

EFFECT OF SODIUM BENZOATE AND POTASSIUM METABISULPHITE COMBINATIONS ON THE QUALITY AND SHELF STABILITY OF APPLE-PEAR JUICE BLENDS

Aqil ur Rehman^{*1}, Saboor Khalid², Nouman Siddique³, Salman Khurshid⁴, Amer Mumtaz⁵, Shahid Yousaf⁶, Faiga Atiq⁷, Abdul Ahad Kolachi⁸, Muhmmad Waseem Kalroo⁹, Behari Lal Meghwar¹⁰, Abdul Karim Khan¹¹, Usama bin Khalid¹², Tehreem Sarwar¹³, Ujala Tahir¹⁴

^{*1,3,4,5,6,13,14}Food Science Research Institute, NARC, PARC Islamabad, Pakistan

²Department of Chemistry, University of Engineering and Technology, Lahore, Pakistan

³National Tea & High Value Crops Research Institute, PARC, Shinkiari, Mansehra, Pakistan

⁴Arid Zone Research Centre, PARC, Umerkot, Pakistan

⁵Mountain Agricultural Research Centre, PARC, Gilgit, Pakistan

⁶Zarai Taraqati Bank Limited, Kamalia, Pakistan

^{*1}aqil6968@parc.gov.pk

DOI: <https://doi.org/10.5281/zenodo.18372428>

Keywords

Shelf life, Fruit Juices, Preservatives, Ascorbic Acid, Apple-Pear Juice Blend, Physicochemical Properties

Article History

Received: 18 November 2025

Accepted: 10 January 2026

Published: 26 January 2026

Copyright @Author

Corresponding Author: *

Aqil ur Rehman

Abstract

Fruit juices deteriorate gradually during storage because of chemical reactions, oxidative losses and shifts in acidity. These changes are often more pronounced in blended beverages, where the mixture of fruit components can accelerate instability. In this study, the influence of sodium benzoate (SB) and potassium metabisulphite (KMS) on the quality of an apple-pear juice blend was examined over 90 days of ambient storage. Seven preservative treatments were prepared, including a control without additives and several combinations of SB and KMS. Periodic analyses were carried out for pH, total soluble solids (TSS), titratable acidity, sugar-acid ratio, ascorbic acid and reducing sugar fractions. All samples showed progressive changes during storage, but the extent varied with preservative level. Blends containing both SB and KMS resisted quality losses more effectively than single-preservative treatments. In particular, the formulation with 0.04% SB and 0.06% KMS maintained pH, vitamin C and sugar balance better than the other treatments. Although the study relied on single measurements at each interval, the overall pattern supports the use of combined preservatives for stabilizing apple-pear juice blends during unrefrigerated storage.

1. INTRODUCTION

Fruit juices, whether single-fruit or blended, rarely remain chemically static once they are packed and placed on a shelf. Anyone familiar with juice processing knows how quickly colour, sharpness and even aroma can shift, particularly when products sit at room temperature for long periods. Apple-pear blends behave in much the same way. Although the two fruits complement one another well in terms of flavour and nutritional value, the combination also brings together a mix of organic acids, sugars and phenolic compounds that tend to react slowly but steadily during storage. Over time, these reactions—especially those linked to oxidation—can alter the character of the juice quite noticeably.

Because of these tendencies, processors often turn to chemical preservatives when heat treatment alone does not offer enough protection. Sodium benzoate (SB) and potassium metabisulphite (KMS) are among the most common options in this context. Both have been used for decades, yet their actions are not identical. Benzoate relies heavily on acidic conditions to suppress microbial growth, while KMS behaves differently; it releases sulphur dioxide, which has a useful habit of interfering with oxidative reactions and slowing the loss of sensitive nutrients such as vitamin C. In practical terms, this means that a juice containing sulphites may hold its colour and nutritional profile for a longer period.

Although these preservatives are well documented in studies on mango, guava and citrus juices, blended beverages often respond differently. A mixture of apple and pear, for instance, does not always act like either fruit on its own. Its buffering capacity, phenolic makeup and natural sweetness-acidity balance can shift how preservatives perform. Moreover, food regulations place clear limits on allowable levels of benzoates and sulphites. These regulations leave processors looking for combinations that fall within permissible ranges but still provide enough protection to avoid rapid quality loss.

With these considerations in mind, the present study set out to observe how several ratios of SB and KMS influenced the shelf behaviour of an apple-pear juice blend stored at room temperature for 90 days. The work focused on parameters that tend to signal early quality changes—pH, titratable acidity, soluble solids,

vitamin C and reducing sugar levels. Although the study design relied on single measurements at each interval (as is common in preliminary product-development work), these indicators still provide a clear sense of how each preservative treatment shaped the product during storage. What follows is an account of the patterns that emerged.

2. Materials and Methods

2.1. Juice Preparation

Ripe apples and pears of uniform quality were selected, washed thoroughly and peeled manually. The fruits were pulped using a mechanical extractor, and the resulting juices were passed through a fine muslin cloth to remove coarse particles. To prepare the apple-pear blend, 100 mL of apple juice was mixed with 25 mL of pear juice. Distilled water (125 mL) and 35 g of sucrose were incorporated to obtain a beverage with approximately 14 °Brix. All processing steps were carried out under hygienic conditions to prevent contamination before preservative addition.

2.2. Preservative Treatments

Preservative treatments were formulated to evaluate the effects of sodium benzoate (SB) and potassium metabisulphite (KMS), individually and in combination. The treatment structure was as follows:

Table 1.

Treatment	Sodium Benzoate (%)	Potassium Metabisulphite (%)
T1	0.00	0.00
T2	0.10	0.00
T3	0.00	0.10
T4	0.08	0.02
T5	0.06	0.04
T6	0.04	0.06
T7	0.02	0.08

Preservatives were dissolved directly into the juice blend and stirred until uniformly distributed. Samples were filled into sterilized glass bottles, sealed immediately and labelled clearly with treatment code and storage date.

2.3. Storage and Sampling

All bottles were stored at ambient laboratory conditions (25–30 °C) away from direct light. Analyses were carried out on day 0 and then every 15 days up to 90 days. At each sampling interval, one bottle from each treatment group was opened and analyzed for physicochemical characteristics.

2.4. Analytical Procedures

All determinations were performed using standard analytical protocols recommended for fruit juice evaluation. pH was measured using a digital pH meter calibrated at pH 4.0 and 7.0. Total Soluble Solids (TSS) were determined with a hand refractometer at 20 °C and expressed in °Brix. Titratable Acidity was measured by titration with standard NaOH solution using phenolphthalein as indicator and expressed as percent citric acid. Sugar/Acid Ratio were calculated by dividing TSS by titratable acidity. Ascorbic Acid were quantified using a redox titration method based on dye reduction. Reducing and Non-Reducing Sugars were determined using AOAC approved volumetric techniques.

All reagents used were of analytical grade and equipment was rinsed and standardized before each use to ensure accuracy.

All reagents used were of analytical grade, and equipment was rinsed and standardized before each use to ensure accuracy.

2.5. Statistical Considerations

Measurements were taken once per sample and not replicated. Because of this, the study does not present inferential statistics such as standard deviations or significance testing. Interpretation is instead based on the direction and consistency of changes across treatments, which is a reasonable approach for exploratory formulation trials.

3. Results

The physicochemical properties of the apple-pear juice blend changed steadily over the 90-day storage period, and the magnitude of these changes varied across preservative treatments. The results are summarized below according to the major quality indicators measured.

3.1. pH

A steady fall in pH occurred in all samples during the 90-day period. The control showed the most pronounced drop, while blends containing higher proportions of KMS retained slightly higher pH values throughout storage. The mixture used in T6 (0.04% SB + 0.06% KMS) showed a smaller decline than most other treatments, indicating that this combination offered some restraint against acidification. By day 90, the difference between the control and the most stable treatment exceeded 0.3 pH units, indicating the stronger protective effect of sulphite-based systems against acidification.

Table 2. Effect of storage period and treatments on pH of apple-pear juice blend at ambient temperature.

Day	T1	T2	T3	T4	T5	T6	T7
00	3.81	3.89	3.92	3.98	3.93	3.99	3.91
15	3.81	3.89	3.89	3.98	3.89	3.98	3.89
30	3.79	3.84	3.85	3.88	3.88	3.91	3.79
45	3.75	3.78	3.80	3.85	3.84	3.87	3.71
60	3.70	3.71	3.77	3.79	3.80	3.82	3.62
75	3.66	3.67	3.72	3.74	3.75	3.78	3.53
90	3.58	3.63	3.71	3.70	3.71	3.74	3.41

3.2. Total Soluble Solids (TSS)

TSS increased slightly in all samples over time, with rises generally ranging from 0.5 to 0.8 °Brix. These increases are typical of juice products stored at room temperature and may be associated with polysaccharide breakdown or slow moisture loss from the product headspace. The pattern was broadly similar across treatments, although

combinations of SB and KMS appeared to moderate the rate of increase compared with the control and single-preservative samples. The T6 blend showed one of the smallest overall increases in TSS, suggesting a more controlled pattern of compositional change.

Table 3. Total Soluble Solids (TSS)

Day	T1	T2	T3	T4	T5	T6	T7
00	14.00	14.08	14.00	14.01	14.00	14.02	14.00
15	14.08	14.13	14.07	14.14	14.09	14.13	14.11
30	14.20	14.29	14.17	14.35	14.25	14.21	14.27
45	14.35	14.48	14.34	14.49	14.35	14.37	14.39
60	14.51	14.51	14.42	14.60	14.39	14.42	14.53
75	14.67	14.65	14.61	14.65	14.61	14.54	14.67
90	14.84	14.73	14.71	14.81	14.79	14.68	14.98

3.3. Titratable Acidity

Titrateable acidity rose progressively during storage in all treatments. The increase was most evident in the control sample, which showed the highest acidity at the end of the storage period. Treatments containing KMS tended to produce slightly higher acidity values

than those with SB alone, an effect that has been reported in other sulphite-preserved fruit beverages. Nevertheless, the combined treatments produced more gradual acidity increases than the single-preservative formulations, indicating that mixtures of SB and KMS created a more balanced stabilising effect.

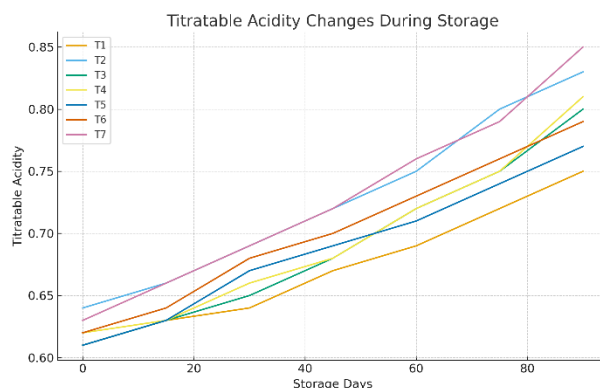


Figure . 1 Titratable Acidity Changes during Storage

3.4. Sugar–Acid Ratio

The sugar–acid ratio declined over time in every treatment because of the simultaneous rise in acidity and modest increase in soluble solids. The decline was steepest in the untreated control, which

experienced the largest drop in sweetness–acidity balance by day 90. Blends containing both SB and KMS showed a noticeably slower reduction in this ratio. T4, T5 and especially T6 retained a more favourable balance, indicating better preservation of flavour attributes compared with other treatments.

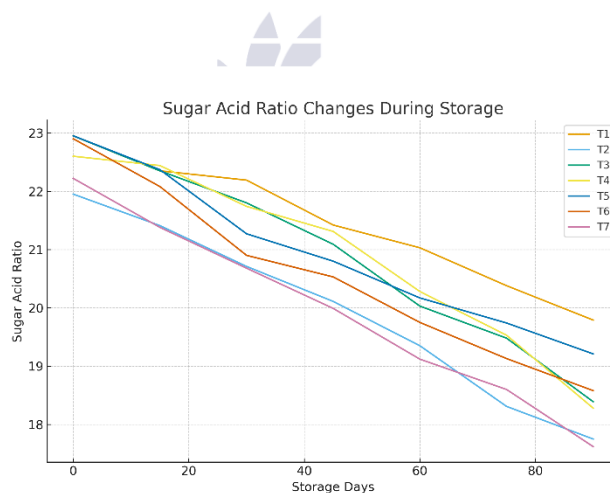


Figure . 2 Sugar – Acid Ratio

3.5. Ascorbic Acid

Ascorbic acid content decreased sharply across all storage intervals, particularly during the first 45 days. The rate of decline was slower in KMS-containing treatments, which is consistent with the known oxygen-scavenging properties of sulphur dioxide. By

day 90, T6 and T7 retained substantially more vitamin C than the untreated control or the benzoate-only sample. The preservative mixture in T6 yielded one of the highest final ascorbic acid levels, suggesting that this ratio provided stronger protection against oxidative loss.

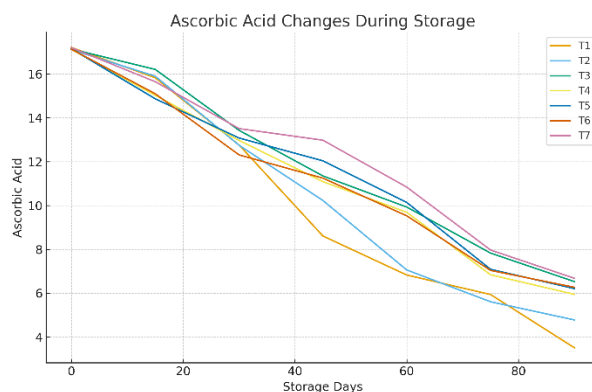


Figure .5 Ascorbic Acid Changes during Storage

3.6. Reducing and Non-Reducing Sugars

Reducing sugars increased over time as sucrose underwent hydrolysis, while non-reducing sugars declined correspondingly. These patterns appeared

in all treatments but were most pronounced in the control. Samples treated with combined preservatives exhibited slower shifts in sugar composition, with T6 again maintaining the most stable profile.

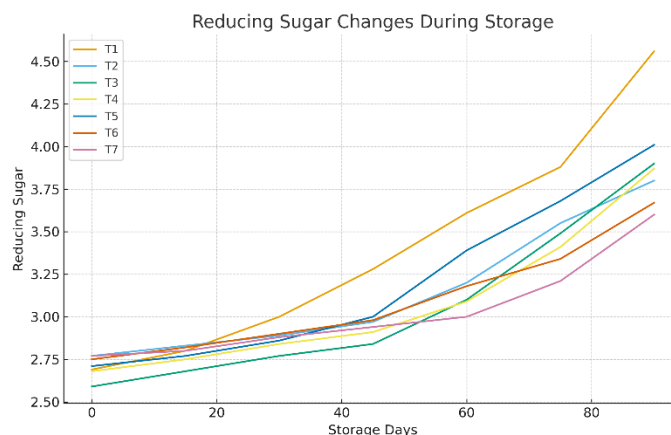


Figure .6 Reducing Sugar Changes during Storage

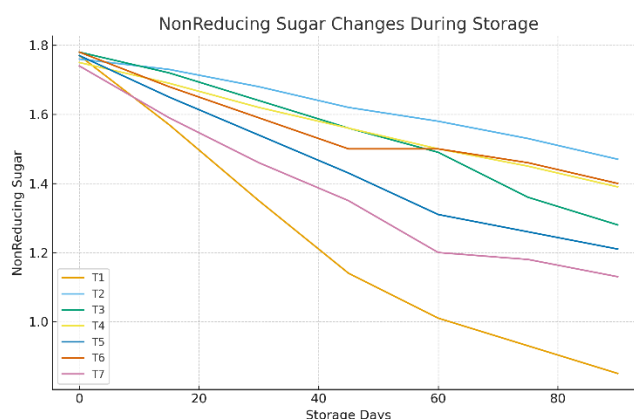


Figure .7 Non Reducing Sugar Changes during Storage

4. Discussion

The results observed here are generally consistent with what is known about the storage behaviour of fruit-based beverages. The fall in pH across treatments is typical of juices held at room temperature and reflects a combination of acid liberation and other metabolic changes. The preservation of pH seen in KMS-containing blends, particularly T6, likely stems from sulphur dioxide's role in slowing reactions that contribute to acid development.

The slight increases in TSS observed during storage also align with earlier work on fruit juices. These increases probably arise from the breakdown of soluble solids or minor water loss inside the sealed containers. Although the magnitude of change was small, the combined preservative treatments helped moderate this shift.

Acidity increases were expected as well, and the somewhat higher acidity in KMS-containing treatments has been noted in other studies. Even so, the changes were not large enough to compromise product quality and may simply reflect natural storage chemistry.

The sugar-acid ratio is an especially useful indicator when discussing flavour stability, and the slower decline in the combined-preservative treatments reinforces the earlier observation that SB and KMS work better together than alone. The stabilisation of ascorbic acid by KMS also stood out, confirming the antioxidant function of sulphur dioxide.

The continual rise in reducing sugars and fall in non-reducing sugars follows the well-known path of sucrose inversion in acidic environments. Treatments with both SB and KMS delayed this process to some extent, adding weight to the idea that the two preservatives offer complementary benefits.

Across all parameters, T6 consistently produced the most stable result. Its ratio of SB to KMS appears to hold the blend in a more favourable equilibrium, slowing oxidative, acidic and hydrolytic changes simultaneously. Although single-point measurements limit the ability to draw statistical conclusions, the consistency of the patterns across intervals and treatments suggests that this formulation is promising for commercial development.

5. Conclusion

The study shows that sodium benzoate and potassium metabisulphite can effectively slow several forms of quality loss in apple-pear juice blends stored under ambient conditions. All samples changed over time, but those receiving both preservatives deteriorated more slowly than the untreated control or either preservative used alone. The combination of 0.04% SB with 0.06% KMS produced the most stable outcomes across multiple parameters, including pH, vitamin C content and sugar balance. Although the findings are based on single measurements, they point to a practical role for SB-KMS mixtures in preserving blended fruit beverages, and they provide a basis for future trials

that incorporate replicated testing, sensory analysis and microbial assessments.

REFERENCES

- Gutierrez Pozo, Maria & Serna Escolano, Vicente & Giménez Berenguer, Marina & Botella, Maria & Zapata, Pedro & Giménez, M.J.. (2025). Effect of Preharvest Application of Sodium Benzoate and Potassium Sorbate on Fungal Decay Incidence and Postharvest Quality of Cold-Stored Fino Lemon Fruit. *Agronomy*. 16. 105. 10.3390/agronomy16010105.
- Liu, Yanlong & Zhu, Wenjing & Wang, Zhengkai & Wang, Huabin & Liu, Li & Mirjatt, Abdul Nabi & Zhang, caili. (2025). Sodium benzoate and chitosan composite coating synergistically reduces jujube fruit decay by inhibiting pathogenic fungi and increasing fungal diversity. *Food Bioscience*. 10.1016/j.fbio.2025.107233.
- Zahan, Imroze & Khan, Md & Rana, Suman & Sahabuddin, Md & Rasik, Md & Uddin, M.. (2024). Effect of selective preservatives on shelf-life of guava juice extracted using pectinase enzyme. *Heliyon*. 10. e37596. 10.1016/j.heliyon.2024.e37596.
- Mawa, Janat & Wasila, Humaira & Ahmed, Imran & Ali, Murad & Pervez, Lubna & Saleem, Hina & Saba, Maria & Bibi, Kalsoom & Zubair, Muhammad. (2024). To Study the Physico Chemical Characteristics and Mineral Contant of Pomegranate Arils Juice. *Journal of Health and Rehabilitation Research*. 4. 874-878. 10.61919/jhrr.v4i2.903.
- Shivaji, Arabati & Jagdish, Swami & Raut, Subhash. (2024). Assessment of Physico-Chemical and Microbiological Shelf Life of Marinated Chicken Malai Kebab Under Refrigerated Conditions. *Journal of Advances in Biology & Biotechnology*. 27. 977-981. 10.9734/jabb/2024/v27i121844.
- Dada, Toluwase & Adegbanke, Omolara & Oyeyemi, Febisola. (2024). Production and Storage Stability of Composite Juice from Watermelon, Grape, Soursop, and Cashew Apple. *IPS Journal of Nutrition and Food Science*. 3. 207-213. 10.54117/ijnfs.v3i3.51.
- Awan, Muhammad & Ahmad, Asif & Khalid, Waseem & Khalid, Muhammad Zubair & Coțovanu, Ionica & Afzal, Farhan & Alomar, Suliman & Yaqub, Shazia & Kanaan, Manal & Saad, Sura & Madilo, Felix. (2023). Assessment of physicochemical parameters, and antioxidant properties of mango concentrate during different storage intervals. *International Journal of Food Properties*. 27. 71-87. 10.1080/10942912.2023.2293463.
- Abidi, Walid & Akrimi, Rawaa & Hajlaoui, Hichem & Rejeb, Hichem & Gogorcena, Yolanda. (2023). Foliar Fertilization of Potassium Silicon Improved Postharvest Fruit Quality of Peach and Nectarine [*Prunus persica* (L.) Batsch] Cultivars. *Agriculture*. 13. 10.3390/agriculture13010195.
- Tujoo, Milkessa & Adera, Tseganesh. (2023). Milkessa Feyera, Tseganesh Abdo. Importance of Some Chemical Preservatives Used in Mango Pulp: A Review. 6. 45-51. 10.11648/j.ijfet.20220602.13.
- Serna Escolano, Vicente & Gutierrez Pozo, Maria & Dobon, Alicia & Zapata, Pedro & Gimenez, Jose. (2023). Effect of Preharvest Treatments with Sodium Bicarbonate and Potassium Silicate in Navel and Valencia Oranges to Control Fungal Decay and Maintain Quality Traits during Cold Storage. *Agronomy*. 13. 2925. 10.3390/agronomy13122925.
- Valentine, Sama & Molua, Ernest & Nkongho, Raymond & Ngosong, Christopher. (2023). Potential of sodium benzoate additive to control food-borne pathogens and spoilage microbes on cassava (*Manihot esculenta* Crantz) fufu and shelf-life extension. *Journal of Agriculture and Food Research*. 11. 100521. 10.1016/j.jafr.2023.100521.
- Kantanet, Napong & Triditanakiat, Pavalee. (2022). Impact of Storage Temperature on Physiological Changes and Shelf Life of Mango CV. Mahachanok. 10.2991/absr.k.220101.053.
- Hussain, Adil & Hussain, Azhar & Ahmad, Bilal & Rehman, Fazal. (2022). Analysis of Physicochemical Stability of Apricot Pulp Stored With Chemical Preservatives. 17-23.

- Latif, Souzan & El-aal, H. & Hussein, Sukur. (2022). Effect of some chemical preservatives and storage condition on phytochemical components and antioxidant activity of some fruit pulp. Archives of Agriculture Sciences Journal. 192-205. 10.21608/aasj.2022.273471.
- Ali, Rukhsar & Muhammad, Ali. (2021). Influence of Different Chemical Preservatives on the Quality Attributes of Mango Loquat Blended Pulp at Ambient Conditions. Sarhad Journal of Agriculture. 37. 10.17582/journal.sja/2021/37.2.564.572.
- Molaei, Sanaz & Soleimani, Ali & Rabiei, Vali & Razavi, Farhang. (2021). Impact of chitosan in combination with potassium sorbate treatment on chilling injury and quality attributes of pomegranate fruit during cold storage. Journal of food biochemistry. 45. e13633. 10.1111/jfbc.13633.
- Kaur, Amandeep & Pps, Gill & Jawandha, Dr. (2019). Effect of sodium benzoate application on quality and enzymatic changes of pear fruits during low temperature. Journal of Food Science and Technology. 56. 1-8. 10.1007/s13197-019-03823-5.
- Akinola, Stephen & AKINMADEYEMI, AKINBINUADE & Ajatta, Mary & AWORH, CHARLES. (2018). Influence of chemical preservatives on quality attributes of orange juice. Croatian Journal of Food Science and Technology. 10. 8-15. 10.17508/CJFST.2018.10.1.02.
- Verma, Astuti & Kushwaha, Archana. (2014). Extraction of Pear (Pyrus Pyrifolia cv. Gola) Fruit Pulp and its Storage Stability. International Journal of Agricultural Science and Technology. 2. 85-93. 10.47856/ijaast.2014.v02i2.001.
- Burdurlu, Hande & Koca, Nuray & Karadeniz, Feryal. (2006). Degradation of vitamin C in citrus juice concentrates during storage. Journal of Food Engineering. 74. 211-216. 10.1016/j.jfoodeng.2005.03.026.
- Akhtar, Saeed & Riaz, Muhammad & Ahmed, Dr Anwaar. (2010). Physico-chemical, microbiological and sensory stability of chemically preserved mango pulp. Pakistan Journal of Botany. 42. 853-862.