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Changes in Coconut Water Quality (*Cocos nucifera* L) During the Storage Process

Nurlisa Andini[1], Junaedi Muhidong[1], Haerani[1] ,Febriana Intan Permata Hati[1]
[1]Agriculture Engineering Study Program, Department of Agricultural Technology, Faculty of Agriculture, Hasanuddin University

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ABSTRACT

Coconut water (*Cocos nucifera* L.) is a natural beverage widely recognized for its high nutritional and health benefits. It contains essential electrolytes such as potassium, magnesium, and calcium, along with various vitamins and antioxidants; however, the quality deteriorates over time during storage. This study compares changes in the quality of young and mature coconut water stored at cold and ambient temperatures over a specific period of time. The research method includes measuring turbidity levels, pH, and total dissolved solids (TDS). The results indicate that both young and mature coconut water experience degradation in quality during storage, although at different rates. Storage at ambient temperature leads to a more rapid decline in quality than cold storage for both maturity types. Additionally, microbial growth is more frequently detected in coconut water stored at ambient temperature, particularly in mature coconut water. This study summarises that the quality of young and mature coconut water is influenced by storage temperature, with mature coconut water deteriorating at a higher rate. These findings can be recommended for storing coconut water at cold temperatures and consuming it shortly after opening it.

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Corresponding Author(s):

Junaedi Muhidong
Faculty of Agriculture, Hasanuddin University
Jl. Perintis Kemerdekaan KM.10, 90245, Tamalanrea, Makassar, Sulawesi Selatan, Indonesia
Email: junaedi@unhas.ac.id

1. INTRODUCTION

The coconut tree is one of the most important crops in Indonesia, playing a significant role in both culture and economy. Often referred to as the "tree of life," every part of the coconut tree has valuable uses. The coconut fruit, in particular, is extensively utilized in various industries and daily life. The coconut meat is commonly processed into coconut milk or oil, with by-products such as fiber, shell, and coconut water. However, young coconut water is often discarded after consumption because it has a short shelf life due to microbial contamination and a decline in pH. Proper storage methods, such as using airtight food-grade containers and refrigeration, can slightly extend its shelf life (Lempoy et al., 2020). Each tree component—from leaves and fruit to trunk and roots—possesses distinct advantages. The fruit, in particular, is a key commodity widely utilized in various industries and everyday life; for example, the flesh is frequently processed into coconut milk or oil, while by-products such as fiber, shell, and coconut water are also generated. However, young coconut water is often partially discarded after consumption because it has a short shelf life due to contamination and a decline in pH. In fact, its longevity can be marginally improved by storing it in clean, airtight containers made of food-safe materials—such as high-quality glass or plastic—and keeping it at low temperatures; similarly, mature coconut water may also be preserved a little longer under refrigeration (Langkong et al., 2018).

For both young and mature coconut water contains numerous health benefits. Young coconut water is characterized by its sweet taste and is rich in essential electrolytes such as potassium, sodium, and magnesium, in addition to natural sugars, vitamins, and minerals. Conversely, mature coconut water is less sweet, yet its composition is not markedly different from young coconut water's, particularly regarding electrolytes, though present in lower amounts. Typically, mature coconut water contains more fat and less sugar compared to young coconut water. Owing to their isotonic properties and abundant nutritional benefits, both types are popular beverages for alleviating dehydration (Pramesti & Puspikawati, 2020)

Coconut water exhibits a short shelf life because it is highly susceptible to microbial contamination. Once extracted from its husk and shell, the water rapidly deteriorates due to direct microbial invasion when transferred into an open container. On the contrary, storing coconut water in an airtight container prolongs its freshness slightly; for instance, mature coconut water may last only 2–6 hours, while young coconut water can endure for 6–12 hours at room temperature. Moreover, when refrigerated, mature and young coconut water may remain viable for approximately 2–3 days, as low temperatures inhibit microbial growth (Ramadhani, 2022).

Storage temperature greatly influences the rate of chemical reactions and microbial growth in coconut water of chemical reactions and microbial activity in coconut water. Low temperatures inhibit microbial proliferation and slow the chemical processes that degrade quality, whereas high temperatures accelerate these changes. Ambient humidity also plays a crucial role; high humidity may foster the growth of undesirable microorganisms, while low humidity can lead to water evaporation and alterations in the concentration of the water's components. Additionally, exposure to light can hasten oxidation and color changes in coconut water. Thus, storing the water in a dark environment and using airtight, lightproof packaging can better preserve its quality (Sangadji et al., 2022).

Since fallen coconuts may become contaminated with foreign items during harvesting, measuring turbidity is part of the post-harvest management of coconuts (Mela, 2020). As a result, turbidity measurement is an essential step in evaluating the quality of coconut water. A rise in turbidity may be a precursor to microbial contamination-induced quality deterioration. While contained within the fruit's flesh tough shell, coconut water is sterile; but, as soon as it is placed in a container, it becomes contaminated by microorganisms. As a result, coconut water cannot be kept in an open container at room temperature for an extended period of time. On the other hand, turbidity development is slowed when refrigerated in an airtight container because microbial activity is reduced. Furthermore, the maturity of the coconut influences the rate at which turbidity increases, with mature coconut water becoming cloudy more rapidly than young coconut water due to its higher acid content (Burns et al., 2020).

The quality of coconut water is also determined by its pH level. A decline in quality or microbiological contamination is indicated by deviations from the typical pH range, which is roughly 5.4–7 for mature coconut water and 4–6 for young coconut water. Constant pH level monitoring gives information about the water's general quality and cleanliness. Temperature and the surrounding environment considerably impact pH by regulating how quickly bacteria can contaminate the water; for example, microbial activity is substantially slower at low temperatures than at room temperature. Because pH levels that are too high or too low can harm health, the type of storage container helps maintain the proper pH, which is crucial for guaranteeing the water's safety for human consumption (Lukiyono & Zain, 2022).

Furthermore, preserved coconut water has total dissolved solids (TDS), which are the minerals, salts, and other substances contained in the water. TDS levels may vary during storage due to temperature, storage length, and hygienic conditions. TDS usually rises with time as water evaporates, resulting in a larger concentration of leftover minerals and chemicals. However, these alterations might differ depending on extrinsic conditions. TDS levels must be monitored to avoid substantial changes that may influence the flavor and nutritional quality of coconut water. This is especially significant in view of the abundance availability of packaged coconut and isotonic drinks, which involves the measurement of TDS under varied storage temperatures (Amanda et al., 2019).

The influence of storage methods at different temperatures on the quality of coconut water is substantial. Research has demonstrated that low storage temperatures—between 4–10°C—can effectively slow down microbial growth and enzymatic activity, thereby delaying quality degradation. Refrigeration helps preserve the nutritional content and fresh taste of coconut water and extends its shelf life. In contrast, storage at higher temperatures, such as above 28°C, accelerates the proliferation of pathogenic microorganisms and induces rapid changes in taste, aroma, and color, ultimately leading to diminished quality. Consequently, the shelf life of coconut water may be very brief, lasting only a few days, as high temperatures expedite both microbial growth and enzymatic activity (Rindawati, 2020).

Based on the foregoing discussion, this study was undertaken to determine how long mature and young coconut water can maintain their quality during storage. The investigation focused on assessing the rate at which the water becomes turbid, the decline in pH, and the increase in total deposits in both mature and young coconut water until these parameters reach a constant value.

2. MATERIALS AND METHODS

2.1. Materials

The tools used in this study include a turbidity meter, a pH meter, a total dissolved solids (TDS) meter, 100 ml glass bottles, pipettes, a refrigerator, and a camera.

The materials used in this research consist of young coconut water and mature coconut water.

2.2. Research Procedure

The procedure for investigating the changes in the quality of coconut water (Cocos nucifera L.) during the storage process (Figure 1) is as follows:

2.2.1. Initial Quality Measurement of Coconut Water

Initially, mature and young coconuts are prepared, and their husks are removed to extract the water. The extracted water is then transferred into storage containers. Three distinct measurements are subsequently conducted on both mature and young coconut water to determine their baseline quality prior to storage: turbidity is measured using a turbidity meter, acidity (pH) is assessed with a pH meter, and total dissolved solids (TDS) are quantified using a TDS meter.

2.2.2. Storage

Following the initial quality assessments, mature and young coconut water is stored using two approaches. The water is placed in containers and maintained under two conditions: at room temperature and under refrigeration. For each storage condition, three rounds of measurements are performed using a total of 12 samples. These measurements continue until the quality parameters for both types of coconut water stabilize, at which point the storage phase is concluded. A comparative analysis of the quality levels is undertaken.

2.2.3. Determination of Coconut Water Quality

Determination of the quality of the coconut water for both mature and young, which are stored under room temperature and refrigerated conditions, is done by measuring several parameters. Measurements are taken four times daily at 09:00, 11:00, 13:00, and 15:00, allowing for monitoring hourly changes in the samples. The parameters assessed include turbidity, pH, and total dissolved solids (TDS). The resulting data are tabulated and graphically represented, and the measurement process is discontinued once the variations between the mature and young coconut water samples reach a constant value or become statistically insignificant.

2.3. Research Parameters

The parameters measured to assess the changes in coconut water quality (Cocos nucifera L.) during storage are as follows:

2.3.1. Turbidity Level

Turbidity is measured using a turbidity meter (Fajar, 2022), an instrument designed to quantify the turbidity of a liquid. The procedure involves transferring a coconut water sample—prior to storage—into a turbidity tube using a pipette. The turbidity meter is activated, and the tube is inserted into the device. Measurements are recorded once the NTU (Nephelometric Turbidity Unit) value stabilizes. This process is repeated three times to ensure the accuracy of the readings, and turbidity is measured four times daily at predetermined intervals throughout the storage period for both mature and young coconut water.

2.3.2. pH

The pH of the coconut water is measured using a pH meter. Based by Wariyanti (2008), an untreated sample of either mature or young coconut water is initially measured to determine its baseline pH. After transferring the water into a container, the pH meter is activated and calibrated before being immersed in the sample. The measurement is taken after a brief waiting period. This procedure is conducted four times per day at established intervals and repeated throughout storage.

2.3.3. Total Dissolved Solids

Total dissolved solids are measured in a similar manner to turbidity and pH. The TDS measurement is performed on coconut water samples from the first to the last day of storage, with four measurements taken per day at the designated intervals. According to Monica (2021), the TDS meter is activated first, then its tip cap is removed. The instrument is immersed in the coconut water sample, and the TDS value is displayed after a short delay.

2.4. Data Analysis

The collected data will be tabulated and graphically represented. A descriptive analysis will compare the changes between mature and young coconut water samples stored at room temperature and under refrigeration based on the measured parameters.

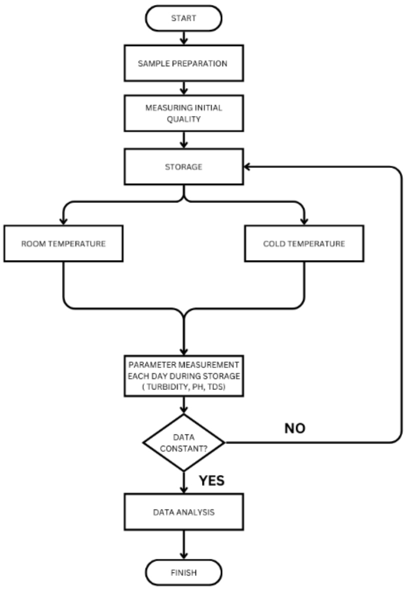

Figure 1. Flow Diagram of the Research

3. RESULTS AND DISCUSSION

3.1. Turbidity Level of Coconut Water

The coconut water's turbidity level refers to its clarity or cloudiness. Turbidity is an optical property of a liquid characterized by the scattering and diffusion of light caused by fine suspended particles rather than direct light transmission. It measures the intensity of light dispersed by these particles. The graph depicting the turbidity values of coconut water during storage is shown in this research.

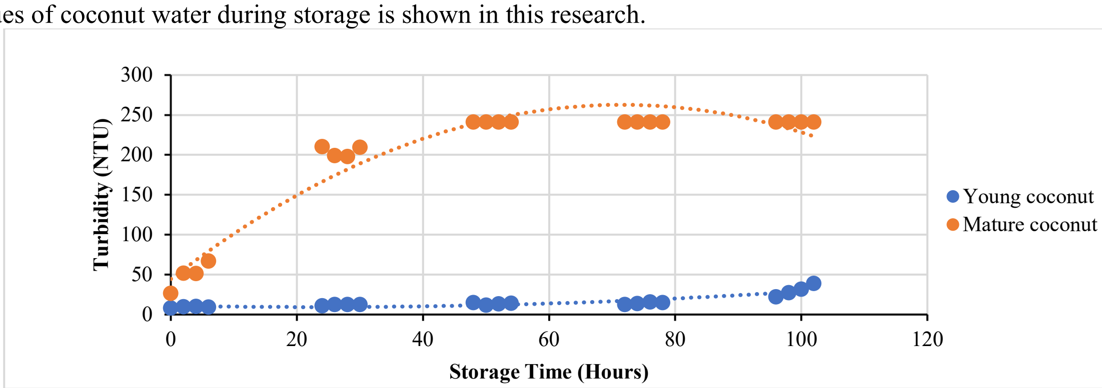

Figure 2. Graph of Coconut Water Turbidity Level During Storage Process at Cold Temperatures

In Figure 2, the turbidity levels of young and mature coconut water stored at low temperatures exhibit a distinctly significant difference. Young coconut water maintains a relatively low turbidity level, with only a slight increase observed at the 100-hour mark. In contrast, mature coconut water shows a significant rise in turbidity over the storage period, reaching up to 102 hours. This indicates that young coconut water better preserves its clarity during storage. These findings are consistent with Wariyanti (2008) who reported that young coconut water demonstrates superior clarity compared to mature coconut water.

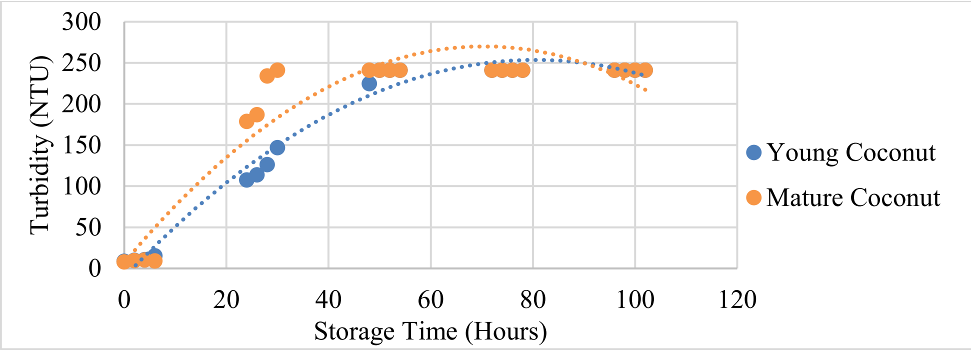

Figure 3. Graph of Coconut Water Turbidity Level During Storage Process at Room Temperature

Figure 3 illustrates the changes in turbidity levels of young and mature coconut water during storage at room temperature, revealing only marginal differences. Young coconut water appears slightly clearer than mature coconut water, as the turbidity values for mature coconut water are higher. This difference is attributed to the higher concentration of total dissolved solids—such as fibers—in mature coconut water, which can settle or interact with one another. This observation aligns with Wariyanti (2008), who noted that the elevated total dissolved solids in mature coconut water lead to a more rapid increase in turbidity compared to young coconut water.

Furthermore, Figures 2 and 3 demonstrate that the turbidity levels of young and mature coconut water differ under both refrigerated and room temperature conditions. Under cold storage, young coconut water maintains its clarity, whereas mature coconut water consistently experiences an hourly increase in turbidity. Conversely, at room temperature, neither young nor mature coconut water can preserve clarity. This finding corroborates the assertion by Wariyanti (2008) that cold storage effectively slows the degradation of young coconut water quality, while mature coconut water remains prone to turbidity increases due to its more complex compound composition.

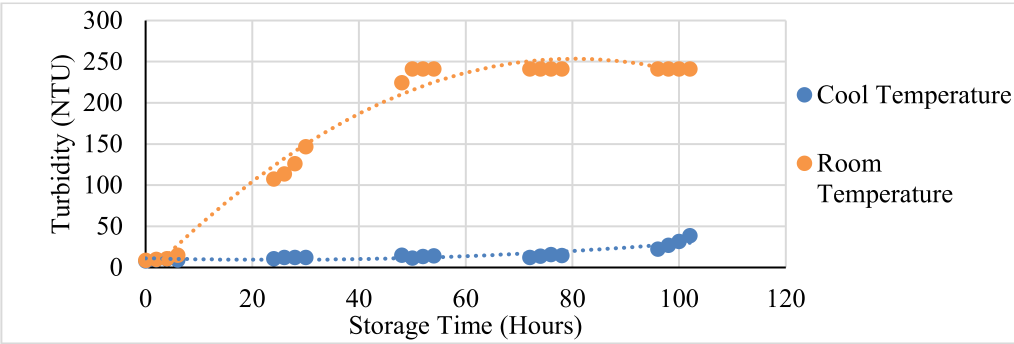

Figure 4. Graph of Turbidity Level of Young Coconut Water During Storage

In Figure 4, a significant difference is observed in the turbidity levels of young coconut water stored at cold and room temperatures. At room temperature, turbidity increases sharply within a short period and remains high throughout the storage duration. In contrast, under cold storage, turbidity remains consistently low, with only a slight increase observed at the 100-hour mark. This finding indicates that refrigeration effectively slows the processes responsible for turbidity increase, thereby better preserving the quality of young coconut water. This observation is consistent with Wariyanti (2008), who reported that cold storage significantly inhibits microbial growth and oxidation reactions, which are primary contributors to the deterioration of young coconut water quality, compared to storage at room temperature.

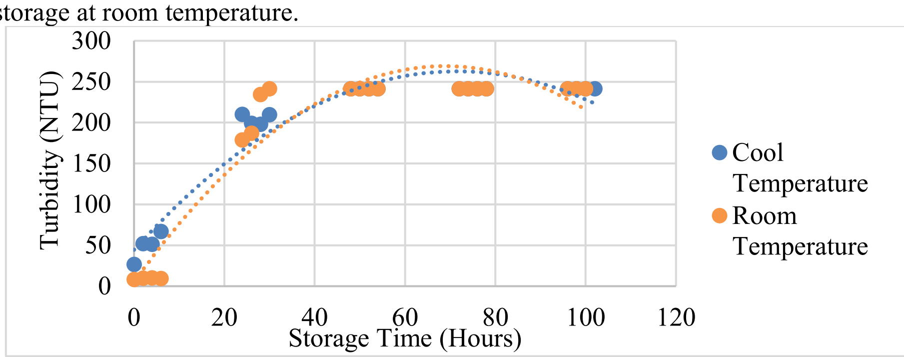

Figure 5. Graph of Turbidity Level of Old Coconut Water During Storage

Figure 5 illustrates the turbidity levels of mature coconut water under cold and room temperature storage, showing no significant differences between the two conditions. Initially, at room temperature, mature coconut water retains its clarity for a brief period. However, by the 40-hour mark, its turbidity level matches that of the refrigerated sample, and by the 50-hour mark, the turbidity at room temperature surpasses that of the cold-stored sample, continuing to rise until the end of the storage period. This suggests that while refrigeration slightly helps in maintaining clarity compared to room temperature, the difference is not substantial, and mature coconut water tends to become cloudy under both conditions. This finding aligns with Wariyanti (2008), who noted that although cold temperatures can slow down certain chemical reactions, their effect on mature coconut water is less pronounced than on young coconut water due to differences in composition.

Figures 4 and 5 collectively illustrate the differences in turbidity changes between young and mature coconut water stored at cold and room temperatures. Cold storage effectively preserves the clarity of young coconut water but is ineffective at room temperature, where turbidity increases rapidly. In contrast, mature coconut water fails to maintain clarity under either storage condition. Thus, it can be concluded that refrigeration is beneficial only for young coconut water, while room temperature storage is unsuitable for both types over extended periods.

(a) (b) (c) (d)

Figure 6. Coconut Water (a) Young Coconut Water at Room Temperature (b) Young Coconut Water at Cold Temperature (c) Old Coconut Water at Cold Temperature (d) Old Coconut Water at Room Temperature

Figure 6 illustrates the differences in the appearance of young and mature coconut water when stored at cold and room temperatures. In sections (a) and (d), it is evident that both young and mature coconut water stored at room temperature appear cloudier. This indicates that room temperature accelerates spoilage and turbidity due to microbial growth and chemical reactions. In contrast, sections (b) and (c) show that young coconut water stored at cold temperatures remains clearer, whereas mature coconut water does not exhibit the same clarity. Although refrigeration helps maintain the cleanliness and freshness of young coconut water by slowing microbial growth, it does not have the same effect on mature coconut water. Instead, mature coconut water continues to become cloudier, and temperature changes may cause fats and proteins to precipitate, forming sediment at the bottom of the container. This observation aligns with Wariyanti (2008), who stated that mature coconut water is more susceptible to chemical composition changes, leading to increased turbidity even under refrigeration due to the higher presence of organic compounds that degrade more readily.

3.1. Acidity Level (pH) of Coconut Water

The pH of coconut water refers to its level of acidity or alkalinity. Fresh coconut water is generally mildly acidic, with a pH range of approximately 4.5 to 5.5. This acidity is attributed to the presence of natural organic acids, such as citric acid and phosphoric acid. The slightly acidic pH contributes to the fresh and refreshing taste of coconut water. The following graph illustrates the pH values of coconut water during storage.

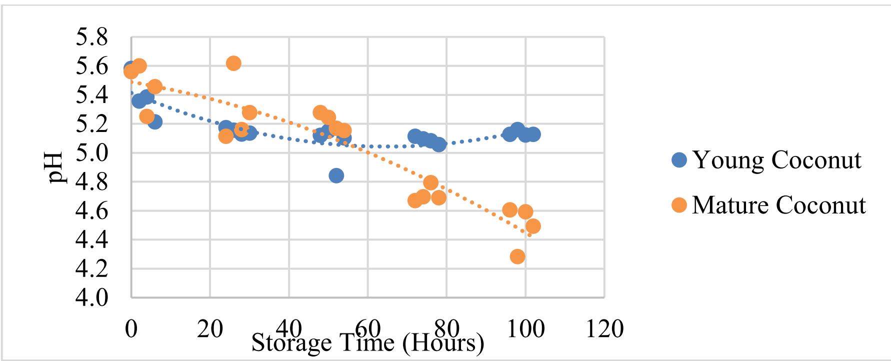

Figure 7. Graph of Coconut Water Acidity Levels During Cold Storage

The graph presented in Figure 7 illustrates that during cold storage, the pH of both young and mature coconut water decreases over time. Young coconut water, which initially has a pH of approximately 5.5, declines to around 5.0 after 100 hours, remaining within the SNI (Indonesian National Standard) range of 4.5–5.5. Meanwhile, mature coconut water, which starts at a slightly higher pH of 5.6, drops to approximately 4.4 within the same period, still within the acceptable SNI range. This suggests that cold storage is effective in maintaining coconut water pH within the permitted range, although the decline is more pronounced in mature coconut water.

This observation aligns with Lukiyono & Zain (2022), who state that differences in pH reduction between young and mature coconut water may be attributed to variations in nutrient composition and native microflora. These factors are more active in mature coconut water, leading to a more rapid decline in pH.

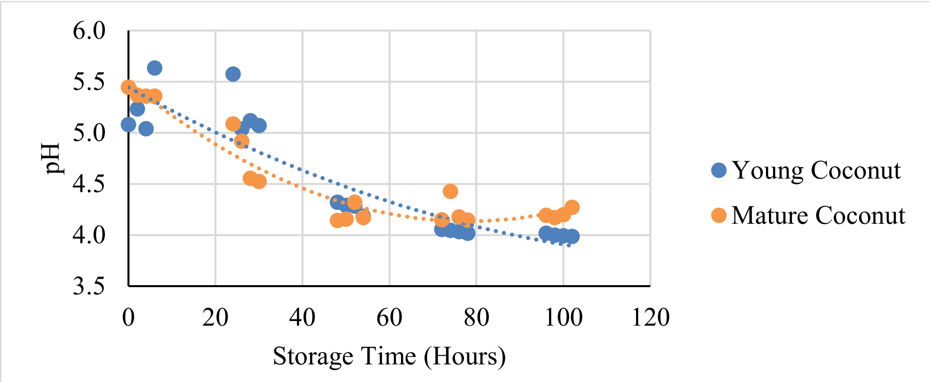

Figure 8. Graph of Coconut Water Acidity Levels During Storage at Room Temperature

The graph in Figure 8 indicates that during storage at room temperature, the pH of both young and mature coconut water declines at a similar rate, with no significant difference between the two. Initially, young coconut water has a pH of approximately 5.5, while mature coconut water starts at around 5.4, both within the acceptable SNI (Indonesian National Standard) range of 4.5–5.5. However, over time, the pH of both decreases below the SNI threshold. Within the first 40 hours, the pH drops to approximately 4.5 and continues declining to around 4.0 within 100 hours.

This trend demonstrates that storage at room temperature leads to a rapid and significant reduction in pH, causing both young and mature coconut water to fall below the SNI standard within less than 40 hours. This suggests that room temperature storage is ineffective in maintaining the acidity of coconut water within the required standards. These findings align with the statement by Lukiyono & Zain (2022), which asserts that room temperature accelerates microbial activity, particularly those that produce lactic and acetic acids, thereby drastically lowering the pH of coconut water.

The graphs in Figures 7 and 8 illustrate the differences in pH changes for young and mature coconut water stored under cold and room temperature conditions. Cold storage effectively maintains the pH of young coconut water within the SNI standard. However, room temperature storage causes its pH to drop beyond the permissible limit. In contrast, mature coconut water fails to retain its pH stability under both storage conditions.

Thus, it can be concluded that cold storage is only effective in preserving the pH of young coconut water. This finding is consistent with Lukiyono & Zain (2022), who state that low temperatures slow the rate of chemical changes in food products, making cold storage more effective in maintaining pH stability and overall quality.

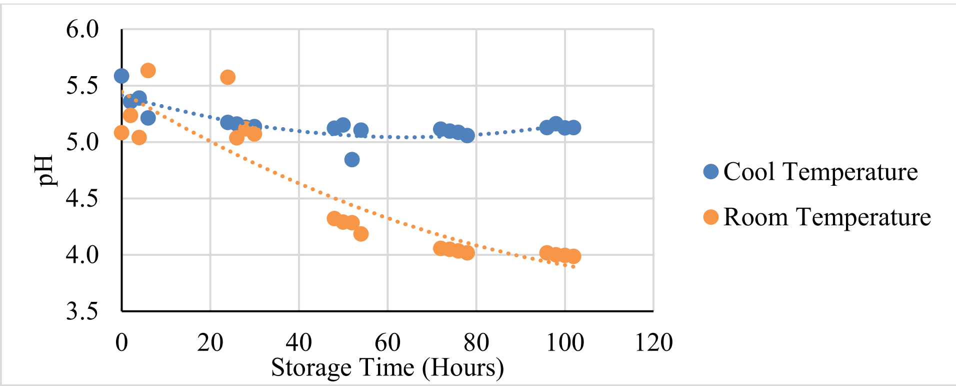

Figure 9. Graph of Young Coconut Water Acidity Levels During Storage

Figure 9 illustrates the acidity levels (pH) of young coconut water under two different temperature conditions: cold storage and room temperature. A significant difference is observed between the two storage conditions. Under cold storage, the initial pH of young coconut water is approximately 5.5 and gradually decreases to around 5.0 over 100 hours, remaining within the SNI (Indonesian National Standard) range. In contrast, at room temperature, the pH declines much more rapidly, dropping from approximately 5.5 to below 4.5 within 60 hours, falling outside the SNI limits.

This finding suggests that cold storage is effective in maintaining the pH of young coconut water within the permissible range, whereas room temperature storage results in a rapid pH decline, leading to faster quality degradation.

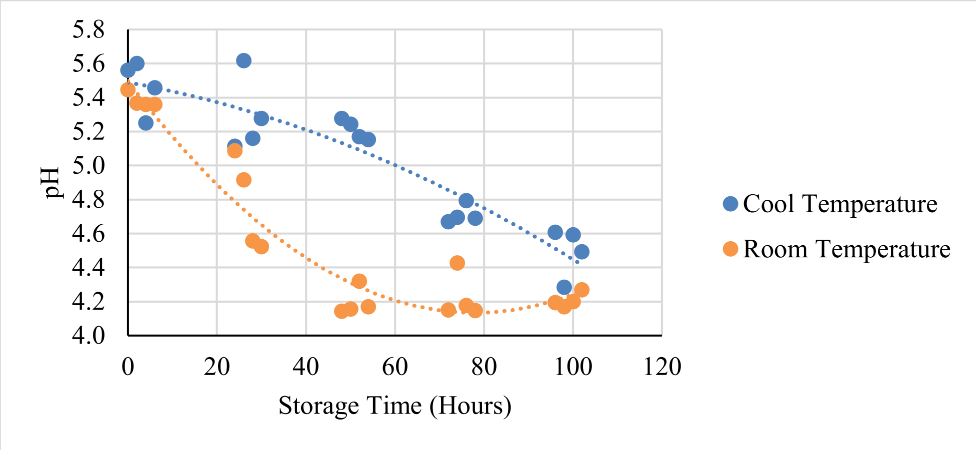

Figure 10. Graph of Mature Coconut Water Acidity Levels During Storage

Figure 10 presents a graph illustrating the changes in acidity levels (pH) of mature coconut water, highlighting a significant difference in the rate of pH decline between the two storage conditions. The data indicate that mature coconut water stored at cold temperatures remains more stable, with pH levels staying within the SNI (Indonesian National Standard) range of approximately 5.2 to 5.5 for up to 100 hours. In contrast, mature coconut water stored at room temperature experiences a more rapid decline in pH, dropping below the SNI minimum threshold (pH 4.5) after approximately 50 hours of storage. This suggests that cold storage is more effective in maintaining the pH stability of coconut water over time.

Figures 9 and 10 collectively demonstrate that storage temperature significantly affects pH changes in both young and mature coconut water. Cold storage helps retain pH stability for a longer duration, slowing the increase in acidity, whereas room temperature storage accelerates the acidification process. This finding reinforces that refrigeration is a more effective method for preserving the pH of both young and mature coconut water.

This conclusion aligns with Lukiyono & Zain (2022), who stated that storage temperature has a significant impact on pH changes in coconut water. Lower temperatures slow down the acidification process, helping to maintain pH stability for an extended period.

3.2. Total Dissolved Solids (TDS)

Total Dissolved Solids (TDS) in coconut water refers to the overall concentration of dissolved substances, including minerals, salts, organic, and inorganic compounds. In coconut water, TDS encompasses various components such as natural sugars (glucose and fructose), amino acids, and vitamins.

The following graph illustrates the changes in total dissolved solids (TDS) values in coconut water during storage.

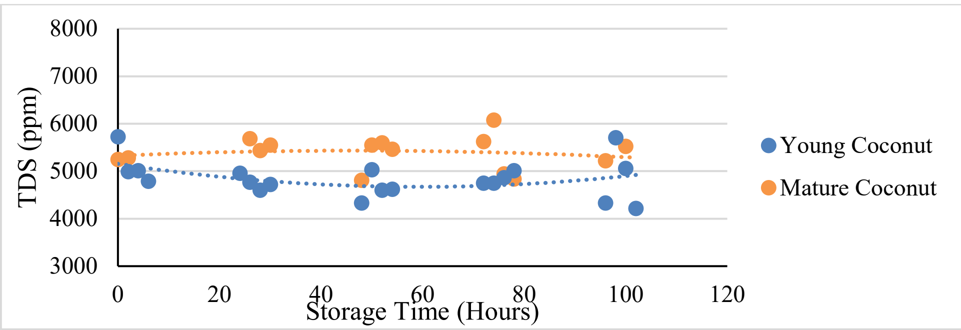

Figure 11. Graph of Total Dissolved Solids in Coconut Water During Cold Storage

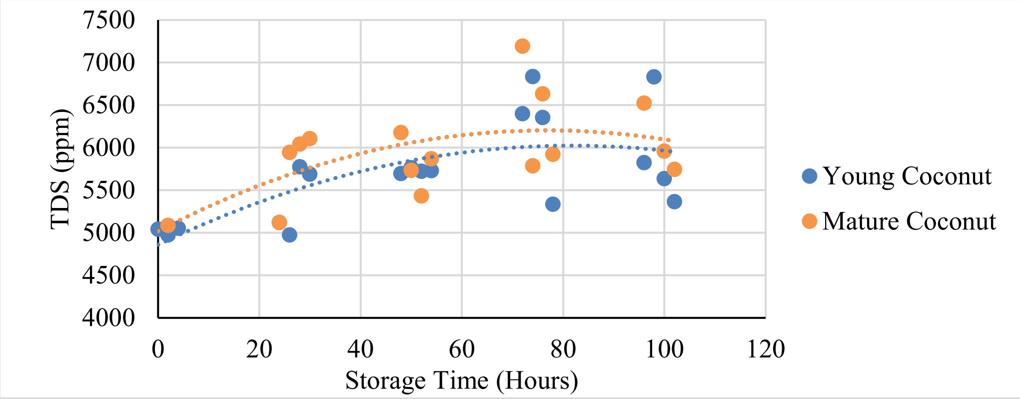

Figure 12. Graph of Total Dissolved Solids in Coconut Water During Storage at Room Temperature

Figures 11 and 12 illustrate the changes in Total Dissolved Solids (TDS) in young and mature coconut water under cold and room temperature storage. The results indicate no significant difference in TDS levels between the two storage conditions.

Under cold storage, both young and mature coconut water exhibit relatively similar TDS values; however, young coconut water consistently has lower TDS levels compared to mature coconut water. A similar trend is observed at room temperature, where young coconut water maintains lower TDS levels than mature coconut water.

These findings suggest that young coconut water is slightly better at preserving its quality than mature coconut water, regardless of storage temperature. This aligns with Lukiyono & Zain (2022), who stated that the more complex chemical composition of mature coconut water contributes to a slightly faster increase in TDS during storage.

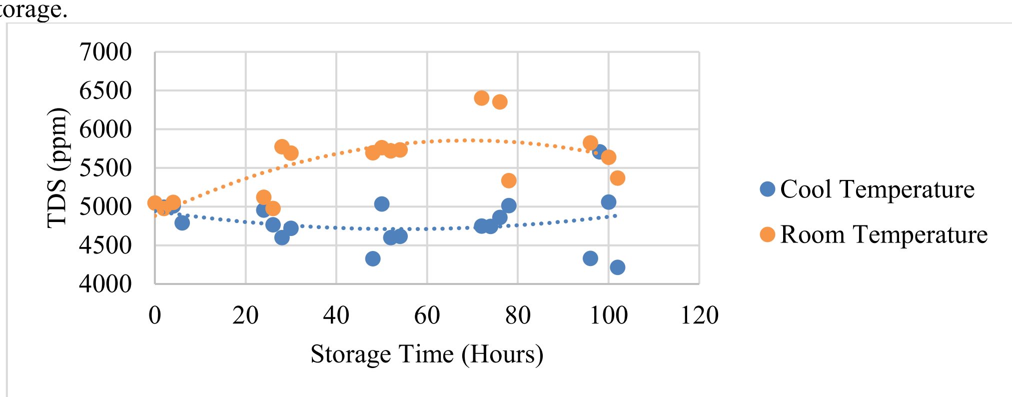

Figure 13. Graph of Total Dissolved Solids in Young Coconut Water During Storage

Figure 13 illustrates the changes in Total Dissolved Solids (TDS) in young coconut water under cold and room temperature storage, showing a significant difference between the two conditions. The graph indicates that cold storage is more effective in maintaining the quality of young coconut water, as the TDS values remain lower compared to those at room temperature. In contrast, TDS levels in room temperature storage increase more rapidly, suggesting greater degradation of coconut water quality.

This finding highlights that cold storage is a more efficient method for preserving young coconut water compared to room temperature storage. These results align with Lukiyono & Zain (2022), who stated that refrigeration slows enzymatic activity and microbial growth, both of which contribute to increased TDS levels over time.

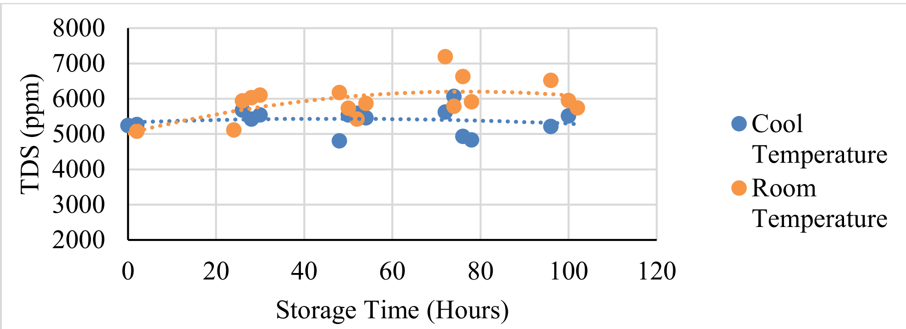

Figure 14. Graph of Total Dissolved Solids in Mature Coconut Water During Storage

Figure 14 presents the changes in Total Dissolved Solids (TDS) in mature coconut water stored at different temperatures. The results indicate that there is no significant difference in TDS levels between cold and room temperature storage during the initial period. Both storage conditions show similar TDS values at the beginning; however, by the 20-hour mark, the TDS level in room temperature storage increases steadily until the end of the storage period. In contrast, TDS levels in cold storage decrease slightly towards the end of the storage period. This suggests that cold storage is more efficient in maintaining the quality of mature coconut water compared to room temperature storage.

Figures 13 and 14 illustrate the TDS trends in young and mature coconut water under different storage conditions. The findings confirm that cold storage is more effective in preserving the quality of both young and mature coconut water compared to room temperature storage. Refrigeration slows down processes that contribute to increased TDS, such as microbial activity, making it a more suitable storage method for maintaining stability.

These results align with Lukiyono & Zain (2022), who stated that cold temperatures slow down chemical reactions and microbial activity, contributing to greater stability in TDS levels in coconut water.

4. CONCLUSION

Based on the findings of this study, it can be concluded that cold storage is more effective in preserving the quality of young coconut water compared to mature coconut water:

1. Turbidity Levels: Young coconut water retains its clarity better under cold storage, whereas mature coconut water remains cloudy under both storage conditions.
2. pH Stability: Young coconut water maintains a more stable pH within the SNI (Indonesian National Standard) limits under cold storage, while mature coconut water experiences a more rapid decline in pH, particularly at room temperature.
3. Total Dissolved Solids (TDS): Young coconut water preserves its quality more effectively under cold storage, whereas mature coconut water shows a faster increase in TDS under both storage conditions.

Overall, cold storage effectively slows the degradation of young coconut water quality but is less effective for mature coconut water. Room temperature storage is not recommended for long-term preservation, as it accelerates the decline in quality for both young and mature coconut water.

REFERENCES

Amanda, I. P., Tamrin, & Hermanto. (2019). Pengaruh Suhu Dan Lama Pemanasan Terhadap Karakteristik Fisik, Kimia Dan Penilaian Organoleptik Air Kelapa Kemasan. *Sains Dan Teknologi Pangan*, *4*(2), 2030–2040.

Burns, D. T., Johnston, E. L., & Walker, M. J. (2020). Authenticity and the Potability of Coconut Water-A Critical Review. *Journal of AOAC International*, *103*(3), 800–806. https://doi.org/10.1093/jaocint/qsz008

Fajar, muhammad tri. (2022). MONITORING KEKERUHAN MUARA SUNGAI DENGAN ANALISIS CITRA SATELIT DAN KORELASINYA DENGAN CURAH HUJAN (STUDI KASUS SUNGAI KRUENG ACEH). In *universitas islam negeri ar-raniry darusalam banda aceh*.

Langkong, J., Sukendar, N. K., & Ihsan, Z. (2018). Studi Pembuatan Minuman Isotonik Berbahan Baku Air Kelapa Tua (Cocos Nicifera L) Dan Ekstrak Belimbing Wuluh (Avverhoa Bilimbi L) Menggunakan Metode Sterilisasi Non-Thermalselama Penyimpanan. *Canrea Journal: Food Technology, Nutritions, and Culinary Journal*, 53–62. https://doi.org/10.20956/canrea.v1i1.22

Lempoy, W. K., Mandey, L. C., & Kandou, J. E. A. (2020). PENGARUH PENAMBAHAN SARI BUAH SIRSAK TERHADAP SIFAT SENSORIS MINUMAN ISOTONIK AIR KELAPA (Cocos nucifera L.). *Jurnal Teknologi Pertanian (Agricultural Technology Journal*, *11*(1). https://doi.org/10.35791/jteta.11.1.2020.29972

Lukiyono, T. Y., & Zain, S. S. (2022). POTENSI AIR KELAPA KUNING (Cocos nucifera L.) UNTUK MEMINIMALISASI KADAR LOGAM BERAT TIMBAL (Pb) PADA KERANG HIJAU (Perna viridis). *Prosiding Rapat Kerja Nasional Asosiasi Institusi Perguruan Tinggi Teknologi Laboratorium Medik Indonesia*, 240–262.

Lukiyono, Y. T., & Zain, S. S. (2022). Potensi Air Kelapa Kuning (Cocos Nucifera L.) Untuk Meminimalisasi Kadar Logam Berat Timbal (Pb) Pada Kerang Hijau (Perna Viridis). *Prosiding Asosiasi Institusi …*, 240–262.

Mela, E. (2020). Diversifikasi Produk Pangan Berbasis Air Kelapa. *Agritech: Jurnal Fakultas Pertanian Universitas Muhammadiyah Purwokerto*, *22*(2), 163. https://doi.org/10.30595/agritech.v22i2.8504

Monica, D. (2021). Pengukuran Nilai Kekeruhan Air Pdam Tirta Keumuening Kota Langsa. *Jurnal Hadron*, *3*(1), 19–22. https://doi.org/10.33059/jh.v3i1.3744

Pramesti, D. S., & Puspikawati, S. I. (2020). Analysis of Turbidity Test Bottled Drinking Water In Banyuwangi District. *Preventif : Jurnal Kesehatan Masyarakat*, *11*(2), 75–85. https://doi.org/10.22487/preventif.v11i2.59

Ramadhani, I. (2022). Analisa Cemaran Bakteriologi pada Minuman Air Kelapa Muda. *Jurnal Pustaka Media*, *1*(1), 5–8.

Rindawati. (2020). Studi Perbandingan Pembuatan Vco (Virgin Coconut Oil) Sistem Enzimatis Dan Pancingan Terhadap Karakteristik Minyak Kelapa Murni Yang Dihasilkan. *Indonesian Journal of Laboratory*, *2*(1), 25. https://doi.org/10.22146/ijl.v2i1.54196

Sangadji, S., Mahulete, A. S., & Marasabessy, D. A. (2022). Studi Produktifitas Tanaman Kelapa (Cocos Nucifera L.) di Negeri Tial Kecamatan Salahutu Kabupaten Maluku Tengah. *Jurnal Agrohut*, *13*(2), 87–96. https://doi.org/10.51135/agh.v13i2.176

Wariyanti, Y. B. (2008). Kualitas air kelapa hijau (Cocos nucifera L.) berdasarkan perbedaan umur buah kelapa. In *Widya Warta* (Vol. 1, pp. 75–82).