**QUALITY PARAMETERS OF JACKFRUIT BASED BLENDED FRUIT LEATHER IN DIFFERENT PACKING MATERIALS DURING STORAGE**

**Abstract**

The primary goal of this study was to assess various packaging materials for their effectiveness in preserving the quality of jackfruit based blended fruit leather throughout storage. Jackfruit, Guava and Pineapple blendedfruit leather was prepared by blending their pulp at ratio 60:20:20. During storage, 0.1% potassium meta-bisulphite (KMS) was incorporated into the pulp. The jackfruit based blended fruit leather (60:20:20) was packed in different packing materials i.e., butter paper, aluminium foil, low density polyethylene, polypropylene with and without vacuum packaging.The blended fruit leather packed in aluminium foil with vacuum packaging showed better results in quality attributes with TSS (60.25oB), pH (5.32), moisture content (14.53%), titratable acidity (2.16%), ascorbic acid (27.86mg/100g), total sugars (16.62%) and total phenols (1.90%) during the storage period.

**Keywords:** Jackfruit, Guava, Pineapple, packaging materials, storage

**Introduction**

Jackfruit (*Artocarpus heterophyllus* Lam*.*)is known as ‘Poor Man’s Food’. Jackfruit, the national fruit of Sri Lanka and Bangladesh and also functions as state fruit of both Kerala and Tamil Nadu in India. It is the largest fruit that grows on tree which belongs to Moraceae family originated from Western Ghats of India (Rain forests). In India, jackfruit covers total area (in 000ha) is 188, production (in 000MT) is 1946 (NHB 2021-22). Guava (*Psidium guajava)* and pineapple (*Ananas comosus*) are major commercial fruit crops cultivated extensively in tropical and subtropical regions due to their nutritional, economic, and industrial significance. Both fruits are rich in vitamin C, fiber, and antioxidants, contributing to overall health and immunity. Fruit leather is a dehydrated product which can be prepared from a single fruit/vegetable or with combination. Processing fruits into fruit leathers serves not only to reduce postharvest losses but also to generate a novel range of value-added products with the potential for higher nutritional value compared to their fresh counterparts (Ofoedu, 2020). Fruits are blended with other fruits to improve colour, flavour, taste, nutritional properties of the leather.

 Food packaging is essential in safeguarding the freshness and safety of food throughout its journey from farm to fork. It serves as protective shield, guarding against physical damage, harmful light exposure and gasses that can spoil food. Additionally, packaging prevents contamination by unwanted microorganisms and chemicals, ensuring food safe, healthy and delicious. Many widely employed packaging materials have been derived from petroleum – based plastics like polyvinylchloride, polyethylene terephthalate, polyethylene, polypropylene and polystyrene. Some other materials like butter paper and aluminium foils also mostly used in packing of foods (Cheng, 2022).

Vacuum packaging is a method of packaging that involves removing air from the package and sealing it tightly, creating an airless environment for storing and preserving food. This technology is extensively utilized in the food industry because of its ability to reduce oxidative reactions within the product at a relatively low cost. It serves as a natural preservative method, significantly extending the shelf life of food products and maintaining their quality (Patil, 2020). An experiment was conducted to evaluate the storage characteristics of jackfruit – based blended fruit leather using different packaging materials over a storage period of 90 days.

**Materials and methods**

**Location:** The experimental study was conducted at College of Horticulture, Anantharajupeta Andhra Pradesh during the year 2024.

**Preparation and packaging of Jackfruit-based fruit leather**

The preparation of jackfruit-based fruit leather involves selecting and preparing jackfruit, guava and pineapple by removing inedible parts and extracting their pulp. Jackfruit, Guava and Pineapple blendedfruit leather was prepared by blending their pulp at ratio 60:20:20. The pulp is then blended in the above mentioned ratio and stewed at 90°C to concentrate the mixture, reducing drying time and energy use. The thickened pulp is spread onto ghee-coated stainless steel trays and dried at 60°C for 6–8 hours until the moisture content reaches 15–16%. The dried sheets are cut into 5 cm × 2 cm pieces, packaged in different materials and stored for three months for storage studies.

**Treatment details**

**Packing Material**

P1 - Butter Paper, P2 - Aluminum Foil, P3 - Low density polyethylene (LDPE), P4 - Polypropylene (PP), P5 - Low density polyethene with vacuum packaging, P6 - Aluminum Foil with vacuum packaging, P7 - Polypropylene with vacuum packaging

****

**Plate 1: Packing Materials A) Butter Paper**

**B) Aluminium Foil C) LDPE D) Polypropylene**



Plate 2 : Jackfruit based blended fruit packed in different packaging Materials

**Quality Attributes Estimation**

The quality parameters of jackfruit-based fruit leather were evaluated throughout storage at intervals of 0, 30, 60, and 90 days. Total Soluble Solids (TSS) were measured in °Brix using an Atago RX1000 digital refractometer following Ranganna (2007). Titratable acidity was determined by titration with 0.1N NaOH using phenolphthalein as an indicator, while pH levels were recorded using a digital pH meter. Moisture content was analyzed with a Radwag MAC 50 moisture analyzer. Ascorbic acid content was estimated through the 2,6-Dichlorophenol Indophenol titration method (Sadasivam & Manickam, 1992), with results expressed in mg/100g. Total sugars were determined using the anthrone reagent method, where absorbance was measured at 630 nm using a spectrophotometer. The total phenolic content was assessed using the Folin-Ciocalteu method (Singleton et al., 1965) by measuring absorbance at 750 nm. These parameters were monitored to assess the storage stability and quality retention of the fruit leather over time.

**Results and discussion**

**Quality Parameters**

Data related to quality parameters which include total soluble solids and pH, moisture content and titratable acidity, ascorbic acid and total sugars, total phenols were presented in tables 1, 2, 3 and 4 respectively.

**TSS (°Brix)**

The highest TSS (°Brix)of 58.53, 59.93, 61.02, 61.60 was recorded in jackfruit based blended fruit leather packed in butter paper (P1) whereas lowest TSS (°Brix)of 58.53, 59.25, 59.85, 60.25 was recorded in jackfruit based blended fruit leather packed in aluminium foil with vacuum packaging (P6) at 0, 30, 60, 90 days after storage respectively.

The increase in TSS during storage may be attributed to the conversion of starch and polysaccharides into sugars, as well as to moisture loss, which tends to enhance the total soluble solids (Shakoor *et al*., 2015). In the study conducted by Suradakar *et al.,* 2021 reported that lowest increase in TSS was observed in aluminium foil packed leather than butter paper packed leather. An increase in TSS (ºB) during storage has also been reported by Khan *et al.* (2023) in guava-chiku blended fruit leather, Khan *et al.* (2015) in guava apple leather etc.

**pH**

The highest pH of 6.01, 5.89, 5.73, 5.32 was recorded in jackfruit based blended fruit leather packed in aluminium foil with vacuum packaging (P6) whereas lowest of 6.01, 5.44, 5.22, 4.87 was observed in leather packed in butter paper (P1) at 0, 30, 60, 90 days after storage respectively.

 The reduction in pH could be due to the rise in acidity, the hydrolysis of pectin as reported by Khan *et al.* (2023). The results were in agreement with Azeredo *et al.* (2006) in mango leather, Phimpharian *et al.* (2011) in pineapple leather, Khan *et al.* (2015) in guava and apple blended leather, Atif *et al*. (2019) in mango papaya leather.

**Table 1:** Effect of packaging material on TSS (°Brix) and pH of jackfruit – based blended fruit leather during storage.

|  |  |
| --- | --- |
| **Treatments** |  **Days after storage (DAS)** |
| **TSS (°Brix)** | **pH**  |
| **0** | **30** | **60** | **90** | **0** | **30** | **60** | **90** |
| **P1** | Butter paper | 58.53 | 59.93 | 61.02 | 61.60 | 6.01 | 5.44 | 5.22 | 4.87 |
| **P2** | Aluminium Foil | 58.53 | 59.61 | 60.38 | 60.98 | 6.01 | 5.63 | 5.50 | 5.06 |
| **P3** | Low density polyethylene (LDPE) | 58.53 | 59.82 | 60.72 | 61.26 | 6.01 | 5.58 | 5.39 | 4.98 |
| **P4** | Polypropylene (PP) | 58.53 | 59.69 | 60.51 | 60.93 | 6.01 | 5.67 | 5.46 | 5.03 |
| **P5** | Low density polyethylene (LDPE) with vacuum packaging | 58.53 | 59.52 | 60.17 | 60.70 | 6.01 | 5.71 | 5.59 | 5.17 |
| **P6** | Aluminium Foil with vacuum packaging | 58.53 | 59.25 | 59.85 | 60.25 | 6.01 | 5.89 | 5.73 | 5.32 |
| **P7** | Polypropylene (PP) with vacuum packaging | 58.53 | 59.38 | 59.98 | 60.63 | 6.01 | 5.77 | 5.65 | 5.23 |
| **S.Em ±** | 0.14 | 0.67 | 0.56 | 0.07 | 0.15 | 0.10 | 0.03 | 0.02 |
| **CD at 5%** | NS | NS | NS | 0.22 | NS | NS | 0.09 | 0.08 |

**Moisture content (%)**

The maximum moisture content of 15.67, 15.48, 15.11, 14.53 was observed in jackfruit based blended fruit leather packed in aluminium foil with vacuum packaging (P6) whereas minimum moisture content of 15.67, 15.03, 13.98, 12.85 was observed in jackfruit based blended fruit leather packed in butter paper (P1) at 0, 30, 60, 90 days after storage respectively.

Decline in moisture content might be attributed to evaporation during storage. Leather showed highest decreasing trend of moisture content in butter paper or vegetable parchment paper and lowest in aluminium foil as reported by Suradkar *et al.* (2021). Similar results were reported by Deepika *et al.* (2016) in aonla fruit bar, Kaushal *et al.* (2017) in ginger plum leather, Ahmad *et al.* (2021) in grapes and pear blended leather and Khan *et al.* (2023) in guava chiku blended leather.

**Titratable Acidity (%)**

The highest acidity percentage of 2.07, 2.18, 2.29, 2.36 was observed in jackfruit based blended fruit leather packed in butter paper (P1) while lowest acidity of 2.07, 2.09, 2.12, 2.16 was observed in jackfruit based blended fruit leather packed in aluminium foil with vacuum packaging (P6) at 0, 30, 60, 90 days after storage respectively.

The rise in acidity may be attributed to break down of pectin into pectinic acid, the formation of sulphurous acid from SO₂ as reported by Ekanayake *et al*. (2002). Suradakar *et al.* (2021) in storage studies on jamun leather, reported that minimum increase in acidity was observed in aluminium foil packed leather when compared to butter paper. Similar reports were found by Ahmad *et al*. (2021) in grapes-pear leather, Singh *et al.* (2020) in guava and papaya leather, Atif *et al.* (2019) in mango papaya blended leather.

**Table 2:** Effect of packaging material on Moisture content (%) and Titratable acidity (%) of jackfruit – based blended fruit leather during storage.

|  |  |
| --- | --- |
| **Treatments** | **Days after storage (DAS)** |
| **Moisture content (%)** | **Titratable Acidity (%)** |
| **0** | **30** | **60** | **90** | **0** | **30** | **60** | **90** |
| **P1** | Butter paper | 15.67 | 15.03 | 13.98 | 12.85 | 2.07 | 2.18 | 2.29 | 2.36 |
| **P2** | Aluminium Foil | 15.67 | 15.31 | 14.61 | 13.71 | 2.07 | 2.11 | 2.17 | 2.24 |
| **P3** | Low density polyethylene (LDPE) | 15.67 | 15.16 | 14.27 | 13.02 | 2.07 | 2.16 | 2.22 | 2.30 |
| **P4** | Polypropylene (PP) | 15.67 | 15.28 | 14.48 | 13.46 | 2.07 | 2.14 | 2.20 | 2.27 |
| **P5** | Low density polyethylene (LDPE) with vacuum packaging | 15.67 | 15.37 | 14.72 | 13.95 | 2.07 | 2.12 | 2.16 | 2.21 |
| **P6** | Aluminium Foil with vacuum packaging | 15.67 | 15.48 | 15.11 | 14.53 | 2.07 | 2.09 | 2.12 | 2.16 |
| **P7** | Polypropylene (PP) with vacuum packaging | 15.67 | 15.41 | 14.87 | 14.12 | 2.07 | 2.10 | 2.15 | 2.19 |
| **S.Em ±** | 0.11 | 0.23 | 0.06 | 0.08 | 0.04 | 0.03 | 0.02 | 0.02 |
| **CD at 5%** | NS | NS | 0.17 | 0.24 | NS | NS | 0.06 | 0.05 |

**Ascorbic acid (mg/100g)**

The highest ascorbic acid content of 28.76, 28.42, 28.03, 27.86 was observed in jackfruit based blended fruit leather packed in aluminium foil with vacuum packaging (P6) whereas lowest ascorbic acid content of 28.76, 28.09, 26.12, 25.80 was recorded in jackfruit based blended fruit leather packed in butter paper (P1) at 0, 30, 60, 90 days after storage respectively.

The reduction in ascorbic acid may result from its oxidation into dehydroascorbic acid, followed by hydrolysis and browning reactions (Clegg 1966 and Ahmad *et al*., 2021). Kaushal *et al*. (2017) reported that lowest reduction of ascorbic acid in ginger plum leather was observed in aluminium laminated foil (ALF). Parallel results were observed by Sarkar *et al*. (2020) and Singh *et al.* (2021) in mango leather, Khan *et al*., 2023.

**Total Sugars (%)**

The highest total sugars of 16.42, 16.61, 16.85, 17.51 was recorded in jackfruit based blended fruit leather packed in aluminium foil with vacuum packaging (P6) whereas lowest total sugars of 16.42, 16.48, 16.55, 16.62 was recorded in jackfruit based blended fruit leather packed in aluminium foil with vacuum packaging (P6) at 0, 30, 60, 90 days after storage respectively.

Increase in sugars could be attributed to hydrolysis of polysaccharides and inversion of non - reducing sugars, loss in moisture. Similar findings were observed by jack fruit leather (Che Man and Taufik, 1995), Deepika *et al*. (2016) in aonla fruit bar and Hussain *et al*. (2023) in guava leather.

**Table 3:** Effect of packaging material on Ascorbic acid (mg/100g) and Total sugars (%) of jackfruit – based blended fruit leather during storage.

|  |  |
| --- | --- |
| **Treatments** | **Days after storage (DAS)** |
| **Ascorbic acid (mg/100g)**  | **Total Sugars (%)** |
| **0** | **30** | **60** | **90** | **0** | **30** | **60** | **90** |
| **P1** | Butter paper | 28.76 | 28.09 | 26.12 | 25.80 | 16.42 | 16.61 | 16.85 | 17.51 |
| **P2** | Aluminium Foil | 28.76 | 28.26 | 26.97 | 26.84 | 16.42 | 16.55 | 16.69 | 16.97 |
| **P3** | Low density polyethylene (LDPE) | 28.76 | 28.24 | 26.50 | 26.36 | 16.42 | 16.59 | 16.75 | 17.26 |
| **P4** | Polypropylene (PP) | 28.76 | 28.26 | 26.87 | 26.68 | 16.42 | 16.55 | 16.71 | 17.18 |
| **P5** | Low density polyethylene (LDPE) with vacuum packaging | 28.76 | 28.40 | 27.21 | 27.02 | 16.42 | 16.53 | 16.64 | 16.79 |
| **P6** | Aluminium Foil with vacuum packaging | 28.76 | 28.42 | 28.03 | 27.86 | 16.42 | 16.48 | 16.55 | 16.62 |
| **P7** | Polypropylene (PP) with vacuum packaging | 28.76 | 28.42 | 27.85 | 27.47 | 16.42 | 16.50 | 16.58 | 16.73 |
| **S.Em ±** | 0.07 | 0.31 | 0.06 | 0.11 | 0.04 | 0.14 | 0.03 | 0.05 |
| **CD at 5%** | NS | NS | 0.19 | 0.34 | NS | NS | 0.09 | 0.16 |

**Total phenols (%)**

The highest retention of phenols of 2.03, 1.98, 1.94, 1.90 was recorded in jackfruit based blended fruit leather packed in aluminium foil with vacuum packaging (P6) whereas lowest retention of phenols of 2.03, 1.87, 1.84, 1.68 was recorded in jackfruit based blended fruit leather packed in butter paper (P1) at 0, 30, 60, 90 days after storage respectively.

The decline in phenols during storage could be due to their susceptibility to volatilization and oxidation (Fennema, 1976). Comparable outcomes were reported by Sharma *et* *al*. (2018) in fruit rolls, Kaushal *et al*. (2017) in ginger plum leather and Dwivedi *et al*. (2015) in bael and aonla leather packed in aluminium laminated pouches showed lowest decrease than polyethylene.

**Table 4 :** Effect of packaging material on Total phenols (%) of jackfruit – based blended fruit leather during storage.

|  |  |
| --- | --- |
| **Treatments** | **Days after storage (DAS)** |
| **Total phenols (%)** |
| **0** | **30** | **60** | **90** |
| **P1** | Butter paper | 2.03 | 1.87 | 1.84 | 1.68 |
| **P2** | Aluminium Foil | 2.03 | 1.93 | 1.89 | 1.79 |
| **P3** | Low density polyethylene (LDPE) | 2.03 | 1.90 | 1.86 | 1.72 |
| **P4** | Polypropylene (PP) | 2.03 | 1.90 | 1.88 | 1.75 |
| **P5** | Low density polyethylene (LDPE) with vacuum packaging | 2.03 | 1.95 | 1.91 | 1.83 |
| **P6** | Aluminium Foil with vacuum packaging | 2.03 | 1.98 | 1.94 | 1.90 |
| **P7** | Polypropylene (PP) with vacuum packaging | 2.03 | 1.95 | 1.92 | 1.86 |
| **S.Em ±** | 0.04 | 0.04 | 0.03 | 0.02 |
| **CD at 5%** | NS | NS | NS | 0.05 |

**Conclusion**

This study found that the selected best combination of 60:20:20 jackfruit-guava-pineapple blend was stored up to 90days. Storage studies revealed that moisture content, pH, ascorbic acid, total sugars and total phenols showed decreasing trend and TSS, titratable acidity showed increasing trend throughout the storage period. Aluminum foil with vacuum packed leather showed best preserved quality attributes, maintaining optimal moisture, acidity, sugars, and nutrients. This highlights the importance of proper packaging in extending the shelf life of fruit leather for commercial viability.

**References**

1. Anonymus, National Horticulture Data Base. 2022. National Horticulture Board, Ministry of Agriculture and Farmers Welfare, Government of India.
2. Ahmad, I, Riaz, A, Khan, A, Shah, S.S, Shah, F.N. and Zeeshan, M. 2021. Preparation and Evaluation of Pear and Grapes Blended Leather: Preparation of Pear and Grapes Blended Leather. *Biological Sciences- Pakistan Journal of Scientific and Industrial Research*. 64(2): 182-91.
3. Atif, S.A. and Mishra, S. 2019. Standardization of blended fruit leather of mango (*Mangifera indica* Linn.) and papaya (*Carica papaya* L.). *Journal of Pharmacognosy and Phytochemistry*. 8(4): 1983-86.
4. Azeredo H.M.C, Brito, E.S, Moreria, G.E.G, Farias, V.L, Bruno, L.M. 2006. Effect of drying and storage time on the physicochemical properties of mango leathers. *International Journal of Food Science and Technology*. 41(6): 635-38.
5. Cheng, H.X.H, McClements, D.J, Chen, L, Jiao, A, Tian, Y, and Jin, Z. 2022. Recent advances in intelligent food packaging materials: Principles, preparation and applications. *Food Chemistry*. 375: 131738.
6. Che Man, Y.B. and Taufik. 1995. Development and stability of jack fruit leather. *Tropical Science*. 35(3): 245-50.
7. Clegg, K.M. 1966. Citric acid and the browning of solutions containing ascorbic acid. *Journal of the Science of Food and Agriculture*. 17(12): 546-49.
8. Deepika, Panja, P, Marak, D.S, Thakur, P.K. 2016. Effect of packaging on quality of enriched fruit bars from aonla (*Emblica officinalis* G.) during storage. *International Journal of Agriculture, Environment and Biotechnology*. 9(3): 411-19.
9. Dwivedi, S.K, Mishra, V, Saran, S. and Roy, S.K. 2015. research A. *Journal of Postharvest Technology*. 3(2): 36-42.
10. Ekanayake, S. and Bandara, L. 2002. Development of banana fruit leather. *Annals of the Sri Lanka Department of Agriculture*. 4: 353 - 58.
11. Hussain, B, Sammi, S, Amin, S. E, Fiaz, B, Abid, J. and Shoukat, U. 2023. Standarization and prepration of guava leather. 19(1): 1120-35.
12. Kaushal, M, Dhiman, A, Gupta, A. and Vaidya, D. 2017. Formulation, acceptability and storage stability of appetized ginger plum leather. *International Journal of Environment, Agriculture and Biotechnology*. 2(1): 389 - 96.
13. Khan, S.H, Arsalan Khan, A.K, Uzma Litaf, U.L, Shah, A.S, Khan, M.A, Ali, M.U. and Sumayya Rani, S.R. 2015. Effect of different concentration of guava pulp, apple pulp and sugar solution on the shelf stability of blend leather storage at ambient temperature. *Journal of Food processing and technology.* 6(7): 1000466.
14. Khan, I, Zubairi, M.N, Afzaal, M.K, Arshad, M.S. and Aziz, H. 2023. Development and storage studies of guava-chiku blended fruit leather. *Jammu Kashmir Journal of Agriculture*. 3(1): 1-9.
15. Ofoedu, C.E, Ubbaonu, C.N, Agunwah, I, Obi, C. D, Odimegwu, N.E. and Okeke, F. K. 2020. Production and comparative evaluation of leather products from pawpaw (*Carica papaya*) and banana (*Musa acuminata*) fruit pulp. *Croatian journal of food science and technology*. 12(2): 218-28.
16. Patil, A.R, Chogale, N.D, Pagarkar, A.U, Koli, J.M, Bhosale, B.P, Sharangdhar, S.T. and Kulkarni, G.N. 2020. Vacuum packaging is a tool for shelf life extension of fish product: a review. 23: 807-10.
17. Phimpharian, C, Angchud, A, Jangchud, K, Therdthai, N, Prinyawiwatkul, W. and H. K. 2011. Physicochemical characteristics and sensory optimisation of pineapple leather snack as affected by glucose syrup and pectin concentrations. *International Journal of Food Science and Technology*. 46(5): 972–81.
18. Ranganna S. 2007. Handbook of analysis and quality control for fruits and vegetables products. 3rd edition. Tata Mcgraw Hills. 25-45.
19. Sadasivam, S. and Manickam, A. 1992. *Biochemical Methods for Agricultural Sciences*. Wiley Eastern Ltd. New Delhi.
20. Sarkar, T, Nayak, P. and Chakraborty, R. 2020. Storage study of mango leather in sustainable packaging condition. *Materials Today: Proceedings*. 22: 2001-07.
21. Shakoor, A, Ayub, M, Wahab, S, Khan, M, Khan, A. and Rahman, Z. 2015. Effect of different levels of sucrose-glucose mixture on overall quality of guava bar. *Journal of Food Processing and Technology*. 6: 1-7.
22. Sharma, K.D, Vinay, C, Anil, G. and Anil K.V. 2018. Effect of packing and storage behaviour on shelf stability of functionally enriched fruit rolls. *International Journal of Economic Plants*. 5(1): 15-22.
23. Singh, L.J, Tiwari, R.B. and Ranjitha, K. 2020. Studies on effect of different packaging materials on shelf-life of blended guava-papaya fruit leather. *European Journal of Nutrition & Food Safety*. 12(8): 22-32.
24. Singh, B, Pandey, V.K, Shukla, R.N, Singh, K. and Singh, S. 2021. Development and physico-chemical analysis of value-added mango leather packed in different packaging materials. *Journal of Postharvest Technology*. 9(3): 29-39.
25. Singleton, V.L, Joseph, A. Rossi. 1965. Colorimetry of Total Phenolics with Phosphomolybdic-Phosphotungstic Acid Reagents. *American Journal Enology and Viticulture*. 16: 144-58.
26. Suradkar, N, Pawar, V, Deshpande, H, Mane, V, Ughade, J. and Ghorband, A. 2021. Storage stability of jamun fruit bar with respect to different temperature and packaging material. *Pharma Innovation*. 101:172-76.