FRUIT JUICE PRODUCTION USING SOME NIGERIA SELECTED FRUITS

BY

AJAYI OLUWATOSIN ELIZABETH

PSC1808602

DEPARTMENT OF CHEMISTRY
FACULTY OF PHYSICAL SCIENCES
UNIVERSITY OF BENIN
BENIN CITY EDO STATE,
NIGERIA

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A PROJECT SUBMITTED TO THE DEPARTMENT OF CHEMISTRY, UNIVERSITY OF BENIN, BENIN CITY, NIGERIA, IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF SCIENCE DEGREE (B.SC)

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CERTIFICATION

We the undersigned hereby agree that this work was carried out by Elizabeth Oluwatosin Ajayi with matriculation number of PSC1808602 in the Department of Chemistry, Faculty of physical sciences, University of Benin., Benin City.

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Oluwatosin Elizabeth Ajayi Date
(Project student)

_____ _____

Dr. E.N Dibie Date
(Project Supervisor)

_____ _____

Prof. J.U. Iyasele Date
(H.O.D)

DEDICATION

This project work is dedicated first and foremost to God Almighty who has been my pillar and rock from the beginning till date. This project is also dedicated to my parents and my siblings who have been my source of strength, inspiration, a source of financial and moral support.

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ABSTRACT

The study was concluded to produced fruit juice and its blend using some Nigeria selected fruits. The fruits were purchased in Edo Street, Ekosodin, Benin City. The fruit juices were produced and analysed using standard method. From the analysis, it was observed that the pH ranges from 3.30 – 5.80 without pulp and 3.50 – 5.70 with pulp. A reversed case occurred on these samples for titratable acidity with a range of 0.030% - 0.88% without pulp and 0.32% - 1.82%. The pH and titratable falls within acceptable range

CHAPTER ONE

INTRODUCTION AND LITERATURE REVIEW

1.1 INTRODUCTION

Fruit juices have long been revered for their refreshing taste, nutritional benefits, and versatility in quenching thirst. With a growing emphasis on healthier dietary choices, the demand for natural and nutritious beverages has surged, propelling the exploration of various fruits for juice production. Watermelon (Citrullus lanatus), coconut (Cocos nucifera), and pineapple (Ananas comosus) are three diverse fruits that stand out for their unique flavors, abundant nutrient profiles, and potential health benefits. This comprehensive introduction delves into the intricate realm of fruit juice production, preservation, and storage, with a focus on these three iconic fruits.

Watermelon (Citrullus lanatus): Watermelon, a quintessential summer fruit, is celebrated for its high-water content, natural sweetness, and generous doses of vitamins A and C (Citrullus lanatus- Watermelon). Beyond its hydration properties, watermelon is also rich in lycopene, a potent antioxidant linked to cardiovascular health (Pinto *et al*., 2011). Harnessing these attributes for juice production entails efficient methods of extraction that retain the delicate balance between sweetness and nutritional value.

Coconut (Cocos nucifera): Coconut, often dubbed the "tree of life," offers a unique blend of electrolytes, vitamins, and healthy fats (Cocos nucifera - Coconut). Its versatile nature allows for the extraction of both refreshing water and creamy milk from its core. The lauric acid content in coconut has been associated with antimicrobial and immune-boosting properties (Dacasin *et al*.,2021). Incorporating coconut into fruit juice formulations requires innovative techniques to harness its distinctive flavors and capitalize on its inherent health benefits.

Pineapple (Ananas comosus): Pineapple, renowned for its tropical tang and vibrant color, is a vitamin C powerhouse that also provides bromelain, an enzyme with potential anti-inflammatory and digestive benefits (Pineapple – Ananas comosus). This enzyme's delicate nature poses challenges for preservation while retaining its activity. Additionally, pineapple's acidity requires careful consideration during formulation to achieve a harmonious flavor profile. The demand for fruit juices has led to advancements in production techniques, preservation methods, and storage technologies. It is paramount to strike a balance between maintaining the nutritional integrity, flavor, and safety of the juices throughout their shelf life. Consumer preferences for minimally processed, additive-free products necessitate exploring natural preservation methods like pasteurization and hurdle technology, which involves combining multiple preservation techniques (Qiu *et al.,* 2019). Furthermore, sustainable packaging solutions play a pivotal role in prolonging shelf life while minimizing environmental impact.

The convergence of watermelon, coconut, and pineapple in the realm of fruit juice production presents an exciting opportunity to create beverages that encapsulate not only the flavors of these fruits but also their diverse nutritional benefits. By navigating the challenges of extraction, preservation, and storage, producers can deliver high-quality, wholesome juices that cater to the modern consumer's quest for health-conscious refreshment.

1.1.1 BACKGROUND OF STUDY

The consumption of fruit juices has transcended mere refreshment to become a vital component of modern dietary habits. With an increasing emphasis on healthier lifestyles and natural products, the demand for fruit juices has surged globally. Among the myriad of fruits available for juice production, watermelon, coconut, and pineapple stand out due to their distinctive flavors, nutrient-rich profiles, and potential health benefits. This comprehensive exploration delves into the multifaceted realm of fruit juice production, preservation, and storage, with a specific focus on these three remarkable fruits.

Fruit juices are celebrated for their potential to deliver concentrated doses of vitamins, minerals, antioxidants, and dietary fibers. The variety of flavors and nutritional attributes they offer make them an appealing choice for consumers seeking both taste and health benefits (Gowe., 2015). As dietary patterns shift towards healthier choices, the market for fruit juices has expanded, prompting manufacturers to innovate in terms of production, preservation, and storage to cater to this growing demand.

Watermelon: Watermelon, botanically known as Citrullus lanatus, is a quintessential summer fruit celebrated for its high-water content and thirst-quenching properties. Its natural sweetness makes it a popular choice for juice production, while its vibrant red hue is indicative of the presence of lycopene, a powerful antioxidant associated with cardiovascular health. In addition to lycopene, watermelon is a source of vitamins A and C, which contribute to immune support and skin health.

Coconut: The coconut, scientifically referred to as Cocos nucifera, boasts a versatile composition. Its water and milk offer hydration, electrolytes, and essential minerals, while the meat yields healthy fats, fiber, and proteins. Notably, coconut contains lauric acid, a medium-chain fatty acid with antimicrobial properties (Narayanankutty *et al.*, 2018). The broad array

of nutrients and health benefits associated with coconut make it an intriguing candidate for inclusion in fruit juice formulations.

Pineapple: Tropical Sweetness with Enzymatic Benefits: Pineapple, or Ananas comosus, is renowned for its tropical flavor and vibrant color. Apart from being rich in vitamin C, which supports immune function, pineapple also contains bromelain, an enzyme associated with anti-inflammatory and digestive properties (Pineapple). The tangy sweetness and enzymatic benefits of pineapple have positioned it as a sought-after ingredient in the fruit juice landscape. The journey from whole fruits to bottled juices involves multiple stages. Juice extraction methods vary based on the fruit's characteristics. Mechanical extraction, such as pressing and blending, is commonly used for watermelon due to its high-water content. In contrast, coconut requires a combination of techniques like grating, pressing, and filtering to obtain its water and milk. Pineapple necessitates enzymatic treatments to break down its fibrous structure and optimize juice yield (Pareek *et al.,* 2018). Challenges include maintaining the fruits' original flavors, preserving nutrients, and minimizing enzymatic degradation during processing.

Preservation is crucial to extend the shelf life of fruit juices while retaining their nutritional and sensory qualities. Pasteurization, a heat treatment process, is widely employed to reduce microbial load and enzyme activity. However, high heat can lead to flavor and nutrient losses. Alternative methods, such as high-pressure processing and ultraviolet (UV) irradiation, have been explored to retain freshness and extend shelf life (Rodríguez-Roque *et al.,* 2014). The challenge lies in balancing microbial safety, flavor preservation, and nutrient retention.

Selecting appropriate packaging materials and techniques is integral to preserving fruit juices. Oxygen, light, and temperature can degrade flavors and nutrients. Glass, plastic, and aseptic packaging methods offer different advantages. Aseptic packaging, in particular, minimizes exposure to oxygen and light, enhancing shelf life (Holman *et al.,* 2018). Cold storage, along

with temperature-controlled distribution chains, further contributes to maintaining juice quality over time. The convergence of watermelon, coconut, and pineapple in fruit juice production offers a fascinating avenue to create beverages that marry distinct flavors with abundant nutrients. Navigating the complexities of production, preservation, and storage is paramount to provide consumers with juices that fulfill both taste preferences and health-conscious aspirations. As the fruit juice industry continues to evolve, innovative solutions will arise to ensure that the delightful symphony of flavors and nutrients from watermelon, coconut, and pineapple is preserved for consumers to savor.

1.2 STATEMENT OF PROBLEM

The production, preservation, and storage of fruit juices using watermelon, coconut, and pineapple present a multifaceted set of challenges and concerns that require comprehensive investigation. As these fruits possess unique characteristics and nutritional attributes, ensuring the maintenance of flavor, nutrients, and safety throughout the entire process becomes paramount. This statement of problem outlines the key challenges and issues that arise in the context of fruit juice production, preservation, and storage using these three distinct fruits.

Preservation of Nutritional Integrity

One of the primary challenges is preserving the nutritional integrity of the juices. Watermelon, coconut, and pineapple each offer a distinct array of vitamins, minerals, antioxidants, and enzymes. The extraction, processing, and preservation techniques employed should aim to minimize the loss of these vital nutrients, as high temperatures and extended storage periods can lead to degradation. Balancing preservation methods that ensure microbial safety while retaining the fruits' original nutritional content presents a delicate dilemma.

Enzymatic Degradation

Enzymatic degradation is particularly significant in the case of pineapple due to the presence of bromelain, an enzyme with potential health benefits. While bromelain's activity can be advantageous, it can also lead to undesirable changes in flavor and texture over time. Controlling the enzymatic activity during extraction and preserving its functionality while avoiding over-processing poses a substantial challenge (Perera., 2020).

Flavor Profile Maintenance

The distinctive flavors of watermelon, coconut, and pineapple are key selling points for their respective juices. However, the preservation process can alter the volatile compounds responsible for these flavors. High-temperature processing, such as pasteurization, can lead to flavor losses and the development of off-flavors. Striking a balance between preserving the original flavors and ensuring microbial safety requires innovative solutions.

Microbial Safety and Shelf-Life Extension

Ensuring microbial safety is crucial to prevent spoilage and food borne illnesses. Pasteurization is a common method used to destroy harmful microorganisms, but it can also affect the sensory and nutritional quality of the juices. Moreover, finding alternative preservation methods that effectively extend shelf life while minimizing negative impacts on quality is a significant challenge (Rodríguez-Roque *et al.,* 2014).

Packaging and Oxidative Deterioration

Packaging plays a pivotal role in maintaining the quality of fruit juices during storage. Oxygen and light exposure can lead to oxidative deterioration, resulting in flavor changes and nutrient degradation. Selecting the appropriate packaging materials and techniques that create a barrier against these factors without compromising the overall sustainability and consumer appeal is a complex task (Holman *et al.,* 2018).

Consumer Preferences and Natural Preservation

Modern consumers seek natural and minimally processed products. Incorporating additives or high-heat pasteurization conflicts with this preference for "clean label" products. Exploring natural preservation methods, such as high-pressure processing and UV irradiation, that align with consumer expectations while ensuring safety and quality presents a significant challenge (Lloyd., 2021). The challenges inherent in fruit juice production, preservation, and storage using watermelon, coconut, and pineapple underscore the need for innovative solutions that balance flavor, nutritional content, microbial safety, and consumer preferences. Addressing these challenges requires a multidisciplinary approach that combines expertise in food science, engineering, packaging, and consumer behavior. Through rigorous research and experimentation, the aim is to develop strategies that result in high-quality fruit juices that retain their freshness, nutrients, and flavors throughout their shelf life.

1.3 JUSTIFICATION/RELEVANCE OF STUDY

The investigation into fruit juice production, preservation, and storage using watermelon, coconut, and pineapple holds immense significance within the realms of food science, health, and consumer preferences.

Health and Nutrition: Fruit juices are valuable sources of essential vitamins, minerals, antioxidants, and dietary fibers. The study of watermelon, coconut, and pineapple juices' production, preservation, and storage is crucial to maximize the retention of these nutrients, ensuring that consumers can benefit from their potential health-enhancing properties. By understanding and optimizing the processes, the industry can deliver beverages that align with modern dietary trends, supporting overall well-being.

Consumer Preferences: Consumers are increasingly seeking natural, minimally processed, and additive-free products. Understanding how to produce, preserve, and store fruit juices

without compromising their natural characteristics satisfies consumer preferences for clean label products (Gomes *et al.,* 2023). This study aims to provide insights into preservation methods that cater to these preferences, enhancing the appeal and marketability of the juices.

Flavor Experience: The unique flavors of watermelon, coconut, and pineapple juices are their distinguishing features. The study's focus on maintaining these distinct flavors through preservation and storage methods is crucial for consumer satisfaction. Ensuring that the juices deliver the expected taste experience will contribute to positive brand associations and repeat purchases.

Microbial Safety: Food safety is of paramount importance. Investigating effective preservation techniques that minimize microbial risks while preserving product quality addresses consumer concerns about contamination and health risks. This study can provide industry professionals with valuable insights into ensuring microbial safety throughout the product's shelf life.

Sustainability: Sustainable packaging solutions and efficient preservation methods contribute to minimizing food waste and environmental impact. Research into packaging materials and techniques that extend shelf life and reduce product spoilage aligns with sustainable practices and reduces the carbon footprint of the industry.

Innovation and Industry Advancement: As consumer preferences evolve and technology advances, the food and beverage industry must continually innovate to remain competitive. Investigating novel preservation techniques, packaging solutions, and methods of extracting unique flavors from watermelon, coconut, and pineapple can drive industry advancement and foster product diversification.

Economic Implications: Fruit juice production is a significant contributor to the agricultural and food processing sectors. An in-depth study of production, preservation, and storage

methods can lead to improved efficiency, reduced waste, and enhanced product quality. These factors have direct economic implications, benefiting both producers and consumers.

Global Impact: The findings of this study could have a global impact, benefiting diverse populations with access to these fruits. By developing best practices for production, preservation, and storage, the industry can contribute to providing nutritious and flavorful beverage options to consumers worldwide.

The investigation into fruit juice production, preservation, and storage using watermelon, coconut, and pineapple is undeniably relevant and justified. The study's outcomes can positively impact health-conscious consumers, the food industry, sustainability efforts, and innovation within the field. By addressing the challenges and opportunities presented by these fruits, this research endeavor holds the potential to shape the future of fruit juice production and consumption.

1.4 SCOPE OF THE WORK

The scope of this work encompasses a comprehensive study of fruit juice production, preservation, and storage techniques utilizing watermelon, coconut, and pineapple. It involves exploring extraction methods, assessing preservation techniques, investigating packaging options, and analyzing the impact of storage conditions. The study's focus extends to maintaining nutritional content, flavor integrity, and microbial safety throughout the entire process. The scope also includes considering consumer preferences for natural and minimally processed products. Ultimately, this work aims to contribute insights that enhance the quality, safety, and sustainability of fruit juices made from these three fruits.

1.5 AIM AND OBJECTIVES

1.5.1 AIM

The aim of this study is to produce fruit juice and its blend using some Nigeria selected fruits.

1.5.2 SPECIFIC OBJECTIVES

1. Compare and analyze various extraction methods to optimize juice yield, flavor, and nutritional content for watermelon, coconut, and pineapple juices.
2. Evaluate the efficacy of natural preservation techniques, like high-pressure processing and enzymatic treatments, in extending the shelf life of juices while maintaining sensory attributes and nutritional value.
3. Investigate diverse packaging materials and methods to minimize oxygen exposure and light penetration, aiming to sustain the freshness and quality of juices during storage.
4. Examine the microbial safety of the juices through preservation and storage, with a focus on reducing harmful microorganisms while ensuring compliance with safety standards.
5. Utilize trained sensory panels to perform regular evaluations of the juices' taste, aroma, color, and overall acceptability throughout their shelf life to ensure consistent quality and consumer satisfaction.

1.6 LITERATURE REVIEW

1.6.1 JUICE EXTRACTION TECHNIQUES

Efficient juice extraction serves as a cornerstone in upholding the quality of the ultimate fruit juice product. Distinct fruits necessitate tailored techniques to achieve optimal yield while retaining the essence of their flavors. This section delves into the significance of proficient extraction methods and how their application aligns with the specific attributes of watermelon, coconut, and pineapple.

1.6.1.1 Maintaining Quality through Efficient Extraction

The success of fruit juice production is intricately tied to the extraction process. It is during this phase that the inherent flavors, nutrients, and sensory characteristics of the fruits are extracted and preserved. The efficiency of extraction methods plays a critical role in

maximizing juice yield and minimizing nutrient loss, thereby contributing to the overall quality of the final product.

1.6.1.2 Adapted Techniques for Varied Fruits

Each fruit presents unique characteristics that dictate the optimal extraction technique. The choice of method must consider factors such as the fruit's water content, cellular structure, and enzymatic composition. Applying tailored techniques ensures that the extracted juice

1.6.1.3 Watermelon Juice Extraction

Watermelon, renowned for its high-water content and refreshing taste, demands techniques that efficiently extract its abundant liquid. Mechanical methods such as pressing and centrifugation are frequently employed for watermelon juice extraction (Oroian and Escriche., 2015). These methods harness mechanical force to liberate the juice from the fruit's cellular structure. They offer a balance between juice yield and preserving the naturally present vitamins, minerals, and sugars.

1.6.1.4 Coconut Milk Extraction

Coconut, with its unique composition of water, meat, and milk, necessitates a specialized approach for milk extraction. The challenge lies in effectively obtaining both the water and milk components. Techniques such as grating and pressing are employed. Grating the coconut meat facilitates the separation of the liquid components (Richardson., 2018). This method capitalizes on breaking down the coconut's fibrous matrix, enabling the successful extraction of both its distinct water and milk.

1.6.1.5 Pineapple Juice Extraction

Pineapple poses distinct challenges due to the presence of bromelain, an enzyme with enzymatic activity that can alter the juice's sensory attributes (Al-Dhabi *et al.,* 2020). Effective pineapple juice extraction involves controlled crushing to release the juice, followed by enzymatic treatments to manage bromelain activity. By employing techniques

that mitigate bromelain's impact, the extraction process aims to capture the fruit's characteristic flavor while preventing undesirable changes.In the realm of fruit juice production, the extraction process stands as a pivotal determinant of the final product's quality. Tailoring extraction methods to the unique attributes of watermelon, coconut, and pineapple ensures the optimal yield of juices rich in both flavor and nutrients. As the extraction techniques adapt to each fruit's individual characteristics, they play an indispensable role in maintaining the essence of the fruits throughout the production journey.

1.6.1.6 Preservation Methods

The preservation of fruit juices is a critical step in ensuring their longevity while safeguarding their sensory attributes and nutritional value. An array of preservation techniques has been explored to extend the shelf life of fruit juices. This section delves into the significance of preservation methods and highlights the advantages and challenges associated with pasteurization, high-pressure processing, and UV irradiation.

1.6.1.7 Extending Shelf Life while Preserving Attributes

The preservation of fruit juices is an intricate balancing act. While the primary goal is to inhibit the growth of harmful microorganisms and prolong shelf life, it's equally essential to retain the natural flavor, color, aroma, and nutritional content of the juices. Effective preservation methods achieve this balance by minimizing the impact on sensory attributes and nutritional value.

1.6.1.8 Pasteurization

Pasteurization is a widely recognized preservation method employed to enhance the microbial safety of fruit juices. This process involves subjecting the juice to moderate heat for a specified duration to reduce the microbial load. While effective in extending shelf life, pasteurization is not without its challenges. The application of heat can lead to flavor and nutrient losses, altering the overall sensory experience of the juice (Gomes *et al.*, 2023).

1.6.1.9 High-Pressure Processing

High-pressure processing (HPP) emerges as a promising alternative to traditional pasteurization. HPP employs high levels of hydrostatic pressure to inactivate microorganisms, thereby extending the shelf life of fruit juices. Unlike heat-based methods, HPP preserves the sensory and nutritional attributes of the juices to a greater extent. This is particularly advantageous for delicate flavors and heat-sensitive nutrients. Additionally, HPP does not entail prolonged exposure to high temperatures, minimizing the detrimental impact on flavor and nutrition.

1.6.1.10 UV Irradiation

UV irradiation is another innovative preservation method gaining attention. This approach employs ultraviolet light to target and destroy microorganisms present in the juice. UV irradiation offers several advantages, including minimal heat exposure and the absence of chemical additives. By utilizing specific wavelengths of UV light, microbial load can be reduced without compromising the sensory and nutritional quality of the juice. UV irradiation has potential for application in producing minimally processed, high-quality fruit juices with extended shelf life (Putnik *et al.,* 2020).The preservation methods explored in fruit juice production are pivotal in striking a delicate balance between extending shelf life and preserving sensory and nutritional attributes. While traditional pasteurization remains effective, alternatives such as high-pressure processing and UV irradiation offer innovative avenues to achieve microbial safety without compromising flavor and nutrients. The selection of preservation methods depends on the unique characteristics of the juice and consumer preferences, ultimately shaping the quality and acceptability of the final product.

1.7 Packaging Strategies

The role of packaging in fruit juice production extends beyond containment—it significantly influences the preservation of quality and the maintenance of sensory attributes. Packaging materials and methods act as a shield, protecting juices from harmful elements like oxygen and light exposure. This section delves into the importance of packaging strategies and sheds light on the advantages of aseptic packaging and the pursuit of sustainable packaging solutions.

1.7.1 Preservation through Effective Packaging

Packaging is a critical determinant of the overall quality and shelf life of fruit juices. The right packaging materials and methods can ensure that the juices are safeguarded against external factors that could compromise their sensory attributes and nutritional value.

1.7.2 Aseptic Packaging

Aseptic packaging has emerged as a prominent technique to preserve the freshness and nutritional content of fruit juices. This method involves filling the juices into containers in a sterile environment, preventing the ingress of oxygen and light. Cartons and pouches are commonly used in aseptic packaging due to their ability to effectively shield the contents from external elements. This approach minimizes oxidation and light-induced degradation, thus maintaining the flavor and nutrient integrity of the juices throughout their shelf life.

1.7.3 Sustainable Packaging

In alignment with growing environmental consciousness, the quest for sustainable packaging solutions has gained prominence. The exploration of bio-based plastics and environmentally-friendly materials has led to the development of packaging options with reduced environmental footprints. Bio-based plastics, derived from renewable resources, offer an alternative to conventional plastics, addressing concerns related to plastic waste. Embracing these sustainable materials can contribute to minimizing the environmental impact of fruit juice packaging (Rodríguez-Roque *et al.,* 2014).Packaging strategies play a pivotal role in

ensuring the preservation of fruit juices by shielding them from oxygen and light exposure. Aseptic packaging offers a reliable method to maintain flavor and nutrient integrity, while sustainable packaging options address environmental concerns associated with conventional plastics. By embracing effective packaging techniques and aligning with sustainability principles, fruit juice producers can uphold the sensory and nutritional quality of their products while contributing to environmentally responsible practices.

1.7.4 Enzymatic Activity and Flavor Preservation

The interplay of enzymatic activity and flavor preservation in fruit juices is a delicate balance that demands specific attention. Enzymes, such as bromelain in pineapple, can pose challenges to maintaining the desired sensory attributes and texture of the juice. This section delves into the significance of enzymatic activity in fruit juices and outlines the techniques, such as bromelain inactivation, employed to safeguard pineapple flavor.

1.7.5 Enzymatic Activity and Flavor Alterations

Enzymatic activity is a double-edged sword in fruit juice production. While enzymes contribute to the development of characteristic flavors and aromas, they can also lead to undesirable changes over time. Bromelain, a protease enzyme present in pineapple, is particularly notorious for causing texture degradation and flavor alterations if left unchecked.

1.8 Bromelain Inactivation

The preservation of pineapple juice's unique flavor hinges on managing the activity of bromelain. Bromelain inactivation techniques are pivotal in curbing the enzyme's impact. Heat treatment and pH adjustment are commonly employed methods to control bromelain activity and preserve the desirable pineapple flavor(Holman *et al.,* 2018). Heat treatment involves subjecting the juice to elevated temperatures, effectively denaturing the enzyme. pH adjustment manipulates the juice's acidity, creating an environment that is less conducive to enzymatic activity.

1.8.1 Preserving Pineapple Flavor and Texture

By skillfully applying bromelain inactivation techniques, producers can strike a balance between retaining the pineapple's characteristic flavor and ensuring a pleasing texture. These methods inhibit the enzyme's potential to cause undesirable changes, thus safeguarding the sensory experience for consumers. Effective flavor preservation not only enhances consumer acceptance but also contributes to the product's marketability and reputation.

Enzymatic activity, while contributing to the development of unique flavors, can also jeopardize the sensory attributes of fruit juices, particularly when enzymes like bromelain are present. Employing bromelain inactivation methods, such as heat treatment and pH adjustment, becomes imperative to retain the authentic flavor and texture of pineapple juice. By managing enzymatic activity, producers can ensure that consumers enjoy the essence of the fruit without any undesirable alterations.

1.8.3 Sensory Attributes and Consumer Acceptance

The sensory attributes of fruit juices, encompassing taste, aroma, color, and texture, hold the key to consumer acceptance and overall market success. In the realm of fruit juice production, understanding and preserving these sensory characteristics are of paramount importance. This section delves into the significance of sensory attributes, consumer preferences, and the role of sensory evaluations in ensuring product quality.

1.8.2.1The Influence of Sensory Attributes

Consumer preferences are heavily driven by the sensory attributes that fruit juices offer. The taste, aroma, color, and texture collectively contribute to the overall experience of consuming these beverages. These attributes form a sensory profile that shapes consumers' perceptions of the product's quality, authenticity, and desirability.

1.8.2.2 Sensory Evaluations

Sensory evaluations play a pivotal role in the fruit juice production process. Trained sensory panels are engaged to rigorously assess the sensory attributes of juices at various stages, including production and throughout shelf life. These evaluations involve sensory experts who are adept at detecting nuances in taste, aroma, color, and texture. Through these assessments, any changes in sensory attributes over time can be identified, and potential quality concerns can be addressed promptly.

1.8.2.3 Guiding Formulation and Preservation Strategies

The insights garnered from sensory evaluations act as valuable guidance for formulation and preservation strategies. Any alterations or deterioration in sensory attributes can alert producers to potential issues, enabling them to refine their processes and formulations accordingly. For instance, if a juice's color or aroma is found to change over time, adjustments can be made in the formulation or preservation techniques to mitigate these changes.

1.8.2.4 Consumer Acceptance and Market Success

Consumer acceptance is directly linked to the sensory experience provided by fruit juices. A harmonious blend of taste, aroma, color, and texture not only entices consumers but also fosters brand loyalty. A product that consistently delivers on sensory expectations gains a competitive edge in the market, building a positive reputation and ensuring repeat purchases. Sensory attributes are pivotal in shaping consumer preferences, acceptance, and market success of fruit juices. By conducting sensory evaluations through trained panels, producers gain invaluable insights into the changes that occur in taste, aroma, color, and texture over time. These evaluations guide formulation and preservation strategies, ultimately contributing

to the creation of high-quality, appealing fruit juices that resonate with consumer expectations.

1.8.2.5 Consumer Trends and Health Concerns

Consumer preferences and health concerns have a profound impact on the food and beverage industry, including the production, preservation, and consumption of fruit juices. In recent times, there has been a significant shift in consumer demand towards natural and minimally processed products. This paradigm shift has prompted the exploration of clean label preservation methods, where the emphasis is on maintaining the integrity of the product while aligning with health-conscious preferences. This comprehensive exploration delves into the intersection of consumer trends, health concerns, and the pursuit of clean label preservation methods in the context of fruit juices.

1.8.2.6 Emergence of Consumer Trends

Modern consumers are increasingly mindful of what they consume, seeking products that align with their values, preferences, and health aspirations. One of the prominent consumer trends in the food and beverage industry is the inclination towards natural and minimally processed options. Consumers are now scrutinizing ingredient lists and seeking products with recognizable components, free from artificial additives and chemical preservatives.

1.8.2.7 Clean Label Preservation

The concept of clean label has become a rallying point for both consumers and producers. Clean label preservation methods emphasize the use of natural, familiar ingredients and processes that are easy to understand and transparent. This approach resonates with consumers who are cautious about the impact of artificial additives and preservatives on their health and well-being.

1.8.2.8 Exploring Clean Label Preservation Methods

The demand for clean label products has prompted the exploration of innovative preservation methods that align with natural and minimally processed standards. These methods seek to maintain the shelf life of fruit juices without compromising on sensory attributes or nutritional content. Clean label preservation techniques include a spectrum of approaches such as high-pressure processing, pulsed electric field, and natural antimicrobials derived from plants and essential oils. These methods aim to inhibit microbial growth, extend shelf life, and enhance safety, all while preserving the innate characteristics of the juices.

1.8.2.9 Health Benefits of Fruit Juices

Consumers' preference for fruit juices is not only driven by taste but also by the potential health benefits they offer. Fruit juices are a natural source of antioxidants, vitamins, and enzymes, all of which are highly valued for their potential positive impacts on health. Antioxidants help combat oxidative stress, vitamins contribute to overall well-being, and enzymes aid indigestion. For instance, studies have shown that pineapple juices, enriched with bromelain, possess anti-inflammatory and digestive benefits (Adetuyi *et al.,* 2022).

1.8.2.10 Consumer Empowerment and Decision-Making

The consumer's evolving consciousness is reshaping the landscape of the food and beverage industry. By seeking out products with health-enhancing attributes, consumers are exercising their power as informed decision-makers. This shift has spurred manufacturers to innovate and adapt, leading to the development of cleaner, more transparent, and health-conscious preservation methods.

1.8.2.11 Market Dynamics and Future Outlook

As consumer trends continue to evolve, the demand for clean label products is expected to intensify. Manufacturers are challenged to strike a balance between preserving the quality and shelf life of products while adhering to natural and minimally processed standards.

Research into innovative preservation technologies that cater to these demands will play a pivotal role in shaping the future of the fruit juice industry.

Consumer trends and health concerns are steering the trajectory of the fruit juice industry towards natural, minimally processed, and health-conscious products. The exploration of clean label preservation methods is a testament to the symbiotic relationship between consumer preferences and industry innovation. By embracing preservation techniques that align with clean label principles, manufacturers not only meet consumer expectations but also contribute to healthier choices and a more sustainable future.

1.9 Taxonomy and Classification of Watermelon, Coconut and Pineapple

Understanding the taxonomy and classification of plants is essential for categorizing, studying, and communicating about different species.

Watermelon (Citrullus lanatus)

Kingdom: Plantae

Division: Angiosperms (Flowering Plants)

Class: Eudicots

Order: Cucurbitales

Family: Cucurbitaceae (Gourd Family)

Genus: Citrullus

Species: Citrullus lanatus

Coconut (Cocos nucifera)

Kingdom: Plantae

Division: Angiosperms (Flowering Plants)

Class: Monocots

Order: Arecales

Family: Arecaceae (Palm Family)

Genus: Cocos

Species: Cocos nucifera

Pineapple (Ananas comosus)

Kingdom: Plantae

Division: Angiosperms (Flowering Plants)

Class: Monocots

Order: Poales

Family: Bromeliaceae

Genus: Ananas

Species: Ananas comosus

1.9.1 Taxonomic Descriptions

1. **Watermelon (Citrullus lanatus**): Watermelon belongs to the family Cucurbitaceae, which includes cucumbers, pumpkins, and squashes. It is a trailing vine plant with large, edible fruits known as watermelons. These fruits have a thick rind, juicy flesh, and black seeds. Watermelons are native to Africa and are cultivated for their sweet and refreshing taste.
2. **Coconut (Cocos nucifera):** Coconuts are members of the palm family Arecaceae. They are characterized by their tall, slender trunks with a crown of large, feathery leaves and large, round fruits called coconuts. Coconuts are widely distributed in tropical regions and are valued for their versatile uses - from the water and flesh inside the coconut to the production of oil, fiber, and wood.
3. **Pineapple (Ananas comosus):** Pineapples are part of the family Bromeliaceae, which also includes other tropical plants like bromeliads. Pineapple plants have spiky, sword-like leaves and produce a single, large, compound fruit. The fruit has a rough

outer skin with a sweet, juicy, yellow to golden interior. Pineapples are native to South America and are cultivated for their unique flavor and culinary versatility.

1.9.2 Significance of Taxonomy

Taxonomy and classification help scientists and researchers organize and understand the diversity of life on Earth. By classifying plants like watermelon, coconut, and pineapple into specific categories, it becomes easier to study their characteristics, relationships, evolution, and ecological roles. Additionally, accurate taxonomy aids in communication between experts and the broader public.

CHAPTER TWO

MATERIAL AND METHOD

The materials that were used for this study are:

2.1. Materials:

- Knife
- Bowl
- Blender
- Hot plate
- Pots
- Sieve
- Hand gloves
- Tray
- Retort stand
- Pipette
- Burette
- Conical flasks/volumetric flasks
- Stirrer
- pH meter
- Measuring cylinder
- Bottle
- Beaker
- Weighing balance
- Spoon
- Storage bottle

- Spectrophotometer

2.2 Chemicals and Reagents

- NaOH
- Ascorbic acid
- Oxalic acid ($Na_2C_2O_4$)
- Potassium permanganate ($KMnO_4$)
- Distilled water
- Indicator (Phenolphthalein)

2.3 Fruits

- Watermelon
- Coconut
- Pineapple

2.4 Preparation

- The fruits were washed thoroughly under running water to remove dirt and contaminants.
- The outer skin of the fruits was carefully peeled using a knife.
- The fruits were cut into small, uniform pieces using a knife and cutting board.
- The required amount of each fruit was separately weighed using a weighing balance, and the weights were recorded.

2.5 Pineapple Juice Production

- The process began with the pineapple, the weighed pineapple pieces were placed in a pot.
- The pot was heated on a hot plate for 5 minutes to slightly soften the pineapple pieces.
- Some of the heated pineapple pieces were transferred into a sieve cloth to extract the juice, with the pulp being pressed to extract as much juice as possible.

- The remaining pineapple pieces were processed into a pulp-like consistency using a blender.

2.6 Watermelon Juice Production

- For the watermelon juice, the required amount of watermelon pieces was weighed.
- The watermelon pieces were placed in a pot without water.
- Pasteurization was carried out by heating the watermelon on a hot plate for 10 minutes.
- The pasteurized watermelon was blended to achieve a smooth consistency.
- The blended watermelon was sieved to remove pulp, obtaining clean juice.

2.7 Coconut Milk Production

- Coconut milk is gotten from coconut after blending
- Ripe coconut with high water content is selected for production, typically gotten from market.
- Coconut water is extracted carefully by creating a small opening in the top of the coconut and collecting the water in a clean container.
- The coconut was chopped into small pieces and was put inside the pot, the coconut water was used to boil it with a little distilled water (pasteurization).
- It was then blended after which some were filtered to get fresh milk while some were left with pulp.
- Stringent quality control measures are implemented throughout the production including pH and acidity testing to ensure safety and quality standards are met

2.8 Tests carried out

2.8.1 pH Test using pH Meter: The pH of the fruit juice was determined using a pH meter. This instrument provides a quick and precise measurement of the acidity or alkalinity of a solution. A small sample of the coconut juice was taken and placed on the pH meter probe. The pH meter displayed the pH value, which indicates the acidity or basicity of the juice. This information is essential for assessing the quality and taste of the fruit juice.

2.8.2 Acidity Test using Titration Method: To determine the acidity of the fruit juice, a titration method was employed. Phenolphthalein indicator was added to the juice to act as a pH indicator. The fruit juice was titrated with a standardized solution of a strong base (usually sodium hydroxide) until the solution turned pink. The pink color indicates that the juice had reached a neutral pH, and the volume of the base solution used in titration was recorded. This volume was then used to calculate the acidity of the fruit juice.

2.8.3 Ascorbic Acid Content Test using Spectrophotometric Method: The ascorbic acid content in the fruit juice was quantified using a spectrophotometric method. This involved following specific analytical procedures to extract and measure the ascorbic acid. After extraction, a calibration curve graph was plotted using known concentrations of ascorbic acid.

The absorbance of the fruit juice was measured at a specific wavelength using a spectrophotometer, and the result was compared to the calibration curve to determine the ascorbic acid concentration in the juice.

2.9 Preparation of Stock and Standard Solutions of Ascorbic Acid

- Prepare a standard solution of ascorbic acid by dissolving 0.01g of standard ascorbic acid in a small amount of 0.5% oxalic acid solution.
- Complete the solution to a total volume of 100 ml with the same oxalic acid solution to achieve a concentration of 100 µg/ml.
- Create a series of dilutions with concentrations of 10, 8.0, 6.0, 4.0, and 2.0 µg/mL from the stock ascorbic acid solution.

2.10 Preparation of Potassium Permanganate Solution

- Prepare a potassium permanganate ($KMnO_4$) solution with a concentration of 100 µg/mL.
- Accurately dissolve 0.01 g of $KMnO_4$ in 5.0M H_2SO_4 solution.
- Transfer the resulting solution into a 100 mL volumetric flask and fill it to the mark with distilled water. Thoroughly mix the solution.

2.11 Determination of Ascorbic Acid

- Measure 10 ml of the sample extract accurately and transfer it into a test tube.
- Add 1.0 ml of $KMnO_4$ solution (100 µg/ml) to the test tube and mix the contents thoroughly.
- Allow the mixture to stand for 5 minutes.
- Treat the standard solutions and a blank sample in the same manner.
- Measure the resultant solutions' absorbance at 530 nm using a UV/Visible Spectrophotometer against the reagent blank.

2.12 Preservation and Storage

- A predetermined amount of ascorbic acid (vitamin C) and oxalic acid ($Na_2C_2O_4$) were added to each batch of extracted juice as preservatives. Thorough mixing was done.
- The pH level of each juice was measured using a pH meter.
- The preserved juices were poured into clean, sterilized bottles, leaving some space at the top.
- The bottles were securely sealed to prevent exposure to air.
- The labeled bottles were stored in a cool, dark place or refrigerated for extended shelf life.

CHAPTER THREE

RESULTS AND DISCUSSION

TABLE 3.1: RESULTS FOR PH MEASUREMENT

The results for pH determination are presented in Table 3.

pH Measurement of the Samples

Table 3.1: pH value after pasteurization

S/N	Samples	pH Value
1	Coconut	5.6
2.	Pineapple	3.4
3.	Watermelon	5.1

S/N	Samples	Sample Ground with Pulp			Sample Ground without pulp		
		Day 1	Day 2	Day 3	Day 1	Day 2	Day 3
1.	Coconut	5.7	5.0	4.9	5.8	4.9	4.7
2.	Pineapple	3.9	3.6	3.5	3.8	3.4	3.3
3.	Watermelon	5.2	5.0	4.9	5.1	4.9	4.8
4.	Blend	4.7	4.6	4.5	4.7	4.6	4.5

Table 3.2: pH value after ground

For the samples ground with pulp, there was a noticeable decrease in pH of the samples from Day 1 to Day 3. This trend suggests ongoing chemical reactions or microbial activity within the samples, possibly influenced by the presence of pulp. Conversely, when the samples was ground without pulp, the pH values also decreased over the three-day period, albeit slightly lower than those with pulp. This indicates that pulp may moderate the decrease in pH, possibly acting as a buffer or affecting microbial activity.

Several factors may contribute to these pH variations, including microbial activity, chemical reactions, and the potential influence of the pulp.

Table 3.3: Results for Titrable Acidity Level

S/N	SAMPLES	SAMPLES GROUND WITH PULP	SAMPLES GROUND WITHOUT PULP
1	COCONUT	0.32%	0.25%
2	PINEAPPLE	1.82%	0.88%
3	WATERMELON	0.32%	0.03%
4	BLEND OF COCONUT, PINEAPPLE AND WATERMELON	1.48%	1.69%

The data presented in table above provides titrable acidity values for samples with and without pulp. The titrable acidity values of the coconut milk, pineapple juice and watermelon juice ground with pulp were 0.32%,1.82%,0.32% respectively while the ones without pulp 4have the values of 0.25%,0.88%,0.03%. Coconut milk and watermelon juice had the lowest titrable acidity value of 0.32% while pineapple juice had the highest titrable acidity value of 1.82% for the one with pulp. While without pulp, watermelon has the least titrable acidity value of 0.03%, follow by coconut milk (0.25%), pineapple juice had the highest titrable acidity of 0.88%. While in the case of the blend, the one without pulp has the highest titrable acidity value of 1.69% while the one with pulp has the value of 1.48%.

The acidity values reported in this research were slightly higher than those reported by (Gbaroko *et al.,* 2020). According to (Anvoh *et al*., 2009), fruit acids influence colour, flavour and gustative characteristics of the juice products.

The substantial differences in titration values between the two blends suggested variations in the types and concentrations of acidic compounds. These differences may have been influenced by the specific fruits used in the blend, their proportions, and the presence or absence of pulp. Additionally, the accessibility of acidic compounds to the titrant and the rate of neutralization reactions may have been influenced by the presence of pulp.

The decline in the pH of fruit juice over time is primarily attributable to a natural biological process known as fermentation. Fermentation occurs when indigenous microorganisms, including yeasts and bacteria present in the fruit juice, metabolize the sugars within the juice and convert them into acids, notably lactic acid and acetic acid. This metabolic transformation leads to a reduction in the juice's pH level, resulting in increased acidity.

- The mechanism by which fermentation induces a pH decrease in fruit juice:
- Presence of Sugars: Fruit juices inherently contain natural sugars, such as fructose and glucose, serving as a nutrient source for the indigenous microorganisms.
- Microbial Activity: Yeasts and bacteria, naturally occurring in the fruit juice, engage in fermentation. They metabolize the sugars, initiating a conversion process into acids.
- Acid Production: During fermentation, these microorganisms generate acids as metabolic byproducts, with lactic acid and acetic acid being the primary products. These acids impart a sour taste to the juice and concurrently lower its pH
- pH Decrease: As the concentration of acids within the juice intensifies due to fermentation, the pH value experiences a decrease. pH serves as a measure of a solution's acidity or alkalinity, with a lower pH indicating higher acidity.
- The rate at which fermentation transpires and the ensuing pH reduction in fruit juice can be influenced by an array of factors, including temperature, exposure to oxygen, sugar content, and the specific microorganisms present. In scenarios where fruit juice is inadequately stored without refrigeration or is exposed to air or contaminated with certain microorganisms, fermentation can accelerate, leading to a more rapid pH decline. It is essential to recognize that while fermentation is a natural process and can be desirable in specific contexts, such as the production of fermented beverages like wine or cider, it may not be preferred for commercially produced fruit juices. To ensure a consistent flavor and extend shelf life, measures are taken to manage

fermentation and uphold a stable pH. This is achieved through pasteurization, a heat treatment process that eliminates or deactivates microorganisms, thereby preventing further fermentation and pH reduction.

Table 3.4: The Vitamin C content of pineapple, watermelon and coconut juice samples

Samples	**Vit.C Concentration(µg/ml)**
Pineapple juice	13
Coconut milk	2
Watermelon juice	11

The Vitamin C content of pineapple, coconut, and watermelon fruit juice samples

Ascorbic Acid (Vitamin C) in the fruit samples was determined by spectrophotometer. Each of unknown fruit samples solutions were treated in the sample way for ascorbic acid determination. The absorbances of unknown sample solutions were measured. These absorbance values were referred to their related concentrations in the calibration curve. The result obtained by UV-visible spectrophotometer reveals varying amounts of vitamin C in fruit samples.

The vitamin C contents varied among the different fruit sample and are summarized in table 3.4. The values ranges from 13 to 2 where pineapple fruit sample has the highest value follow by watermelon fruit sample and Coconut milk having the least value. This study coincides with that reported by (Agbaje *et al*., 2020). Ascorbic acid content of fruit juices is the most prominent quality index of fruit juices due to its health significance as a vitamin and cellular antioxidant. (Landon, 2007).

CONCLUSION

In this study, pineapple, watermelon and coconut juices and its blend were successfully produced and analyzed for physical chemical properties, from the resultant sample it was observed that the pH ranges from 3.30-5.80 without pulp and 3.50-5.70 with pulp. A reversed case occurred on these samples for titratable acidity with a range of 0.003% - 0.88% without pulp and 0.32% - 1.82%. The pH and titratable falls within acceptable range.

REFERENCE

Adetuyi, B.O., Odine, G.O., Olajide, P.A., Adetuyi, O.A., Atanda, O.O. and Oloke, J.K. (2022). Nutraceuticals: role in metabolic disease, prevention and treatment. *World News of Natural Sciences,* 42, pp.1-27.

Agbaje R. B., Ibrahim, T. A., & Raimi, O. T. (2020). Physico-chemical properties and sensory qualities of juices extracted from five selected fruits and their peels. International Journal of Engineering Applied Sciences and Technology, 4(11):2455-2143.

Agbaje R.B., Ibrahim, T.A., and Raimi, O.T. (2020). Physico-chemical properties and sensory qualities of juices extracted from five selected fruits and their peels. *International Journal of Engineering Applied Sciences and Technology,* 4(11):2455-2143.

Al-Dhabi, N.A., ValanArasu, M., Vijayaraghavan, P., Esmail, G.A., Duraipandiyan, V., Kim, Y.O., Kim, H. and Kim, H.J. (2020). Probiotic and antioxidant potential of Lactobacillus reuteri LR12 and Lactobacillus lactis LL10 isolated from pineapple puree and quality analysis of pineapple-flavored goat milk yoghurt during storage. *Microorganisms*, 8(10), p.1461.

Dacasin, A.B., Diagono, D.M.B., So, P.K.N., Von Rovic, L.B., Bucu, M.L.B., De Grano, R.V.R., Yu, G.F.B. and Bueno, P.R.P. (2021). The potential use of virgin coconut oil as an adjunctive treatment for COVID-19: A review. *Journal of Pharmacognosy and Phytochemistry*, 10(6), pp.37-49.

Deekshika B., Praveena, L.B., Hemanth, S., and Sukumaran, M.K. (2015). Estimation of ascorbic acid content in fruits & vegetables from Hyderabad, India for a theoretical assessment of vitamin C activity. *International Journal of Current Microbiology and Applied Sciences,* 4(1):96-99.

deOliveira, L.M., DosSantos, V.B., daSilva, E.K., Lopes, A.S. and Dantas Filho, H.A., 2020. An environment-friendly spottest method with digital imaging for the micro-titration of citricfruits*. Talanta,* 206,p.120219.

Elgailani, I.E.H., Elkareem, M.A.M.G., Noh,E., Adam, O. and Alghamdi, A., 2017. Comparison of two methods for the determination of vitamin C (ascorbicacid) in some fruits. *American Journal of Chemistry*, *2*(1),pp.1-7.

Gomes, A., Bourbon, A.I., Peixoto, A.R., Silva, A.S., Tasso, A., Almeida, C., Nobre, C., Nunes, C., Sánchez, C., Gonçalves, D.A. and Castelo-Branco, D. (2023). Strategies for the reduction of sugar in food products.*In Food structure engineering and design for improved nutrition, health and well-being*. Academic Press. pp. 219-241.

Gowe, C. (2015). Review on potential use of fruit and vegetables by-products as a valuable source of natural food additives. *Food Science and Quality Management*, 45(5), pp.47-61.

Holman, B.W., Kerry, J.P. and Hopkins, D.L. (2018). Meat packaging solutions to current industry challenges*: A review. Meat Science*, 144, pp.159-168.

Landon S. (2007). Fruit juice nutrition and health. Food Australia, 59(11): 533-538.

Lloyd, M.L. (2021). *Carotenoid Processing:* The Effects of Microwave-assisted Processing on Carotenoid Ingredients.North Carolina State University.

Madhavi N., and Jyothi, B. (2016). Colorimetric determination of vitamin C in fresh and dilute fruit juices and effect of thermal exposure on concentration at various stages. *International Journal of Pharma and Bio Sciences,* 7(4):197-211.

Narayanankutty, A., Illam, S.P. and Raghavamenon, A.C. (2018). Health impacts of different edible oils prepared from coconut (Cocos nucifera)*:* A comprehensive review. *Trends in Food Science & Technology*, 80, pp.1-7.

Oroian, M. and Escriche, I. (2015). Antioxidants: Characterization, natural sources, extraction and analysis. *Food Research International*, 74, pp.10-36.

Perera, C.O. (2020). Minimal processing of fruit and vegetables. *In Handbook of food preservation*.CRC Press. pp. 191-206.

Pinto, P., Santos, C., Henriques, C., Basto de Lima, M.G. and Quedas, M.D.F. (2011). Lycopene content and antioxidant capacity of Portuguese watermelon fruits. *Electronic Journal of Environmental, Agricultural and Food Chemistry*, pp.2090-2097.

Putnik, P., Pavlić, B., Šojić, B., Zavadlav, S., Žuntar, I., Kao, L., Kitonić, D. and Kovačević, D.B. (2020). Innovative hurdle technologies for the preservation of functional fruit juices. *Foods*, 9(6), p.699.

Qiu, L., Zhang, M., Tang, J., Adhikari, B. and Cao, P. (2019). Innovative technologies for producing and preserving intermediate moisture foods: A review. *Food research international*, 116, pp.90-102.

Richardson, P. (2018). The Development of Spectroscopic Methods for the Detection of Adulteration in Coconut Water (*Doctoral dissertation*), The University of Manchester (United Kingdom)).

Rodríguez-Roque, M.J., Rojas-Graü, M.A., Elez-Martínez, P. and Martín-Belloso, O. (2014). In vitro bioaccessibility of health-related compounds from a blended fruit juice–soymilk beverage: Influence of the food matrix. *Journal of Functional Foods*, 7, pp.161-169.

Sadler, G.D. and Murphy,P.A.,2010.pHandtitratableacidity. *Foodanalysis*, 4,pp.219-238.

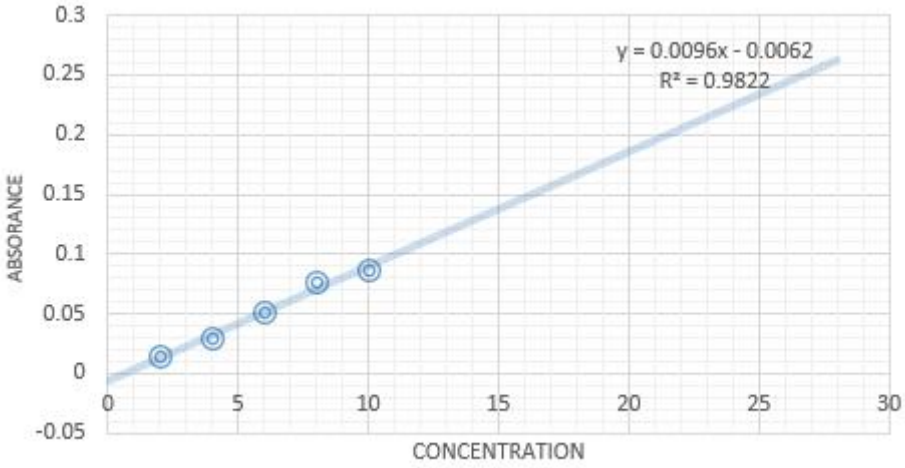
Sagar, N.A., Pareek, S., Sharma, S., Yahia, E.M. and Lobo, M.G. (2018). Fruit and vegetable waste: Bioactive compounds, their extraction, and possible utilization. *Comprehensive reviews in food science and food safety,* 17(3),pp.512-531.

APPENDIX

Table : Concentration of ascorbic acid standard solution

Concentration of ascorbic acid (µg/mL)	Absorbance at 530nm
10	0.086
8	0.077
6	0.051
4	0.029
2	0.014

Figure : Calibration Curve for Ascorbic Acid



The beer-lambert law which states that the amount of energy absorbed or transmitted by a solution is proportional to the concentration of the solutions and the path length.

CALCULATION FOR TITRABLE ACIDITY

$$\% \text{ titrable acidity } = \frac{\text{vol of base} \times 0.1 \times 100}{\text{vol of sample}}$$

With pulp

$$\text{Coconut } = \frac{1.6 \times 0.1 \times 100}{50} = 0.32\%$$

$$\text{Pineapple } = \frac{9.1 \times 0.1 \times 100}{50} = 1.82\%$$

$$\text{Water melon} = \frac{1.6 \times 0.1 \times 100}{50} = 0.32\%$$

Without pulp

$$\text{Coconut } = \frac{1.25 \times 0.1 \times 100}{50} = 0.25\%$$

$$\text{Pineapple} = \frac{4.4 \times 0.1 \times 100}{50} = 0.88\%$$

$$\text{Water melon} = \frac{0.1 \times 0.1 \times 100}{50} = 0.03\%$$

Titre value	With pulp coconut	Pineapple	Water melon	Blend
Initial reading	0.00	0.00	0.00	0.00
Final reading	3.2	18.2	3.2	14.8

Without pulp

Titre value	With pulp coconut	Pineapple	Water melon	Blend
Initial reading	0.00	0.00	0.00	0.00
Final reading	2.50	8.80	0.30	16.9

Calculations for the samples with pulp without pulp

Coconut milk

$$\frac{0.00. + 3.2}{2} = 1.6$$

Pineapple juice

$$\frac{0.00. + 18.2}{2} = 9.1$$

Water melon juice

$$\frac{0.00. + 3.2}{2} = 1.6$$

B lend

$$\frac{0.00. + 14.8}{2} = 7.4$$

$$\frac{0.00. + 2.50}{2} = 1.25$$

$$\frac{0.00. + 8.80}{2} = 4.40$$

$$\frac{0.00. + 0.30}{2} = 0.15$$

Blend

$$\frac{0.00. + 16.9}{2} = 8.45$$