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Quality assessment of melon-based fruit cocktail: chemical analysis and sensory acceptability

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Abstract. This study aimed to develop and evaluate a melon-based fruit cocktail as a value-added product to extend melon shelf life and enhance its market potential. Fresh melon (*Cucumis melo L.*) was processed into three formulations: untreated, blanched, and citric acid-pretreated, in a standardized syrup solution. Sensory evaluation and chemical analyses were conducted to assess quality attributes. Results showed that citric acid pretreatment significantly increased total soluble solids (TSS) and reducing sugar. However, the untreated sample achieved the highest sensory acceptance (overall score 4.24±0.66), maintaining desirable aroma, texture, and flavor balance. Its vitamin C and reducing sugar contents were also higher than those of fresh melon, likely due to improved extractability during processing. The inclusion of papaya and pineapple contributed additional sugars, enzymes, and organic acids that enhanced TSS and flavor complexity. Overall, the study demonstrates that controlled formulation and mild processing can produce a stable, nutritious, and consumer-preferred melon cocktail suitable for commercialization and waste reduction.

1 Introduction

Melons (*Cucumis melo L.*) are a significant horticultural crop prized worldwide for their refreshing taste, high water content, and nutritional profile, being a valuable source of vitamins (A and C), minerals (particularly potassium), and antioxidants such as carotenoids and phenolic compounds [1]. Despite their global popularity and seasonal abundance, postharvest losses remain a substantial challenge due to their high perishability and short shelf-life [2]. This issue necessitates the development of value-added processed products that

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can extend marketability, reduce waste, and provide convenient, nutritious options to consumers year-round.

In the context of cultivation, melons are often grown for dual purposes: commercial production for direct consumption or processing, as well as specialized cultivation for seed production (producing high-quality seeds). In seed production cultivation, the focus of nutritional conditioning is directed at optimizing seed quality, which directly affects the characteristics of the fruit pulp produced. Melons from this type of cultivation generally have sensory characteristics that differ from commercial melons, mainly characterized by a texture that tends to be denser and less sweet.

The main problem arising from this seedling cultivation practice is the sub-optimal utilization of fruit pulp. After the seeds are removed, the fruit pulp is often not utilized and ends up as biomass waste. This situation poses serious challenges related to agricultural waste management and loss of potential economic value. Therefore, effective diversification and processing strategies are needed to convert this fruit waste into value-added products.

Among the various processing avenues, ready-to-eat fruit cocktails represent a dynamic and growing segment of the food industry. These products cater to modern consumer demands for convenience, health, and variety [3]. However, the commercial fruit cocktail market is often dominated by a limited range of fruits, such as peaches, pears, and pineapples, with melons being an underutilized component. Incorporating melons into a formulated fruit cocktail presents a unique opportunity to diversify the product landscape, but it also introduces specific technical challenges. The delicate texture and subtle flavor profile of melons can be compromised during processing, particularly through thermal treatments, potentially leading to undesirable softening, loss of volatile aromatics, and nutrient degradation [4].

Therefore, a systematic approach to product development is crucial. This study focuses on the formulation and comprehensive evaluation of a novel fruit cocktail where melon serves as the primary or signature ingredient. The research was designed to address two fundamental aspects of product quality. First, organoleptic testing involving trained panelists was conducted to evaluate critical sensory attributes such as flavor, aroma, color, texture, and overall acceptability. Second, chemical analysis was performed to quantify and measure the nutritional compounds in the final product, including assessments of vitamin content, soluble solids.

By bridging the gap between chemical composition and consumer perception, this research aims to establish the scientific and practical feasibility of a melon-based fruit cocktail. The findings will provide critical data for the food industry to optimize processing parameters that maximize both nutritional quality and sensory appeal, ultimately contributing to reduced food waste and the introduction of innovative, health-promoting fruit products to the global market.

2 Materials and Methods

The primary ingridients, melon was obtained from the Smart Greenhouse of Politeknik Negeri Jember. The melon cocktail was formulated using a standardized syrup solution composed of 1 L of water, 10% (w/v) sucrose, 0.1% (w/v) citric acid, and 0.1% (w/v) sodium benzoate were heated at 85–90°C until fully dissolved, then cooled to 30–35°C before being mixed with the fruit to prevent heat damage. This formulation was selected to achieve an optimal balance of sweetness, acidity, and preservation stability, consistent with standard beverage formulations reported in fruit processing studies [5]. Melon, papaya (*Carica papaya*), and pineapple (*Ananas comosus*) were washed, peeled, and cut into uniform size in equal proportions. The fruit and syrup were filled into sterilized glass jars (80% capacity), sealed, and pasteurized at 90°C for 10 minutes.

2.1 Sample treatment

The size-reduced melon pieces was placed into the cocktail mixture. This was done using three different pre-treatment methods for comparison. First batch melon with no pre-treatment. The second batch was blanched in hot water at 75°C for 10 minutes before immersion. The final batch was first soaked in a 0.2% citric acid solution. The prepared fruit cocktail was then cooled to room temperature and stored at 4 ± 1°C to maintain its quality during storage for 5 days until sensory evaluation was performed.

2.2 Sensory Analysis

The sensory acceptance of the three melon cocktail formulations with the three treatments used was evaluated using a Hedonic Test. A total of 25 trained panelists were recruited and presented with the samples in a sensory evaluation laboratory under controlled lighting conditions. Samples were served at a standardized temperature to ensure consistency and were presented in clear, identical plastic cups labeled with random three-digit codes to prevent bias.

2.3 Data Analysis

The organoleptic test data were analyzed using Analysis of Variance (ANOVA) at a 95% significance level. With this method if the results showed a significant effect, researcher was proceeded with the Duncan Test

2.4 Chemical Analysis

Chemical analysis comprised two phases. Initially, all three cocktail formulations were subjected to basic physicochemical assessments: Total Soluble Solids (TSS) and pH. Subsequently, further detailed analysis, including the determination of Vitamin C content and reducing sugar content, was selectively performed only on the sample that demonstrated the highest overall preference based on the combined results of the Hedonic and Hedonic Quality sensory evaluations.

3 Results and Discussion

3.1 Total Soluble Sugar (TSS)

The present study demonstrated that citric acid pretreatment significantly increased the total soluble solids (TSS) content in melon compared to the control treatment showed in Table 1. This finding can be attributed to several interconnected physicochemical mechanisms that occur during acid immersion. This enhancement is primarily attributed to the acid-induced hydrolysis of cell wall polysaccharides, which releases soluble pectin fragments and sugars into the surrounding solution. The acidic environment also increased cell membrane permeability allows sugars, organic acids, minerals, and other water-soluble compounds to migrate from the cellular compartments into the cocktail solution [6], [7].

Furthermore, citric acid promoted sucrose inversion, converting sucrose into the more soluble reducing sugars—glucose and fructose—which contributed to the rise in TSS[8]. In addition, by lowering the pH and inhibiting polyphenol oxidase activity, citric acid helped preserve soluble phenolic compounds and maintain product clarity [7]. Collectively, these mechanisms explain the higher soluble solid content and improved quality of melon cocktails pretreated with citric acid.

The inclusion of papaya and pineapple in the melon cocktail formulation played a role in enhancing both total soluble solids (TSS) and reducing sugar content. This improvement arises from the synergistic interactions between the enzymatic activities of the companion fruits and the acid-based pretreatment. Papaya and pineapple contain proteolytic enzymes—papain and bromelain, respectively—that degrade structural proteins within fruit cell walls. This enzymatic softening complements the acid-induced hydrolysis triggered by citric acid, facilitating greater release of soluble sugars and organic acids into the cocktail medium. The synergy between proteolysis and acid hydrolysis enhances mass transfer and solubilization efficiency, increasing the measurable TSS [9], [10].

The cocktail samples investigated were deemed suitable for commercial sale because their soluble solids content (measured in ∘Brix) fell within the industry-standard range of 6∘Brix to 18∘Brix, as specified by Wazed et al [11].

Table 1. Total Soluble Solids (TSS) Content and pH of Melon Cocktail

Treatment	Total Soluble Sugar (°Brix)	pH
No Treatment	11,4	4,5
Blanched	13,1	4,5
Citric Acid	12,85	4,2

3.2 pH

Citric acid treatment was effective in achieving the highest measured TSS values because the resulting low pH environment helped to preserve the sugar content by reducing enzymatic browning and degradation [12]. The data from this study revealed that the melon fruit cocktail samples that underwent no pretreatment and blanching pretreatment exhibited a relatively high pH of 4.5. In contrast, melon treated with the citric acid immersion pretreatment yielded a significantly lower pH of 4.2. The relatively unchanged pH in the blanching and no pretreatment samples indicates that thermal or no pretreatment does not significantly alter the natural acid composition of melon, even though blanching facilitated the release of sugars from disrupted cell structures.

These results are shown in Table 1. in line with findings reported by Vu et al [13] who observed that citric acid treatment in minimally processed fruits not only reduced pH but also enhanced the retention of soluble solids by limiting oxidative and enzymatic degradation. The observed low pH environment within the melon cocktail formulation is primarily attributed to the inclusion of pineapple as a secondary fruit component, in addition to the exogenous addition of citric acid in the syrup. Pineapple naturally possesses a significantly lower pH compared to melon, which is generally considered a higher pH fruit [14]. When these two fruits are mixed, the substantial release of organic acids—predominantly citric acid and malic acid—from the pineapple tissue [15] into the surrounding cocktail syrup (which is already slightly acidic) effectively lowers the equilibrium pH of the entire system..

3.3 Sensory Analysis

The application of pre-treatments in fruit processing is a common strategy to preserve physicochemical and nutritional quality; however, its impact on sensory acceptability remains a critical determinant of product success. Pre-treatments such as blanching or citric acid immersion can modify color, texture, aroma, and flavor—attributes that directly influence consumer perception and preference. Therefore, beyond improving stability and composition, the sensory response of consumers serves as a key indicator of overall product feasibility. To evaluate these aspects, hedonic and hedonic quality tests were conducted to assess panelists' preferences and perceptions toward the formulated melon cocktail, providing insights into how processing interventions affect consumer acceptance.

3.3.1 Hedonic Assesment

The hedonic test results revealed significant variations in consumer acceptance across different treatment methods, with notable differences observed in multiple sensory attributes.

Table 2. Sensory Evaluation (Hedonic Test) of Consumer Liking for Three Melon Cocktail Formulations

Parameter	No Treatment	Blanched	Citric Acid
Color	3,44 ± 0,82 [a]	3,56 ± 0,71 [a]	3,64 ± 0,91 [a]
Aroma	3,96 ± 0,73 [b]	3,20 ± 0,91 [a]	3,52 ± 0,71 [ab]
Texture	4,00 ± 0,76 [b]	3,36 ±0,81 [a]	3,64 ± 0,56 [ab]
Taste	4,12 ± 0,78 [b]	3,48 ± 0,91 [a]	3,76 ± 0,77 [ab]
Overall	4,24 ± 0,66 [b]	3,52 ± 0,91 [a]	3,88 ± 0,72 [ab]

Analysis of individual sensory parameters provided valuable insights into the factors driving overall consumer preference. Color perception exhibited no significant differences among treatments. This uniformity suggests that the applied treatments did not substantially alter the visual characteristics of the product, or that any color changes that occurred were not discriminable by consumers at a level affecting hedonic response. This finding is consistent with previous studies indicating that mild processing treatments often preserve color attributes while modifying other quality parameters [11].

The uniformity of color perception across treatments may be attributed to several factors. First, the intrinsic pigments of melon appear relatively stable under the mild thermal conditions used during blanching as well as under the moderate acid levels applied during citric acid immersion [16], [17]. Both pre-treatments may have caused only minimal degradation or oxidation of color compounds, leading to visual characteristics comparable to those of the no treated sample. Additionally, citric acid has been reported to act as an antioxidant in certain fruit matrices, potentially helping to preserve color by limiting enzymatic browning [17], although this protective effect did not manifest as a statistically significant improvement in the present study.

In contrast, aroma acceptability demonstrated significant treatment effects, with the untreated sample receiving significantly higher scores than the blanched sample. The citric acid treatment showed intermediate acceptability, not significantly different from either extreme. The reduced aroma acceptability following blanching may be attributed to the thermal degradation of volatile compounds responsible for characteristic aromatic profiles. Heat treatment during blanching typically causes the loss of thermolabile volatile compounds, including esters, aldehydes, and terpenes, which contribute to fresh, fruity, or characteristic notes [18]. The citric acid treatment, being a non-thermal preservation method, appeared to better preserve aromatic compounds compared to blanching, though some modification of the native aroma profile was still evident.

The reduced taste scores for blanched samples may reflect the leaching of soluble flavor compounds into blanching water, a phenomenon commonly observed during hydrothermal treatments. Additionally, heat-induced chemical reactions, including Maillard reactions and caramelization at cellular level, may alter the natural flavor profile [18]. The citric acid treatment introduces tartness and may mask or modify certain flavor notes, explaining its intermediate position, though it avoids the flavor loss associated with thermal processing.

Based on the results of the Duncan Multiple Range Test (DMRT) on the texture aspect, all three formulations showed significantly different levels of preference. This difference in texture preference can be correlated with the results of instrumental texture measurement using a texture analyzer. The fresh melon used in this study had a hardness value of 22.7 N, which reflects the characteristic firm and crisp texture of good-quality melon. After processing into a cocktail product in syrup, a decrease in hardness occurred due to the combined treatment of citric acid soaking and heating (pasteurization), which caused the degradation of cell wall structure and the softening of the fruit tissue. Several previous studies [5], [19], [20]have reported that processed melon products experience a significant reduction in hardness compared to the fresh condition. This decrease in hardness is generally attributed to pectin solubilization, cell wall polysaccharide depolymerization, and pectinolytic enzyme activity during processing.

In the context of fruit cocktail products, a texture that is too soft can reduce consumer acceptability because of the loss of the desired crispness sensation. However, no treatment sample appears to be able to maintain a better texture compared to the other formulations. This aligns with the higher hedonic score for the texture parameter. The most striking finding from this study is the consistent and excellent performance of no pre-treatment sample across almost all sensory parameters.

In the hedonic test, which measures overall liking, formulation containing untreated melon achieved significantly higher scores for aroma, texture, flavor, and overall acceptance compared to the other two formulations. Its overall acceptability score of 4.24±0.66 on a 5-point scale indicates a high level of consumer preference. This suggests that the formulation with melon that was not pretreated retained sensory characteristics that were most appealing to the panelists. The inherent, fresh quality of the fruit, unaffected by thermal or chemical intervention, appears to be the most crucial factor for consumer liking. This enhanced performance is further corroborated by the hedonic quality test, which assesses the appropriateness of attribute intensities.

3.3.2 Hedonic Quality Assesment

Table 3 presents the hedonic quality evaluation of melon cocktail formulations subjected to three different pre-treatments. The sensory attributes assessed include color, aroma, texture, taste, and overall acceptance. This assessment aims to determine how each pre-treatment influences consumer perception of quality and to identify which formulation delivers the most favorable sensory characteristics. The hedonic scores obtained from trained panelists provide critical insights into the effects of thermal and acid-based treatments on the sensory integrity of melon cocktail products.

Tabel 3. Hedonic Quality Test of Melon Cocktail Formulations

Parameter	No Treatment	Blanched	Citric Acid
Color	2,12 ± 0,93 ^{a}	2,12 ± 0,93 ^{a}	2,04 ± 0,93 ^{a}
Aroma	3,20 ± 0,95 ^{b}	2,44 ± 0,96 ^{a}	2,72 ± 1,10 ^{ab}
Texture	2,36 ± 1,19 ^{a}	2,36 ± 1,11 ^{a}	2,44 ± 1,16 ^{a}
Taste	3,84 ± 0,74 ^{b}	3,20 ± 0,91 ^{a}	2,84 ± 1,14 ^{a}
Overall	4,28 ± 0,45 ^{b}	3,40 ± 0,64 ^{a}	4,08 ± 0,76 ^{b}

All formulations were evaluated as having comparable and acceptable levels of color and texture intensity, notable differences emerged in aroma and, particularly, flavor perception. Color scores ranged from 2.04 to 2.12, with no statistically significant differences among treatments. All formulations exhibited similar visual appearance, suggesting that neither blanching nor citric acid treatment substantially altered the color attributes of melon cocktail. The relatively low color scores indicate that panelists perceived the lught, which is characteristic of melon flesh. This uniformity across treatments suggests that color stability was maintained regardless of preservation method, an important quality attribute for consumer acceptance.

Aroma scores varied significantly among treatments, ranging from 2.44 to 3.20. These differences indicate that preservation treatments affected volatile aroma compounds in melon cocktail. The most preferred aroma score of no treated samples reflects the retention of fresh melon volatile compounds while blanching significantly reduced aroma intensity, likely due to thermal degradation and volatilization of heat-sensitive aroma compounds.

Texture scores showed minimal variation, ranging from 2.36 to 2.44, with no significant differences among treatments. All formulations received similar texture ratings, suggesting that blanching and citric acid treatment did not substantially affect the firmness, crispness, or mouthfeel of melon pieces in the cocktail. This consistency is advantageous for product standardization, as texture remains uniform regardless of preservation method employed.

Panelists expressed the highest approval for the taste profile of melon without pre-treatment which received the greatest flavor adequacy rating (3.84 ± 0.74), indicating an optimally balanced flavor intensity. In contrast, melon underwent citric acid immersion, received the lowest flavor score (2.84±1.14). This suggests that citric acid treatment may have introduced a sourness or altered the natural flavor profile in a way that was perceived as less ideal, negatively impacting its hedonic quality despite a moderate overall liking score.

The blanching pre-treatment appears to have been detrimental to its sensory appeal. It consistently recorded the lowest scores in the hedonic test for key drivers of liking such as aroma, texture, flavor, and overall acceptance. Thermal processing often leads to the loss of volatile compounds and enzymatic changes that can diminish fresh aroma and alter texture, which likely explains its poor performance relative to the untreated control [4].

Overall acceptability scores followed a similar pattern to taste ratings, with the no pretreated sample achieving the highest score (4.28 ± 0.45), followed by citric acid-treated and blanched samples. The most preffered sample performance reflects the synergistic effect of maintaining fresh aroma and taste characteristics. Interestingly, despite lower individual sensory scores for some attributes, the citric acid-treated sample achieved relatively high overall acceptability (4.08), suggesting that panelists valued the balance of preservation benefits and sensory quality. The blanched sample received the lowest overall acceptability score (3.40), indicating that thermal treatment's negative impacts on aroma and taste outweighed any potential benefits. This finding suggests that blanching may not be the optimal preservation method for melon cocktail when sensory quality is a priority.

Therefore, no pretreated formulation which represents the highest consumer acceptance, should be considered the benchmark for this product category. Consequently, further tests were conducted on this sample to determine its Vitamin C and reducing sugar content.

3.4 Vitamin C

The analysis of Vitamin C (Table 4.) shows an increase in Vitamin C content in no treatment melon compared to fresh melon fruit. This increase can be explained by the increased extractability of vitamin C after the fruit cell tissue was destroyed during the processing. Physical treatments such as cutting, crushing, or mixing can break down cell walls and release ascorbic acid that was previously trapped in the fruit matrix, resulting in higher measurable vitamin[21]. These results are in line with previous studies showing that processing fruit with mild treatment (light treatment without excessive heating) can maintain or even slightly increase vitamin C content due to increased bioavailability [22].

Table 4. Vitamin C and Reducing Sugar Content in Fresh Melon Fruit and Melon Cocktail

Sample	Vitamin C (mg/100g)	Reducing Sugar (%)
Fresh Melon Fruit	7,69	3,575
Melon Cocktail	8,18	8,361

3.5 Reducing Sugar

The results of the study indicate a significant increase in the reducing sugar content of the most preferred formulation composition occurred during the processing and applied treatment. In fresh fruit, reducing sugars primarily consist of glucose and fructose, which are formed from the hydrolysis of starch or sucrose [8]. During processing, the activity of hydrolytic enzymes (such as invertase or amylase) or physical treatment can enhance the release of simple sugars, thus increasing the measured reducing sugar level. This aligns with the report by Venetikidou et al [10] which states that fruit processing treatments can increase the availability of simple sugars due to the breakdown of sucrose into glucose and fructose.

During the fruit cocktail processing, particularly under acidic conditions and in the presence of heat treatment, the glycosidic bonds in the sucrose molecule can be hydrolyzed. This hydrolysis yields two monosaccharides that are both more readily soluble and more chemically reactive. This reaction not only increases the reducing sugar value but also affects the rise in Total Soluble Solids (TSS) and shifts the flavor profile to be sweeter and smoother [23], [24].

From a sensory perspective, this increase in reducing sugars contributes to the balance of sweet and sour taste, which is a critical factor in the panelists' hedonic evaluation. Overall, these results indicate that the processing treatment and the chemical conditions of the cocktail solution play a significant role in enhancing the reducing sugar value and the sensory quality of the final product.

4 Conclusion

This study successfully developed and characterized a novel fruit cocktail with melon as the primary ingredient. The findings conclusively demonstrate that the choice of pre-treatment profoundly influences the product's final quality, creating a clear trade-off between physicochemical properties and sensory acceptance. While the citric acid pre-treatment was effective in increasing the Total Soluble Solids (TSS) through mechanisms of cell wall hydrolysis and sucrose inversion, it adversely affected the flavor profile, making it less ideal for consumers. Similarly, the blanching pre-treatment consistently resulted in the lowest sensory scores, likely due to the loss of volatile aromas and textural degradation. Therefore, the melon without pre-treatment emerged as the most preferred formulation, achieving the highest level of overall consumer acceptability. Its success is attributed to the preservation of the fruit's inherent fresh aroma, natural texture, and unaltered flavor. The concomitant increases in Vitamin C and reducing sugar content in this sample further validate its quality, suggesting that mild processing can enhance nutrient bioavailability without compromising sensory appeal.

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