Biological Forum – An International Journal **14(2a): 628-632(2022)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Development and Physico-Chemical Analysis of Papaya-Wood Apple Jam: A Novel Fruit-Based Product

Shefali K. Modi*
Department of Basic Engineering and Applied Sciences, College of Agricultural Engineering and Technology, Anand Agricultural University, Godhra (Gujarat), India.

(Corresponding author: Shefali K. Modi)*
(Received 04 May 2022, Accepted 23 June, 2022)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: This study explores the development and evaluation of a novel fruit-based jam made from papaya (*Carica papaya*) and wood apple (*Limonia acidissima*), two fruits known for their distinctive flavors and nutritional benefits. The research focuses on optimizing the jam formulation and assessing its physico-chemical properties, including moisture content, protein content, acidity, ash content, vitamin C levels, pH, and fat content. The findings reveal that the jam has a soft, spreadable consistency with an average moisture content of 74.26% and a protein content of 6.35%, enhancing its nutritional value. The balanced acidity (0.37%) and pH (3.49) contribute to the jam's flavor and microbial stability. The jam is rich in vitamin C (47.23 mg/100g), offering significant health benefits. The study demonstrates that the papaya-wood apple jam is a promising, nutritious product with potential for commercial production, catering to both local and international markets.

Keywords: Papaya-wood apple jam, Physico-chemical properties, Nutritional analysis, Vitamin C content, Food product optimization.

INTRODUCTION

Fruits have become a fundamental component of the human diet, playing a crucial role not only in nutrition but also in the global economy. Rich in essential vitamins, minerals, and dietary fiber, fruits contribute significantly to health and well-being (Pal and Molnár 2021). The demand for diverse and nutritious fruit-based products is growing, driven by increasing consumer awareness of health benefits and a desire for natural, minimally processed foods. This trend is particularly important in regions like Asia, where a wide variety of tropical fruits are readily available (Tejas Gowda *et al*., 2021). These fruits are not only integral to local diets but also hold cultural and economic significance. Among the diverse fruits found in Asia, papaya (*Carica papaya*) and wood apple (*Limonia acidissima*) stand out for their distinctive flavors, nutritional value, and long-standing use in traditional culinary and medicinal practices. In countries like India, these fruits are extensively cultivated and have been a staple in both everyday meals and traditional medicine for centuries. The development and evaluation of new fruit-based products, such as jams and preserves, are crucial for adding value to these fruits, reducing post-harvest losses, and enhancing their economic potential.

Papaya, often referred to as the "fruit of the angels," is valued not only for its pleasant taste and vibrant color but also for its high content of vitamins A, C, and E, along with essential antioxidants and digestive enzymes. Wood apple, on the other hand, though less common globally, is highly esteemed in India and Southeast Asia for its tangy flavor and nutritional benefits, including high levels of dietary fiber, calcium, and iron (Jahagirdar *et al.,* 2022). The fusion of these two fruits into a jam offers a novel product that leverages the complementary sensory attributes and health benefits of each. The process of creating jams from these fruits can contribute to value addition, reduce post-harvest losses, and provide a new avenue for farmers and food processors in the region. The increasing global demand for health-oriented and exotic food products, papaya-wood apple jam has the potential to cater to both local and international markets.

This research paper aims to develop and evaluate papaya-wood apple jam, focusing on its formulation, quality attributes, and nutritional profile. The study seeks to optimize the jam's preparation process and assess its moisture content, protein levels, acidity, ash content, vitamin C concentration, pH, and fat content. By analyzing these parameters, the research aims to establish the jam's potential as a nutritious and commercially viable product, contributing to value addition and reduction of post-harvest losses of the involved fruits. The findings are expected to offer insights into the viability of such products in the Asian and Indian contexts, where traditional knowledge and modern food science can synergize to create marketable and nutritionally rich food items.

MATERIAL AND METHODS

A. Selection of fruits

Fresh, ripe papayas and wood apples were sourced from local markets in Godhara, Panchmahal, Gujarat, India.

These fruits were selected based on their ripeness, size, and lack of physical damage, following visual inspection and standard maturity indices. Ensuring the selection of high-quality fruits was crucial for the study, so proper sorting and grading were conducted manually. The fruits were first thoroughly washed under running tap water to eliminate soil, plant debris, and other contaminants. Grading was then based on key quality criteria, including cleanliness, firmness, soundness, maturity, weight, color, size, shape, and the absence of foreign matter, insect damage, and mechanical injury. Only fruits that were undamaged and free from visible discoloration were chosen. To further reduce the surface microbial load, the selected fruits were soaked in warm water at 80°C for 2 minutes.

B. Preparation of fruit pulp

Papaya pulp: The papayas were washed thoroughly, peeled, deseeded, and cut into small pieces. The pieces were then blended to obtain a smooth pulp.

Wood apple pulp: The wood apples were cracked open, and the pulp was scooped out. The pulp was blended with a small amount of water to achieve a consistent texture.

C. Jam preparation

Ingredients formulations for jam optimization areas wood apple (10 g), papaya (90 g), Sugar (45 g), and water (40ml). Jam was mixed in a food processor for 2 min for proper mixing. The pulp was sieved through 0.710 mm sieve and collected in a container. To this pulp sugar was added and boiled at 105°C after adding little water to it with constant stirring till 68 brix was obtained. The flowchart of jam preparation is given in Fig. 1.

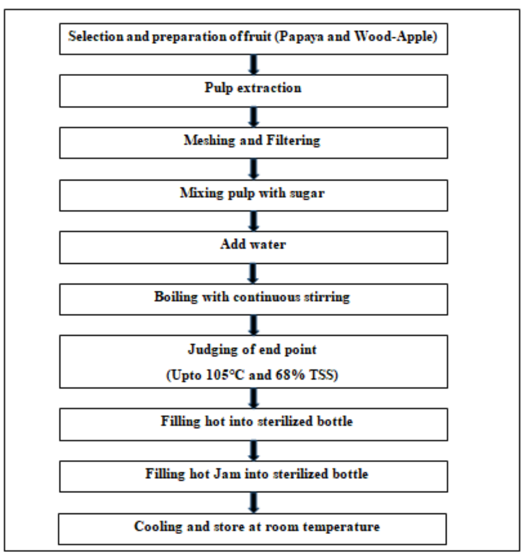

Fig. 1. Flowchart for Jam preparation.

D. Evaluation of Physico-Chemical Properties

The physico-chemical properties of the papaya-wood apple jam were evaluated using a range of standardized methods. Fat content was determined using the Soxhlet extraction method as outlined by Ranganna (1986). Moisture content was measured using the Gravimetric method according to AOAC guidelines (1995) (Ileleji *et al.,* 2010). Protein levels were assessed using the Micro-Kjeldahl method, following AOAC standards (1980) (Jung *et al*., 2003). The acidity of the jam was evaluated using a titration method described by Ranganna (1986), while ash content was also determined using Ranganna's method (1986). Vitamin C levels were analyzed using the Dycloro method for ascorbic acid. The jam pH was measured with a digital pH meter to ensure accuracy in determining its acidity and overall quality.

(i) Fat content. Fat from the oven-dried sample was extracted using hexane in a Soxhlet extraction apparatus, following Ranganna's (1986) method. The dried fruit bar sample, after moisture content determination, was placed in a cotton-plugged thimble and inserted into the Soxhlet apparatus. Approximately 5 g of n-hexane was added, and the sample was extracted for 8 hours. After extraction, most of the ether was distilled off, and the remaining ether was evaporated at low temperature. The residue was dried at 100°C for 1 hour, cooled, and weighed. The crude fat percentage was calculated as:

$$\%\text{ crude fat} = \frac{W_1}{W_2} \times 100$$

Where, W_1 = Weight of hexane soluble material, (gm),
W_2 = Weight of sample, (gm)

(ii) Moisture content. Moisture content was determined using the gravimetric method (AOAC, 1995). The sample was placed in a hot air oven at 105°C until its weight stabilized. After cooling in a desiccator to room temperature, the sample was weighed. Moisture content was calculated using the formula:

$$\text{MC }(\%\text{wb}) = \frac{W_1 - W_2}{W_2} \times 100$$

Where,
W1 = Initial weight of sample, g
W2 = Weight of sample after drying, g
Mw = Moisture content (% wb)

(iii) Protein content. Protein content was determined using the Micro-Kjeldahl method (AOAC, 1980). A 0.23 g sample was digested with concentrated sulfuric acid (H_2SO_4) containing 3 g of a catalyst mixture (K_2SO4: $CuSO_4$, 2.5:0.5). The digested sample was then distilled with 40% NaOH, and the liberated ammonia was trapped in a 4% boric acid solution with a mixed indicator (methyl red: bromocresol green, 1:5). The condensate was titrated with 0.1 N H_2SO_4 until the blue color disappeared. The percentage of nitrogen was calculated using the Kjeldahl method, and protein content was obtained by multiplying the nitrogen value by 6.25. A Kel-plus automatic Kjeldahl setup (Pelican Equipments, Chennai) was used for digestion and distillation.

$$\%\text{ Nitrogen} = \frac{(T - N) \times 14.01}{W \times 100}$$

$$\%\text{ Protein} = \%\text{ Nitrogen} \times 6.25$$

Where,
T = Titre value, (ml)
N = Normality of H_2SO_4,
W = Weight of the sample, (g)

(iv) Acidity. The acidity of the sample was measured and expressed as the amount of anhydrous citric acid per 100 ml of the sample. A 10 g sample was placed in a 250 ml conical flask, diluted with distilled water, and the volume adjusted to 100 ml. A few drops of phenolphthalein indicator were added, and the sample was titrated with 0.1 N NaOH until a pale pink color appeared (Ranganna, 1986). The following equation was used to calculate titratable acidity.

$$\text{Titratable acidity (\%)} = \frac{T \times N \times V \times E}{Ws \times Vs \times 1000} \times 100$$

Where,
T = Titre value, ml
N = Normality of alkali solution
V = Volume made up, ml
E = Equivalent weight of acid, gm
Ws = Weight of sample, gm
Vs = Volume of sample taken for titration, ml

(v) Ash content. Ash content was determined following the method outlined by Ranganna (1986). A 5 g sample was first incinerated on a slow flame burner and then ignited in a muffle furnace at 550 ± 20°C until light grey ash formed, typically after 4 to 6 hours. The ash was cooled in a desiccator, and the difference in weight was recorded. The total ash percentage was then calculated as follows:

$$\text{\% Total ash} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where,
W1 = Weight of silica dish (g)
W2 = Weight of silica dish + sample (g)
W3 = Weight of silica dish + dried sample (g)

(vi) Vitamin C. Take 5 ml of standard ascorbic acid solution and 5 ml of HPO_3. Fill a micro burette with the dye solution. Titrate until a pink color appears and persists for 15 seconds. Determine the dye factor, representing the mg of ascorbic acid per ml of dye, using the following formula:

$$D = \frac{0.5}{\text{titre}}$$

$$\text{Ascorbic acid mg per 100 g or ml} = \frac{T \times D \times V \times 100}{Ae \times \text{Wt or Ve}}$$

T = titre
D = dye factor
V = volume made up
Ae = aliquot of extract taken for estimation
Ve = volume of sample taken for estimation

RESULT AND DISCUSSION

The study aimed to assess the physico-chemical properties of papaya-wood apple jam through a comprehensive set of standardized evaluations. The results, obtained from multiple readings, provided insights into moisture content, protein content, acidity, ash content, vitamin C concentration, pH, and fat content. The results are presented in Table 1 and Fig. 1.

Table 1: Physico-chemical properties of papaya-wood apple jam.

Observations	Moisture content (%)	Protein (%)	Acidity (%)	Ash content (%)	Vitamin c (mg)/100g	PH	Fat (%)
1	76	6.8	0.32	0.8	50	3.07	3.8
2	75	6.32	0.36	1	48	3.49	4.1
3	74	6.08	0.38	1.2	46.62	3.3	4.2
4	73.5	6	0.39	1.35	46.05	3.58	4.5
5	72.08	6.56	0.39	1.41	45.5	3.56	4.4
Avg	74.26	6.35	0.37	1.15	47.23	3.49	4.2

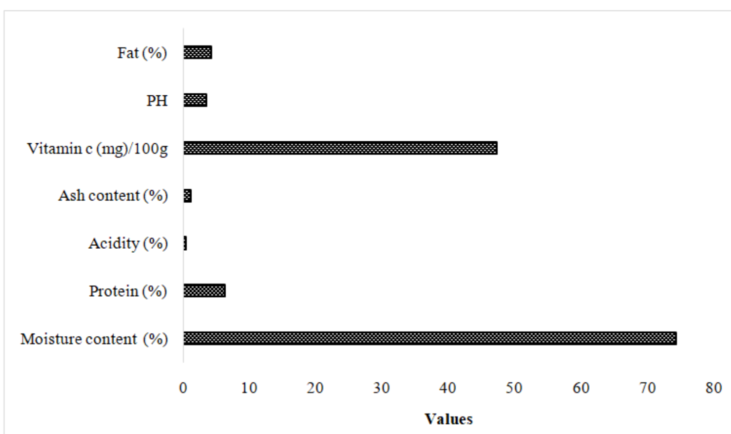

Fig. 1. Physico-chemical properties of papaya-wood apple jam.

The moisture content of the papaya-wood apple jam was measured across five samples, resulting in values ranging from 72.08% to 76%, with an average moisture content of 74.26%. This parameter is crucial as it directly impacts the texture, shelf life, and microbial stability of the jam (Shinwari and Rao 2018). Higher moisture content, as observed in this study, suggests that the jam has a soft and spreadable consistency, which is desirable in fruit preserves. However, it also indicates that the product might have a shorter shelf life due to the potential for microbial growth, emphasizing the need for proper preservation techniques.

The protein content of the jam was found to vary slightly between 6% and 6.8%, with an average of 6.35%. Protein content in fruit jams is generally low (Teixeira *et al*., 2020), but the values obtained here reflect the contribution of both the papaya and wood apple to the nutritional profile of the product. The presence of protein, albeit in small amounts, can contribute to the nutritional value of the jam, making it a slightly better option in terms of dietary intake compared to jams made purely from lower-protein fruits.

The acidity of the jam was measured as a percentage of anhydrous citric acid, with values ranging from 0.32% to 0.39% and an average of 0.37%. Acidity is a key factor in the flavor profile of the jam, contributing to its tartness and balancing the sweetness from the added sugar (Bekele *et al.,* 2020). The relatively low acidity levels in this jam suggest a mild, pleasant tartness that complements the sweetness without overpowering it. Additionally, the acidity plays a role in preserving the jam by inhibiting the growth of certain spoilage microorganisms.

The ash content, representing the total mineral content of the jam, varied from 0.8% to 1.41%, with an average of 1.15%. Ash content is indicative of the inorganic residue remaining after combustion, which corresponds to the mineral content in the jam (Perumpuli *et al.,* 2018). Higher ash content suggests a higher concentration of minerals, which may include essential nutrients like calcium, potassium, and magnesium. This is beneficial from a nutritional standpoint, as it enhances the dietary value of the jam. The gradual increase in ash content across the readings could be attributed to the slight variations in the fruit composition and the precise cooking process.

Vitamin C content in the jam was evaluated and found to range from 45.5 mg to 50 mg per 100 g, with an average of 47.23 mg/100 g. Vitamin C is a crucial antioxidant and nutrient, playing a significant role in immune function, skin health, and the prevention of scurvy (Selvamary *et al*., 2020). The relatively high levels of vitamin C in the jam highlight its potential health benefits, making it not only a tasty product but also a functional food item. The gradual decrease in vitamin C content across the samples could be due to the degradation of the vitamin during the cooking process, which is known to reduce vitamin C levels due to its sensitivity to heat.

The pH values of the jam samples were recorded between 3.07 and 3.58, with an average pH of 3.49. The pH of a food product like jam is crucial for both flavor and preservation. A pH below 4.0, as seen in this study, is effective in preventing the growth of most spoilage microorganisms, including bacteria and molds. The slightly acidic pH contributes to the overall taste profile, ensuring that the jam has a balanced flavor without being overly tart. The variation in pH could be attributed to differences in the acidity of the fruits used and the precision in measuring the ingredients.

The fat content of the jam samples ranged from 3.8% to 4.5%, with an average of 4.2%. While jams are not typically high in fat, the presence of fat in these samples may be attributed to the natural oils present in the fruit pulp or added during the processing stage. Fat content can contribute to the mouthfeel and texture of the jam, providing a richer, more satisfying consistency (Garg *et al.,* 2019). The relatively low but consistent fat content across samples suggests a uniformity in the preparation process, ensuring that the final product maintains the desired sensory properties.

CONCLUSIONS

The physico-chemical analysis of the papaya-wood apple jam provides a comprehensive understanding of its composition and quality. The average moisture content of 74.26% ensures a soft, spreadable consistency, while the protein content of 6.35% adds to its nutritional value. The measured acidity of 0.37% provides a balanced flavor, and the ash content of 1.15% indicates a substantial mineral presence. Vitamin C levels at 47.23 mg/100g offer significant health benefits, and the average pH of 3.49 ensures both flavor and microbial stability. The fat content of 4.2% contributes to the texture and mouthfeel of the jam. These results reflect the successful optimization of the papaya-wood apple jam formulation, highlighting its potential as a nutritious and flavorful food product. The study demonstrates the effectiveness of the preparation methods in achieving a jam with desirable physico-chemical properties, suitable for both consumer enjoyment and potential commercial production.

Conflict of Interest. None.

REFERENCES

Bekele, M., Satheesh, N. and Sadik, J. A. (2020). Screening of Ethiopian mango cultivars for suitability for preparing jam and determination of pectin, sugar, and acid effects on physico-chemical and sensory properties of mango jam. *Scientific African*, *7*, 277-285.

Garg, S., Ghosh, P., Rana, S. S. and Pradhan, R. C. (2019). Preparation and quality evaluation of nutritionally enriched jam made from blends of Indian blackberry and other fruits. *International Journal of Fruit Science*, *19*(1), 29-44.

Ileleji, K. E., Garcia, A. A., Kingsly, A. R. and Clementson, C. L. (2010). Comparison of standard moisture loss-on-drying methods for the determination of moisture content of corn distillers dried grains with solubles. *Journal of AOAC International*, *93*(3), 825-832.

Jahagirdar, M., Gorabal, K., Naik, K. R., Patil, R. T. and Thoke, S. B. (2022). Studies on Preparation and Preservation of Wood Apple Spicy Toffee. *Biological Forum – An International Journal, 14*(2), 1028-1033.

Jung, S., Rickert, D. A., Deak, N. A., Aldin, E. D., Recknor, J., Johnson, L. A. and Murphy, P. A. (2003). Comparison of Kjeldahl and Dumas methods for determining protein contents of soybean products. *Journal of the American Oil Chemists' Society*, *80*, 1169-1173.

Tejas Gowda, K. S., Sadananda, G. K., Kukanoor, L., Gorabal, K., Nagajjanavar, K., Koulagi, S. and Darshan, M. B. (2021). Studies on Physical Properties and Organoleptic Qualities of Jackfruit Seed Powder based Extruded Product. *Biological Forum- An International Journal, 13*(2), 24-30.

Pal, M. and Molnár, J. (2021). Growing importance of fruits and vegetables in human health. *International Journal of Food Science and Agriculture*, *5*(4), 567-569.

Perumpuli, P. A. B. N., Fernando, G., Kaumal, M., Arandara, M. and Silva, S., (2018). Development of low sugar vegetable jam from beetroot (*Beta vulgaris* L.): Studies on Physicochemical Sensory and Nutritional Properties. *International Journal of Theoretical & Applied Sciences*, *10*(2), 22-27.

Ranganna, S. (1986). Hand Book of Analysis and Quality Control for Fruits and Vegetable Products, 2nd edn. Tata McGraw-Hill Publishing Company Limited, New Delhi, India.

Selvamary, V. N., Brundha, M. P. and Girija, A. S. (2020). Role of Vitamin C in Immune Function of Human Body. *Indian Journal of Forensic Medicine & Toxicology*, *14*(4), 1-11.

Shinwari, K. J. and Rao, P. S. (2018). Stability of bioactive compounds in fruit jam and jelly during processing and storage: A review. *Trends in Food Science & Technology*, *75*, 181-193.

Teixeira, F., Santos, B. A. D., Nunes, G., Soares, J. M., Amaral, L. A. D., Souza, G. H. O. D., Resende, J. T. V. D., Menegassi, B., Rafacho, B. P. M., Schwarz, K. and Santos, E. F. D. (2020). Addition of orange peel in orange jam: evaluation of sensory, physicochemical, and nutritional characteristics. *Molecules*, *25*(7), 1670-1682.

How to cite this article: Shefali K. Modi (2022). Development and Physico-Chemical Analysis of Papaya-Wood Apple Jam: A Novel Fruit-Based Product. *Biological Forum – An International Journal*, *14*(2a): 628-632.