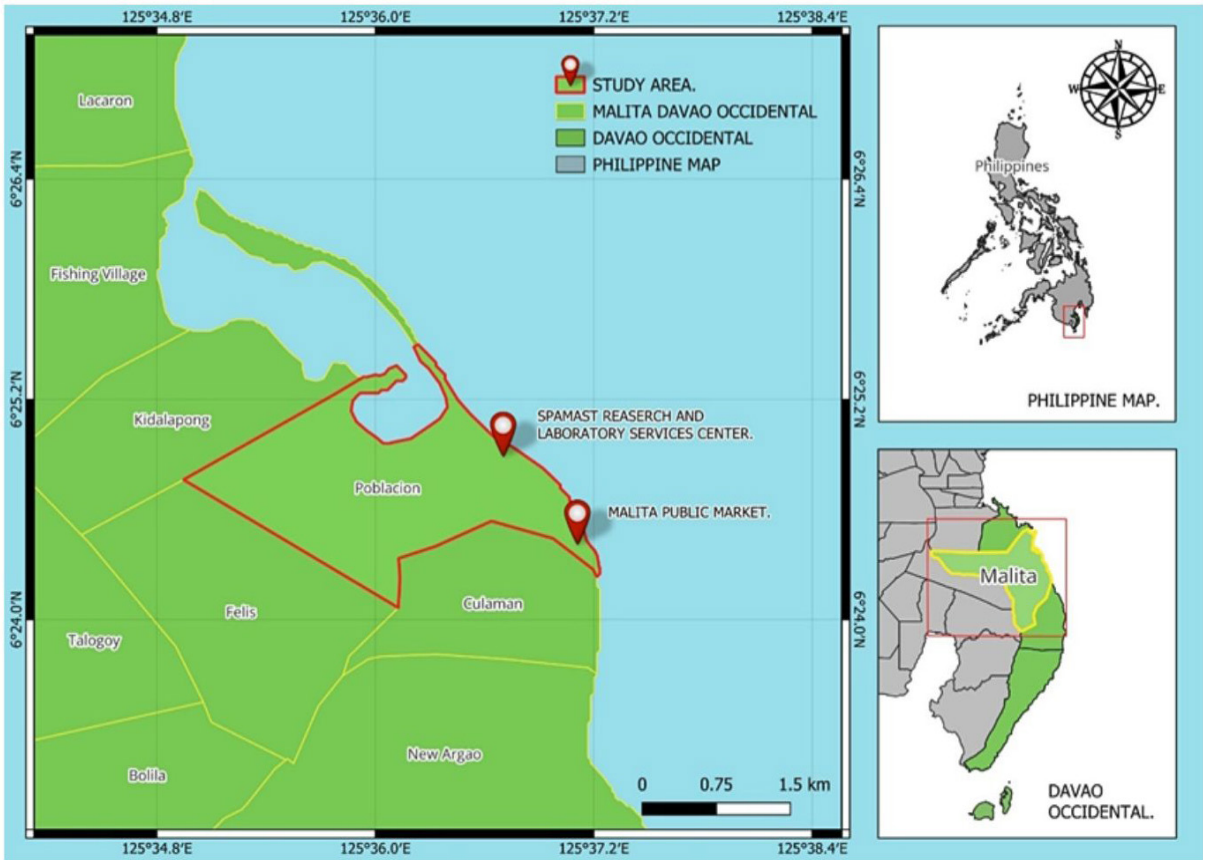

Figure 1. Showing the research locale where coconuts are purchased and processed for pasteurization.

Research design

This study utilized a quantitative research design. Five (5) treatments of pasteurized coconut water were developed and analyzed experimentally. The study employed a modified purposive stratified sampling approach, where an inclusion criterion was used to determine the respondents: semi-experts with working knowledge in product development (stratified) in our research locale. From that criterion, 10 respondents, including faculty, staff, and students (BTLED), were purposively selected.

The formulation of five treatments enabled consumers to evaluate the different blending formulations of young and mature coconut water. Moreover, it will provide comparative data on the consumer acceptability and quality control properties of pure young and mature coconut water. The respondents were the faculty, school staff, and students. The researchers used an adopted surveyquestionnaire to gather appearance, odor, taste, and general acceptability (Adubofour, 2016). Moreover, quality control analysis and the general acceptability of the product were evaluated.

Experimental design and treatments

The five formulations of pasteurized coconut water were prepared. Each formulation constitutes the individual treatment. Treatment one constitutes pure young coconut water, which was prepared by using 100 mL of young coconut water and 5 grams of sugar; Treatment two is the 3:1 ratio, which comprises 75 mL of young coconut water, 25 mL of mature coconut water, and 5 grams of sugar; Treatment three is the 2:2 ratio consisting of 50 mL of young coconut water, 50 mL of mature coconut water, and 5 grams of sugar; and Treatment four is the 1:3 ratio consisting of 25 mL of young coconut water, 75 mL of mature coconut water, and 5 grams of sugar. The fifth treatment consists of pure mature coconut water, with 100 mL of mature coconut water and 5 grams of sugar. All the prepared treatments were pasteurized at 80°C for 5 min. The pasteurized coconut water was kept in the chiller for further analysis.

Raw materials procurement and preparation

Figure 2. Mature nuts (A); Young coconut (B).

The coconut variety collected and purchased in the Public Market of Malita is probably Laguna Tall (LAGT), which is considered a significant tall population cultivated in the Philippines. The LAGT cultivar shows strong genetic potential as a pure population. As a late-bearing tall variety, Laguna Tall produces a large quantity of medium-sized, round nuts, with a yield potential of 12,799 nuts and 3.5 tons of copra per hectare. This variety exhibits notable tolerance to strong winds and resistance to Phytophthora blight disease. Tall varieties serve as the backbone of coconut production in the Philippines, characterized by their height and longevity. Among these, Laguna Tall stands out and is highly valued for its copra and oil production. These palms can reach heights of 20-30 meters and have lifespans of 80 years or more. Their adaptability to various climates makes them a staple on many farms. Laguna Tall is particularly renowned for its high copra yield, making it an ideal location for coconut oil production. It typically takes about 6-10 years for these trees to bear fruit, promising a long and productive lifespan (Punzalan et al., 2019). The estimated weight of the fruit is 1,305 grams, with a husk weight of 365 grams, a shell weight of 220 grams, a meat weight of 430 grams, and a water weight of 291 grams (Coconut Variety in the Philippines, 2023). Coconut trees with tall varieties are highly abundant in the upland and lowland, and constitute the beach forest of Malita, Davao Occidental, as reported by Cañeda et al. (2025).

Figure 3. Preparation of the pasteurized coconut water product prototype (A, B, C, D).

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In the development of the product prototype (Figure 3), young and mature coconuts from the tall variety were purchased in the public market in Malita, Davao Occidental, Philippines. The coconuts were carefully selected and washed thoroughly with tap water. Sugar was bought from a local grocery store. Five beakers were prepared, five flasks were used to prepare five formulations, and a Bunsen burner was used for pasteurization. The researchers wore safety goggles for eye safety and safety gloves for handling the flasks heated in the Bunsen burner. For proper handling,an experimental crucible tong was used. The researchers purchased three pieces of young coconuts, characterized by their green exocarp, and three mature coconuts, characterized by their Light brown exocarp, for sensory evaluation. There are a total of nine pieces of young coconut and nine pieces of mature coconut used in the conduct of the study for the triplicate sensory evaluation (Figure 2). The researcher only used the available and abundant variety of tall coconuts in the market.

Identification of the maturity of coconut water

To assess the maturity of the coconut, nuts were tapped; a solid sound was considered just-matured nuts (6–8 months), and a hollow sound was found later in nut development as the juice volume declined. Young coconuts were harvested 6–9 months after flowering, as the nut approaches full size and the skin is still green. In immature nuts, the skin surface around the calyx (cap) on the top of coconuts is creamy white or whitish yellow. When the area surrounding the cap is green and the coconut is 10 to 12 months old, it is considered mature. The skin changes from green to yellow to brown at maturity, and the rat's tail is entirely brown. Gray skin indicates the nut is old (Paull and Ketsa, 2015). The researchers based their findings on the color variations of the coconut husk, where young coconuts are green and mature coconuts are brown (Danahy, 2022). The green color of the coconut skin is the primary basis for determining the maturity of the coconut water. A green cap indicates a young coconut, while a yellow to brown cap indicates a mature coconut.

Production flow of pasteurized coconut water

The coconut water was manually drilled using a manual driller, and the coconut water of young and mature coconuts was stored separately in a closed and transparent container. The collected water samples were brought to the research and laboratory services center of SPAMAST to prepare the five treatments.All glassware, kitchenware, and equipment used in product development were thoroughly cleaned and sterilized to ensure the safety and cleanliness of the product. The following formulations of treatments were constituted: treatment one is pure, or 100 mL of young coconut water; treatment two is the 3:1 ratio, or 75 mL of young coconut and 25 mL of mature coconut water. The third treatment is a 2:2 ratio, consisting of 50 mL of young coconut and 50 mL of mature coconut water. Treatment four is the 1:3 ratio, 25 mL of young and 75 mL of mature coconut water. The fifth treatment is pure, or 100 mL of mature coconut water. Treatments five were added with five grams of sugar. Treatments 1–5 were subjected to a vortex mixer for proper blending. The formulations were pasteurized at 80°C for 5 minutes on a hot plate. The five treatments were analyzed using the following parameters: total titratable acidity, total soluble solids, pH, and absorbance profile. The five treatments of pasteurized coconut water were sensory rated by 30 respondents on a 9-point hedonic scale using the standard score sheet for sensory evaluation of coconut water by Adubofour (2016). Scoring was conducted based on four parameters: appearance, odor, taste, and general acceptability, following the protocol outlined by Ma et al. (2019).

Quality control analysis

To determine the pH, the pH meter was plugged in and allowed to warm up for 5 to 10 minutes. The researchers washed the glass electrode with distilled water and gently cleaned it with soft tissue. The electrode was placed at pH 7 to buffer the solution and to set the pH meter to 7. I removed the electrode, washed it with distilled water, cleaned it, and dipped it in the pH four buffer solution. The pH readout meter value was adjusted using the slope switch and repeated with pH seven and pH four buffers until a correct and stable reading was displayed. While moving and cleaning the electrode, the selector switch was turned on in standby mode. Switch to pH mode for accurate pH recording.

The researchers placed the electrode on the formulated treatments, and pH was determined.

To determine the total soluble solids, each sample collected from different formulations of coconut water is poured into a 500 mL beaker. With a magnetic rod and magnetic stirrer, the samples were stirred for 10 minutes to remove gases from the samples. The Brix value is a parameter used to measure the sugar content of beverages using a refractometer. This is done by calibrating the refractometer using distilled water or Brix solution (Wilberforce, 2016).

In the determination of titratable acidity, the method described by Oladipo et al. (2014) was used. Briefly, 10 grams of pasteurized coconut water were dissolved in 30 mL of distilled water and mixed thoroughly. A few drops of phenolphthalein indicator were added to the mixed solution. It was titrated against the standard 0.1 N sodium hydroxide solution until a pale pink color persisted for 10-15 seconds, indicating complete neutralization. The titratable acidity was calculated using lactic acid and the equation below.

$$\text{Titratable acidity (\%)} = \frac{\text{Vol. NaOH used (ml) x 0.1 NaOH x milliequivalent factor x 100}}{\text{Mass of sample (g)}}$$

To determine the absorbance profile, A UV-Vis spectrophotometer (UV-1800) in the 190–790 nm wavelength range was used to measure sample absorbance profiles. The measurement was conducted twice, and the results were averaged. Spectrophotometry results were interpreted as a line chart between wavelength (x-axis) and absorbance (y-axis) (Adeeyinwo et al., 2013).

Evaluation of consumer acceptability

The prepared coconut water was evaluated for its sensory characteristics, including appearance, odor, taste, and overall acceptability, by faculty, school staff, and students at the Southern Philippines Agri-Business and Marine and Aquatic School of Technology. An adapted survey questionnaire was employed to quantify the responses of the sensory panelists. The questionnaire used was based on the work of Adubofour (2016) and was used to gather data on consumer acceptability. Adubofour et al. (2016) used a 9-point hedonic scale in rating the sensory attributes of coconut water. The 9-point hedonic scale has a Cronbach's alpha reliability score ranging from 0.78 to 0.92 (W Jirangrat et al., 2012), indicating greater reliability, with values typically above 0.7 considered acceptable. The product ratings provided by the sensory panelists were analyzed using variance analysis. The sensory evaluation followed the protocol established by Ma et al. (2019). The procedure for the sensory evaluation was adopted from Adubofuor et al. (2016). A total of thirty respondents, comprising students, faculty, and staff from the Southern Philippines Agri-Business and Marine and Aquatic School of Technology (SPAMAST), were purposively selected and invited to participate in each scheduled sensory test. There are three separate schedules of sensory tests conducted. These respondents were chosen for their relevant knowledge of product development processes and represent the target market for the product at the school level. Among the thirty respondents, ten faculty members were selected from the Institute of Teacher Education, as well as the Fisheries, Marine Sciences, and Agri-business programs, all of which are directly related to product development. The remaining respondents include ten staff members from the administration and ten BTLED students. Each participant rated the samples based on their preferences for appearance, odor, taste, and overall acceptability using score sheets. Five treatments of coconut water were served in randomly numbered, scentless shot glasses on a tray. To eliminate any residual taste between samples, each participant was provided with a cup of drinking water. The first part of the survey questionnaire included a consent form, followed by parameters for assessing consumer acceptability. Each participant will complete the sensory evaluation in triplicate for each treatment in three separate schedules to validate the sensory rating of each participant. The participants will provide ratings to the five treatments using the survey instrument of Adubofour et al., 2016, where 7-9 if the appearance is, are transparent with no observed impurities, 4-6 if the appearance Less transparent, a small amount of condensate while 1-3, if the product is turbid and has anomalous color.

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For odor, a rating of 7-9, if the product has Appropriate proportion of coconut water flavor, pure aroma, no objectionable odor, 4-6 rating if Appropriate proportion of coconut water flavor, pure aroma, no objectionable odor, while 1-3 rating if no coconut water flavor is present or off taste. Moreover, in terms of taste, a rating of 7-9 if the product has a good mouthfeel, appropriate consistency, refreshing, and exquisite, and a rating of 4-6 if the product has a general mouthfeel, relative consistency, and refreshing while 1-3 rating if it has bad mouthfeel, inappropriate consistency and not refreshing. Lastly, for general acceptability, a rating of 7-9 is considered excellent, a rating of 4-6 indicates general acceptability, and a rating of 1-3 is considered unacceptable.

Statistical tool

Mean and standard deviation were used to assess the statistical significance of the physicochemical properties and consumer acceptability of the various treatments. Additionally, a one-way analysis of variance (ANOVA) was conducted to evaluate whether significant differences in sensory attributes existed among the treatments using IBM SPSS software. The study utilized a modified purposive stratified sampling method to select respondents, ensuring randomization in their ratings. To evaluate the consumer acceptability of various coconut water formulations, we employed analysis of variance (ANOVA), a statistical technique that reveals consumer preferences. This approach is supported by previous research, including studies by Hought et al. (2002), Guardian et al. (2021), Tapia and Lee (2022), Park et al. (2023), and Aini et al. (2024), who also used ANOVA to analyze consumer preferences in a range of food products. The consistent application of ANOVA in these studies highlights its significance in understanding the dynamics of food formulation and consumer acceptability.

RESULTS

Thirty respondents evaluated various treatments of pasteurized coconut water using a 9-point hedonic scale, guided by a standard score sheet designed for sensory evaluation. The scoring criteria encompassed four parameters: appearance, odor, taste, and overall acceptability. Table 1 presents the sensory evaluation results across these categories. The appearance ratings ranged from 6.84 to 7.81, with Treatment 5 receiving the highest score and Treatment 1 the lowest at 6.84. Treatment 5 was distinguished by its transparent appearance and the absence of impurities. For odor, the ratings varied from 7.12 to 8.01, with Treatment 2 receiving the most favorable ratings from respondents. In contrast, Treatment 5 received the lowest acceptability rating. Treatment 2 was commended for its well-balanced coconut water flavor, pure aroma, and lack of off-putting odors. In terms of taste, scores ranged from 7.04 to 7.37, with Treatment 2 again standing out as the favored option due to its pleasing mouthfeel and refreshing, exquisite consistency. Lastly, the overall acceptability ratings fluctuated between 7.23 and 8.01, with treatment 3 achieving the highest score for overall sensory attributes, while treatment 2 received the lowest. treatment 3 demonstrated excellent product acceptability. The overall results indicate that treatment 3 possesses the highest sensory and acceptability attributes, followed by treatments 2, 5, and 4, with treatment 1 receiving the lowest combined rating. Based on these cumulative results, it can be inferred that mature coconut water can effectively be blended with young coconut water without significant differences in sensory attributes and general acceptability.

Table 1. Sensory evaluation of pasteurized coconut water.

Treatments	Appearance	Odor	Taste	General acceptability	Mean
1	6.84	7.27	7.31	7.27	7.17
2	7.12	8.01	7.37	7.23	7.43
3	7.51	7.71	7.21	8.01	7.61
4	7.24	7.42	7.02	7.26	7.24
5	7.81	7.12	7.04	7.26	7.31

Table 2 elucidates the results of the variance analysis concerning the sensory attributes of coconut water. The statistical findings indicate that the characteristics of appearance (p-value = 0.01), taste (p-value = 0.000), and overall acceptability (p-value = 0.000) of the coconut water samples exhibit significant statistical differences, as evidenced by p-values falling below the conventional threshold of 0.05. This provides robust evidence to support the hypothesis that varying treatments yield differentiated levels of acceptability regarding these specific attributes. In contrast, the parameter of odor (p-value = 0.09) fails to achieve statistical significance, as its p-value exceeds the 0.05 criterion, signifying that the odor profiles across the five treatments are statistically indistinguishable. The analysis further dissects variance results derived from post-hoc tests that focus on three sensory attributes—appearance (refer to Table 4 in the appendices), taste (refer to Table 5 in the appendices), and general acceptability (refer to Table 6 in the appendices)—across five distinct pasteurized coconut water treatments. For the appearance attribute, treatment 2 manifests the highest variance (0.989), whereas treatment 5 reflects the lowest variance (0.01). Treatment 1 exhibits a variance greater than treatment 2 (0.98) yet is lower than that of treatment 3 (0.29). In the context of taste, both treatment 1 and treatment 2 display the highest variance (0.100), while treatment 3 reveals the lowest variance (0.026). It is noteworthy that treatment 4 shares no variance with treatment 3, and its variance in relation to treatment 5 equates to 1.000, indicative of perfect similarity in this respect. Regarding the general acceptability metric, treatments 1, 2, 4, and 5 maintain equal variance, as evidenced by a p-value of 1.000, while treatment 3 exhibits no variance in comparison to the other treatments. This pattern of results highlights a consistent perception of acceptability across the majority of treatments, except for treatment 3, which signals a notable deviation in sensory evaluation.

Table 2. Statistical analysis of the sensory attributes of pasteurized coconut water.

		Analysis of Variance (ANOVA)				
		Sum of squares	***df***	**Mean square**	**F**	**Sig.**
Appearance	Between Groups	38.12	4	9.53	3.32	0.01
	Within Groups	1277.54	445	2.87		
	Total	1315.66	449			
Odor	Between Groups	17.17	4	4.29	2.01	0.09
	Within Groups	949.09	445	2.13		
	Total	966.26	449			
Taste	Between Groups	46.49	4	11.62	6.33	0.000
	Within Groups	817.51	445	1.84		
	Total	864.000	449			
General acceptability	Between Groups	51.08	4	12.77	7.25	0.000
	Within Groups	773.000	445	1.74		
	Total	824.08	449			

Table 3 displays the quality control properties of various coconut water treatments, indicating a pH value range of 4.9 to 5.5. Treatment 1 is the most acidic, while treatment 5 is the least acidic. In terms of absorption profile, the range is from 0.03 to 0.07, with treatment 1 being the most transparent and Treatment 5 the least transparent. When considering total soluble solids, treatment 1 has the highest degree of Brix, whereas treatment 5 has the lowest. Furthermore, concerning titratable acidity, treatment 5 has the lowest acidity, while treatment 2 has the highest. The results highlight that the maturity of coconut water directly influences its quality control

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parameters. Pure young coconut water is more acidic than pure mature coconut water. Additionally, young coconut water exhibits a low absorptive profile, which reflects its clarity, while mature coconut water demonstrates the highest absorptive profile. Notably, young coconut water has a higher degree of Brix compared to mature coconut water. In contrast, mature coconut water has the lowest titratable acidity, while the blending of young coconut water results in significantly higher titratable acidity.

Table 3. Quality control properties of pasteurized coconut water.

Treatments	pH	Absorption profile (AU)	Degree brix	Titratable acidity (%)
Treatment 1: Pure young coconut water	4.9	0.03	26	0.20
Treatment 2: 3:1 Ratio of young and mature coconut water	5.0	0.06	25	0.23
Treatment 3:2:2 Ratio of young and mature coconut water	5.2	0.04	25	0.18
Treatment 4.1:3 Ratio of young and mature coconut water	5.4	0.05	24	0.19
Treatment 5. Pure mature coconut water	5.5	0.07	23	0.13
Mean	5.2	0.05	24.6	0.19
Standard Deviation	0.23	0.01	1.14	0.03

DISCUSSION

The sensory qualities of a product are essential in shaping consumer preferences and enhancing enjoyment. Elements such as color, appearance, taste, and texture play a significant role in determining a product's acceptability among consumers, which ultimately affects its market success (Concas et al., 2019; Delahunty and Drake, 2004). Research by Moskowitz and Krieger (1995) highlighted the importance of identifying sensory attributes that enhance overall liking, as this knowledge can inform effective product evaluation criteria. Similarly, Ritvanen et al. (2005) noted that, beyond assessing general chemical and sensory quality, it is vital to pinpoint the specific sensory characteristics that make a product appealing or unappealing to consumers. Factors that showed a strong positive correlation with overall preference included taste, aroma, sweetness, aftertaste, texture, and flavor. This suggests that sensory characteristics, including aroma, sweetness, aftertaste, texture, and flavor, have a significant impact on a consumer's choice and purchasing decisions for a particular product (Lee and Ju, 2024).

The sensory qualities of pasteurized coconut water are notably appealing to consumers, as highlighted by the study's compelling findings. Notably, coconut water subjected to high-pressure processing and brief, high-temperature applications received the highest marks for acceptability. In contrast, coconut water processed at short, high temperatures garnered low ratings for both appearance and taste, while the water treated through high-pressure methods fell short in terms of taste and overall acceptability (Ma et al., 2019). Furthermore, the pasteurized coconut water outshone three fresh varieties—tall, dwarf, and hybrid—demonstrating superior acceptability (Asaad et al., 2022). This pasteurized product not only surpassed the acceptability levels of coconut water derived from various species tested at different maturity stages but also positioned itself as a standout on the market (Assa et al., 2010).

Moreover, the appeal of pasteurized coconut water rivals that of other beverages, showcasing sensory attributes such as color, taste, cloudiness, and overall acceptability. This includes comparisons to vacuum-treated coconut water and those processed through microwave and combination techniques (Juli et al., 2023). Remark ably, its acceptability is on par with microfiltered coconut water, tender coconut water with additives, and even tender coconut water blended with honey—all without any additional ingredients (Assa et al., 2013; Mahnot et al., 2019). The soaring popularity of coconut water can largely be attributed to its delightful taste, enticing appearance, and numerous health benefits (Hidalgo et al., 2017).

The rising consumer awareness of functional foods has significantly boosted the appeal of coconut water. Many consumers cite not just it's refreshing taste but also its impressive health benefits, such as promoting kidney and bladder health, preventing dehydration, and enhancing immune function, as compelling reasons for their choice. Furthermore, a notable preference for fresh coconut water over bottled options stems from perceptions of flavor enhancement and the higher cost associated with bottled varieties (Rajkumar, 2016). The growing recognition of the medical benefits of coconut water has only fueled its popularity. A study by Yaw Codjoe et al. (2021) reveals that many consumers understand the potential of coconut water to protect against heart disease, lower cholesterol levels, improve blood pressure, alleviate diarrhea, and facilitate diabetes management. Traditionally, Cocos nucifera water has also been revered for its ability to treat wounds, inflammation, body pain, and fever (Cabugatan et al., 2022).

In terms of pH levels, the initial measurements across different maturity stages were strikingly consistent, though slight variations were observed with maturation. Overall, the pH tended to rise as coconuts matured from 7 to 9 months, followed by subtle fluctuations in later stages. Initially, the pH increased steadily, dipped slightly during the maturity stage 2, and then rose again in stage 4. These patterns resonate with the findings of Pue et al. (1992), who documented a pH increase from 4.7 to 6.3 as coconuts matured. Titratable acidity, expressed as a percentage of malic acid, plays a crucial role in determining the flavor profile of coconut water. Prior studies indicate that the highest acidity values are found in the young maturity stage, while the lowest reside in the older stages (Kannangara et al., 2018). The total sugar content in coconut water remained relatively stable throughout the maturation process, echoing the findings of Campos et al. (1996). Interestingly, while slight increases in total solids content were observed according to maturity, a significant decline in these levels was noted upon maturation (Jayalekshmy et al., 1986; Appaiah et al., 2015). Lastly, turbidity levels reveal a striking difference between young and mature coconut water when stored at low temperatures. Young coconut water remarkably maintains a low turbidity level, with a mere slight increase noted after 100 hours (Andini et al., 2024). In contrast, mature coconut water exhibits a dramatic increase in turbidity during storage, peaking at 102 hours. This indicates that young coconut water not only retains its freshness but also its clarity over time. These findings align with those of Wariyanti (2008), who observed that young coconut water consistently exhibited superior clarity compared to its mature counterpart. Overall, sensory attributes and stringent quality control parameters wield a profound influence on consumer acceptability in today's competitive coconut water market.

CONCLUSIONS

The high acceptability of sensory attributes for the various formulations indicates a strong market potential for this product. The positive response indicates a growing interest in nutritious and refreshing beverage options that can compete with other health drinks on the market.

The significant differences in appearance, taste, and overall acceptability among the treatments highlight the importance of formulation in product development. The Makers of coconut water can leverage these insights to create products that align closely with consumer preferences, particularly in optimizing flavor profiles and visual appeal.

The findings highlight the significant role of sensory attributes, particularly appearance and taste, in shaping consumer choices. The data suggests that consumers are drawn to a visually appealing product that also delivers on flavor. This can guide marketing strategies focused on promoting these sensory qualities.

The study highly recommends that appropriate packaging and serving chilled coconut water can further enhance the consumer experience. Packaging that maintains product integrity and showcases its appeal can influence purchasing decisions, while serving at the right temperature supports the refreshing quality consumers seek.

The need to explore the shelf life of this blended coconut water prior to commercialization suggests a pathway for further research.

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Understanding how long the product can maintain its quality and safety will be crucial for market readiness and consumer trust.

With an increasing focus on health and wellness, the introduction of nutritious beverage options, such as blended coconut water, aligns well with consumer trends toward healthier lifestyles. This positions the product favorably within a growing health-conscious market.

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AUTHOR CONTRIBUTIONS

The first authors are responsible for conceptualizing, formulating, and drafting the research paper. The second authors assisted and guided the first authors in formulating the introduction, methodology, and overall write-ups. The second author also assisted the first author in their quality control analysis in the laboratory. The second author polished and converted the drafted paper into a publishable format.

CONFLICT OF INTEREST

The authors declared no conflict of interest in the study's outcome.

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