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Research Article

# Storage Stability and Physicochemical Attributes of Kinnow *(Citrus Reticulata cv.)*-Aloe-vera-Mint Blended Juice

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## Abstract

The development of functional beverages using plant-based bioactives is gaining momentum due to rising consumer demand for health-oriented products. This study investigates the formulation and storage stability of a ready-to-serve (RTS) juice blend incorporating Kinnow (*Citrus reticulata cv.*), Aloe-vera (*Aloe barbadensis miller*), and Mint (*Mentha piperita l.*). Five juice blends ($T_0$-$T_4$) were prepared by varying ratios of kinnow, aloe-vera, and mint, and stored at 5 ± 2°C for 2 months. To assess physicochemical parameters (pH, TSS, acidity, ascorbic acid), microbial load (total plate count & yeast and mold count) and sensory quality. Results indicated that $T_2$ (85:10:5) demonstrated optimal sensory acceptability, consistent decline in pH and ascorbic acid, along with an increase in titratable acidity and TSS and significantly lower microbial counts throughout the storage period. It achieved the highest overall acceptability score (8.8/9), reflecting excellent taste, flavor, color, and texture. During 60 days of storage, $T_2$ maintained a favorable pH (3.33), stable TSS ($12.4^0$ Brix), and high ascorbic acid retention (20.1 µg/100 ml), indicating good nutritional preservation was observed in all samples. The inclusion of aloe-vera and mint suppressed microbial growth due to their bioactive compounds, including, aloin emodin, and menthol. The study concludes that aloe-vera and mint can be effectively incorporated into citrus-based beverages to enhance shelf life, nutritional value, and consumer appeal, with $T_2$ identified as the most promising formulation based on the physicochemical, microbial, and sensory data, the formulation was found suitable for consumer consumption and offered therapeutic potential.

## Keywords

Aloe-vera, Kinnow, Mint, Physicochemical Attributes, Sensory Evaluation and Storage Stability

## 1. Introduction

The rising demand for functional beverages stems from their ability to combine hydration, nutrition, and health-promoting effects in a convenient form. These beverages often incorporate bioactive-rich ingredients such as fruits, herbs, and nutraceutical extracts that offer benefits beyond basic nutrition. Among these, citrus-based drinks are particularly favored due to their pleasant flavor and refreshing sensory properties [1, 2].

Kinnow (*Citrus reticulata Blanco*), a hybrid of Citrus nobilis and Citrus deliciosa, was developed by H. B. Frost in 1915 and introduced to India by Dr. J. C. Bakshi in 1954 [3, 4]. It is widely cultivated in India and Pakistan and is renowned for its high juice content, bright orange color, palatability, and high vitamin C concentration. The juice is a rich source of

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phenolics, flavonoids (e.g., naringin and hesperidin), potassium, and vitamin C, offering antioxidant, anti-inflammatory, and antimicrobial benefits [5, 6]. However, the presence of limonoids often imparts bitterness, limiting its processing potential and consumer acceptance [7].

Aloe-vera (*Aloe barbadensis miller*), commonly known as the "plant of immortality," contains over 98% water and a wide array of bioactive compounds including vitamins (A, C, E, B-complex), minerals, amino acids, and glucomannan-based polysaccharides [8]. Its antimicrobial, and immunomodulatory properties make it an attractive functional ingredient for beverages, although its bitter taste and low sugar content require blending with sweeter juices to enhance acceptability [9-11].

Mint (*Mentha piperita l.),* known for its cooling flavor and aroma, enhances beverage functionality due to its high content of essential oils (menthol, menthone), flavonoids, and phenolic compounds. These constituents contribute to its antimicrobial, antioxidant, and digestive health benefits [12, 13]. Mint is also effective in masking the bitterness of aloe-vera, improving the overall sensory appeal and storage stability of blended beverages [14-18].

Combining kinnow juice with aloe-vera and mint provides a novel approach for formulating a natural, health-enhancing beverage. Prior studies have shown that aloe-vera and mint can inhibit microbial growth, and enhance the physicochemical stability of citrus-based drinks [12, 19, 20]. Therefore, this study aimed to develop and evaluate the storage stability, sensory characteristics and microbial activity of Kinnow-Aloe-vera-Mint blended juices over a 60-day refrigerated storage period.

The blend of kinnow, aloe-vera, and mint offers synergistic nutritional and functional benefits providing vitamins (A, C, E, B-complex, folic acid), antioxidants, essential minerals, hydration, and digestive support while aligning with market demand for natural, minimally processed functional beverages; stability testing ensures maintenance of nutritional, functional, and sensory quality, targeting health-conscious consumers seeking refreshing, wellness-oriented drinks.

## 2. Materials and Methods

### 2.1. Raw Materials

Fresh Kinnow fruits (*Citrus reticulata Blanco*), Aloe-vera leaves (*Aloe barbadensis miller*), and Mint leaves *(Mentha piperita l.)* were procured from local markets in Prayagraj, India. All materials were sorted, washed, and processed under hygienic conditions.

### 2.2. Juice Preparation


***Figure 1.*** *The flow chart for the processing of aloe-vera, kinnow and mint juice [20].*

## 2.3. Blended Juice Formulation

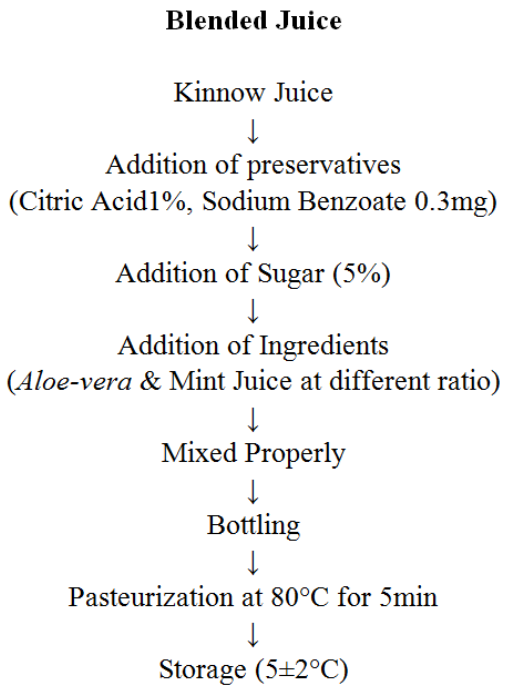


***Figure 2.*** *The flow chart for the blended juice [21, 22].*

***Table 1.*** *Formulations of blended juice.*

| Treatments Code | Kinnow (%) | Aloe-vera (%) | Mint (%) |
|---|---|---|---|
| T0 | 100 | - | - |
| T1 | 90 | 5 | 5 |
| T2 | 85 | 10 | 5 |
| T3 | 80 | 15 | 5 |
| T4 | 75 | 20 | 5 |

## 2.4. Method of Analysis

The prepared juice samples were analysed at regular interval under refrigerated storage (5 ±2 ℃).

## 2.5. Physicochemical Analysis

### 2.5.1. pH

Measured using a calibrated digital pH meter [23].

### 2.5.2. TSS

Determined using digital refractometer at 20 ℃ [23].

### 2.5.3. Titratable Acidity (TA)

Expressed as% citric acid by titration with 0.1N NaOH [23].

### 2.5.4. Ascorbic Acid

Quantified using the 2, 6-dichlorophenol indophenol titration method with 20% metaphosphoric acid as stabilizer [23, 24].

## 2.6. Microbial Analysis

Total plate count and yeast & mold count were performed using pour plate methods with nutrient agar and potato dextrose agar. Incubation was done at 37 ℃ (24h) for TPC and 28 ℃ (48-72h) for yeast/mold. Results were reported as cfu/ml [25].

## 2.7. Sensory Evaluation

Ten semi-trained panelist's evaluated juice samples using a 9-point hedonic scale for color, taste, flavor, consistency, and overall acceptability. Coded samples were presented under controlled conditions.

## 2.8. Statistical Analysis

Data were analyzed using one-way analysis of variance (ANOVA) at 5% significance ($p < 0.05$). Statistical analysis was conducted using Microsoft Excel [26].

# 3. Results

## 3.1. Sensory Evaluation

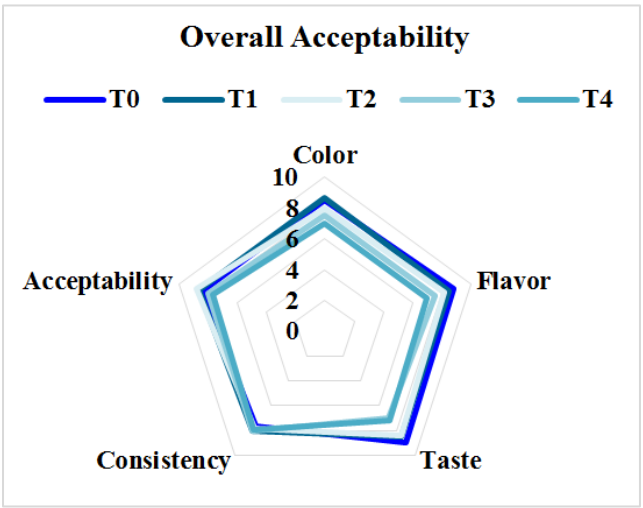


***Figure 3.*** *Overall acceptability scores.*

The sensory quality of the Kinnow-Aloe-vera -Mint juice blends was assessed using a 9-point hedonic scale. Treatment $T_2$ (85:10:5) emerged as the most preferred formulation in terms of overall acceptability (8.8) (Figure 3), followed by $T_1$ & $T_0$ while $T_3$ & $T_4$ were rated lower due to increased bitter-

ness associated with higher aloe-vera and mint. $T_0$ received the highest score for taste (9.0), reflecting the appealing flavor of pure kinnow juice. $T_1$ received the highest color score (8.7), with $T_3$ & $T_4$ showing a duller appearance. The consistency of blends was also positively influenced by aloe-vera viscosity, with $T_1$ & $T_3$ scoring 8.0 [1, 8, 12, 16].

These findings indicate that aloe-vera and mint can be successfully incorporated into citrus-based beverages without significantly compromising consumer acceptability, especially at moderate levels (5-10%).

## 3.2. Physicochemical Properties

### 3.2.1. pH

The pH of all formulations gradually declined during overtime (Figure 4). $T_2$ showed a decrease from 3.56 to 3.33 which remained within the acceptable acidic range for fruit juices. The relatively stable pH in aloe-vera enriched blends may be attributed to aloe-vera buffering capacity and antimicrobial effects. These results corroborate findings by [20, 28] who observed pH stabilization in aloe-vera fortified citrus beverages.

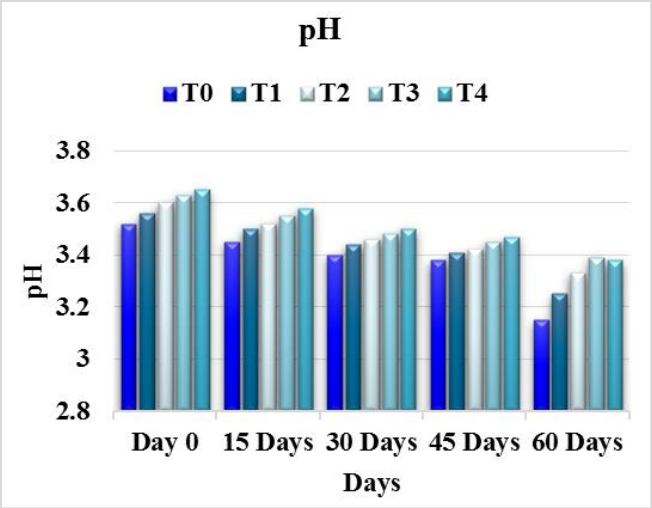


***Figure 4.*** *pH during storage.*

### 3.2.2. Total Soluble Solids (TSS)

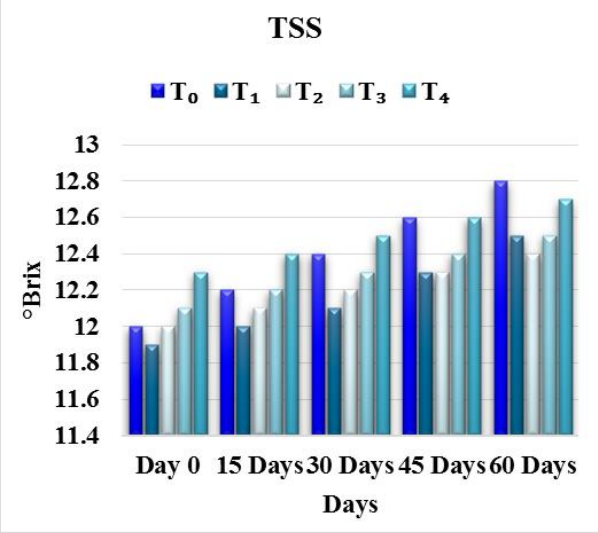


***Figure 5.*** *TSS during storage.*

TSS values increased gradually in all treatments over the storage period (Figure 5). $T_2$ showed an increase from 11.0 to 12.$^{40Brix}$, likely due to hydrolysis of polysaccharide and moisture evaporation. The slower increase in aloe-vera and mint blended treatments suggest protective effects against degradation. Similar trends were reported by [10, 25, 29].

### 3.2.3. Titratable Acidity (TA)

Titratable acidity rose in all treatments, with $T_0$ showing the highest increase (up to 50%), while $T_2$ showed a moderate increase (to 0.44%). This rise may be attributed to microbial fermentation & sugar degradation into organic acids (Figure 6). Aloe-vera had antimicrobial properties likely contributed to the slower increase in titratable acidity consistent with previous observations by [1, 29].

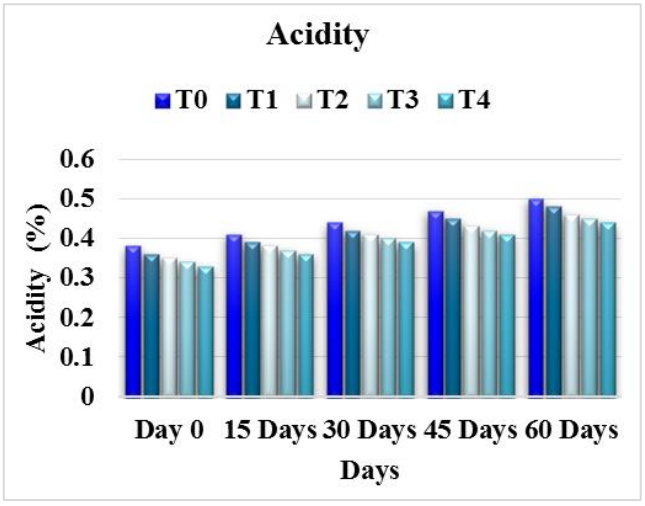


***Figure 6.*** *Acidity during storage.*

### 3.2.4. Ascorbic Acid

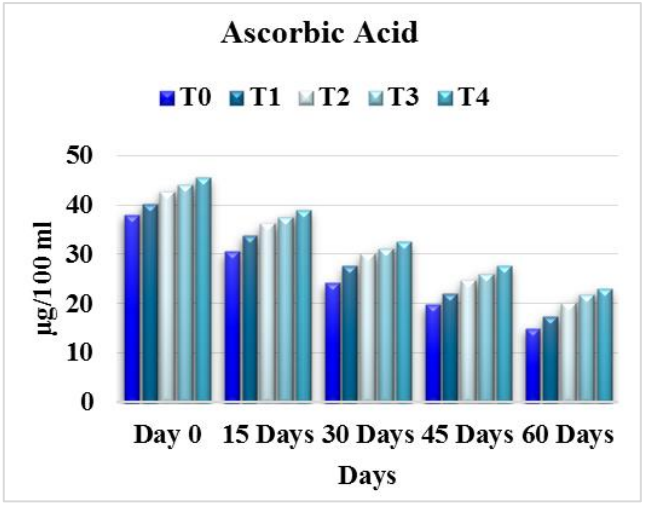


***Figure 7.*** *Ascorbic acid during storage.*

Ascorbic acid content decreased significantly during storage across all blends (Figure 7). $T_2$ exhibited a decline from 42.6 to 20.1 mg/100 ml, which was less severe than in the control ($T_0$). The loss of vitamin C is dependent on temperature with the increase of storage period These observations align with [13, 14, 27]. those who demonstrated enhanced retention of ascorbic acid in aloe-vera fortified juices.

## 3.3. Microbial Quality

### 3.3.1. Total Plate Count (TPC)

Microbial growth increased with storage in all samples, though blends with aloe-vera and mint ($T_1$-$T_4$) exhibited significantly lower microbial loads. At day 60, $T_0$ recorded the highest TPC (6.8cfu/ml), whereas $T_4$ had the lowest (2.5 ×10 ₹fu/ml). Antimicrobial compounds such as aloin and menthol may account for this suppression, consistent with reports by [20, 21].

### 3.3.2. Yeast and Mold Count

Similar to TPC, yeast and mold counts remained undetected initially but rose during storage. $T_0$ reached 6.7 ×10 ₹fu/ml while $T_4$ remained at 3.1 ×10 ₹fu/ml by day 60. Mint and aloe-vera appeared to restrict fungal growth, consistent with antifungal activity reported in previous studies [13, 29].

## 4. Discussion

Moderate incorporation of aloe-vera and mint significantly enhanced the sensory quality, and microbial stability of Kinnow-based RTS beverages. Among the formulations, $T_2$ (85:10:5) consistently demonstrated superior performance during 60 days of refrigerated storage. This can be attributed to the bioactive components in aloe-vera and mint, such as aloin and menthol which contributed to microbial suppression. These results are consistent with earlier findings [1, 2, 8, 9, 19], affirming that botanical enrichment not only improves functional value but also extends shelf life. Thus, aloe-vera and mint show strong potential as natural stabilizers in citrus-based functional drinks.

## 5. Conclusion

This study demonstrates that aloe-vera and mint, when added in appropriate proportions, significantly improve the sensory, nutritional, and microbial qualities of kinnow-based RTS beverages. Among the five formulations evaluated, $T_2$ (85:10:5) emerged as the most effective blend, offering optimal taste, antioxidant retention, and microbial safety throughout refrigerated storage.

The enhanced stability and functional properties observed validate the role of aloe-vera and mint as value-adding ingredients in functional beverage formulation. These findings

not only contribute to the development of health-oriented citrus drinks but also reinforce the importance of natural bioactives in extending shelf life and improving product quality in the beverage industry.

## Abbreviations

| | |
|---|---|
| ANOVA | Analysis of Variance |
| CFU | Colony Forming Unit |
| KMS | Potassium Metabisulphite |
| NaOH | Sodium Hydroxide |
| pH | Potential of Hydrogen |
| TSS | Total Soluble Solids |
| TPC | Total Plate Count |
| RTS | Ready-to-serve |
| TA | Titratable Acidity |

## Author Contributions

**Tripti Jaiswal:** Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing

**Dorcus Masih:** Project administration, Supervision, Validation, Visualization, Writing – review & editing

## Conflicts of Interest

The authors declare no conflicts of interest.

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