J Agric. Res., 2024, Vol. 62(4):255-266
www.jar.com.pk
Agriculture Department
Government of Punjab

ISSN: 2076-7897 (Online) / ISSN: 0368-1157 (Print)
DOI: https://doi.org/10.58475/2024.62.4.2190

Crossref

FOOD TECHNOLOGY

EXPLORING THE JAM MAKING POTENTIAL OF PROMISING BER VARIETIES

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Article received on: 06/05/2024
Accepted for publication: 31/12/2024

ABSTRACT

Ber is nutrient dense but highly perishable underutilized fruit. No processed product of ber fruit is available in Pakistan at present which leads to high postharvest losses. The objective of this study was product diversification for which jam was prepared from four different ber varieties, namely Dil Bahar (T_1), Dehli White (T_2), Alu Bukhara (T_3) and Suffan (T_4). The jam samples were prepared using a standard formula during 2023, and the samples were stored in sterilized glass jars. The samples were then analyzed periodically for their physicochemical attributes, such as pH, TSS, acid content, vitamin C, and organoleptic evaluation, to compare the quality changes of jam for a period of six months. The experiment followed a CRD with factorial arrangements, and the data obtained was analyzed statistically to determine the significance level among the different varieties. During storage, all the treatments showed significant variability at a level of $p<0.05$. The results showed decrease in the pH of jam samples from 3.84-3.76 and ascorbic acid content decreased from 56.13 to 50.06 mg/100g during storage. On the other hand, there was an increase in TSS from 69.92 to 70.20 °Brix, and acidity from 0.63 to 0.68%. The sensory evaluation depicted decline in the acceptance scores of the jams during storage, which could be attributed to changes in its physicochemical properties. Based on the physicochemical and sensorial attributes, the ber jam made from fruits pulp of Dehli White was ranked the best, followed by the Alu Bakhara and Suffan varieties. These results will be useful in the selection of appropriate ber varieties for jam production, thereby ensuring its quality and acceptance by consumers. The value added products of ber will add diversification to existing product list and thus reduce postharvest losses to increase farmer income.

KEYWORDS: *Ziziphus mauritiana*; jam; physicochemical analysis; sensory evaluation; storage; Pakistan

INTRODUCTION

Ziziphus mauritiana, also known as ber, is a fruit tree species that originated in the Indian subcontinent, including Sri Lanka, Bangladesh, India and Pakistan. Fruit is rich source of vitamins especially vitamin C, minerals, carotenoids and other bioactive compounds which make it functional fruit. Ber is highly perishable climacteric fruits with only two to four days shelf life.

The fruit production is seasonal and market gets glut during peak production leading to loss of substantial quantity of ber fruits. Fresh produce are highly perishable and have a tendency to spoil quickly after harvest and their shelf life cannot be increased beyond certain limits owing to continuous respiration, ethylene production, physiological reactions due to active enzyme system leading to accelerated senescence of fruits. This results in significant postharvest losses and requires the application of various technologies during processing, preservation, and transport to different locations. Preservation is pivotal for conserving and improving consumption while excess produce can be used to create value-added products for off-season consumption and to tap into distant markets, thereby reducing the market glut (Gupta *et al*., 2022).

Ber fruit is a healthy snack that is low in calories and high in fiber. It has great antioxidant properties, and contains a significant amount of minerals and vitamins, particularly vitamin C (Moradinezhad and Dorostkar, 2021). Due to its ability to meet the needs of growers, consumers, marketers, governments and society, the ber fruit is considered a super fruit (Stan *et al*., 2021). Apart from being used as food, ber fruits are also used in traditional medicine in Asia (Wang *et al*., 2023). The dried ripe fruit is a mild laxative, while the seeds have sedative properties and are taken, sometimes with buttermilk, to halt nausea, vomiting, and abdominal pains during pregnancy, check diarrhea, and for poulticing on wounds for faster healing. The small spherical or oblong ber fruits turn reddish-brown when ripe (Sishu *et al*., 2023) and can be consumed fresh or dried into powder for baking, jam-making, and traditional loaves. Ber fruits can also be processed into a variety of products such as juice, meal, flour, butter, and candy, making it a versatile and healthy choice for all (Meighani and Sadat-Hosseini, 2024).

Various researchers have made attempts to increase the shelf life of jujubes by processing them into different products. In India, jelly, chutney and pickle are prepared from mature green fruits (Rashwan *et al*., 2020), while ripe fruits are mostly consumed in their raw, fresh form as table fruits. Ripe fruits can also be stewed, candied, or dried for out-of-season purposes. Varieties with high acid content are perfect for pickle or chutney preparation. These products include jam, nectar, dried fruits, powdered tea, fruit extracts, fruits preserved as sweet-sour vinegar infusion, honey-coated, fruit conservation by sweet infusion like pickles, chutney, jelly and compote (Uddin and Hussain, 2012), smoked, destoned jujube in syrup, candied jujube, liquor, juice, paste, beer, slices, pigments, and essence .

Jam is an intermediate moisture product prepared from at least 45% fruit, 55% sugar, and condensed to raise soluble solid content to 65% or above. Standard jam recipe include pectin, sugar, acid and fruit pulp. The mixture is then condensed through thermal processing at high temperatures to achieve the desired total soluble solid content. Fruit jams are gaining popularity due to typical organoleptic attributes, their year-round availability, low cost, changing lifestyle, and busy work schedules (Kuşçu and Bulantekin, 2021). They also have attractive color, uniform consistency with indistinguishable fruit pieces, typical fruit flavor (Gehlot *et al*., 2018), smooth spreadability, and lack of free-flowing liquid (Aziz *et al*., 2023).

Ber fruit has a high polysaccharides content and nutrients, making it a promising functional ingredient (Rashwan *et al*., 2020). Its high sugar content makes it an ideal fruit for preparing jam (Kuşçu and Bulantekin, 2021). Ber jam has a good nutrient profile, versatile sensory attributes, and extended shelf stability (Chen *et al*., 2023). In fact, the demand for ber jam is continuously increasing due to its improved sensory perception, versatility and enhanced attractiveness of food products like coffee, milk, cake, cookies and bread (Makhlouf-Gafsi *et al*., 2018).

Considering the high nutritional value of ber fruits, their tendency to spoil quickly, and the absence of processed ber products in the market, a study has been planned to diversify product list by developing ber jam which is still not commercially available. The study aims to identify the ber variety best suited for jam production.

MATERIALS AND METHODS

The current research was conducted during 2023. Fully ripe fruits from four different ber varieties were harvested from experimental orchards located at the Horticulture Research Institute, Ayub Agricultural Research Institute in Faisalabad, and the Regional Agriculture Research Institute (RARI) in Bahawalpur. The fruits were washed and then boiled in a small amount of water for a few minutes to soften them. Afterwards, they were passed through a pulper to obtain the pulp. Using the pulp, jams were prepared from the four different ber varieties: Dil Bahar (T1), Dehli White (T2), Alu Bukhara (T3), and Suffan (T4). Ber pulp (150g) was taken in stainless steel pan, sugar (1000g) was added with small amount of water and mixed thoroughly. Citric acid (7g), sodium benzoate (1g) and orange red color (1g) was added and cooked till desired Brix (67B□) was obtained. Prepared jam was packed in glass jars and stored at ambient temperature for storage study.

Physicochemical analysis: The jam samples that were prepared underwent different tests to determine their total soluble solids (932.12), pH (981.12), titratable acid (942.15), and vitamin C content (967.22) using respective methods as described in AOAC (2006). A 100 mL glass beaker was used to hold each jam sample, and the pH for each was measured using a digital pH meter (InoLab 720, Germany). The Abbe's Refractometer was used to determine the total soluble solids at room temperature. Five grams of jam samples were dissolved in distilled water to determine acidity via titration against 0.10 N NaOH solution. Phenolphthalein was used as an indicator volume was recorded when at the light pink color appeared which persist for 15 seconds. Finally, the detective dye DCPIP (2, 6-dichlorophenol indophenol) was used for the estimation of ascorbic acid content.

Organoleptic evaluation: A group of 10 semi-trained judges, were selected from the Food Technology Section at the Post Harvest Research Centre, Ayub Agricultural Research Institute, Faisalabad. They evaluated the ber jam samples based on their color, taste, flavor and overall acceptance using a hedonic scale (1-9), as explained by Meilgaard *et al.* (2016). The score 1 indicated that the samples were extremely disliked, while 9 indicated that they were extremely liked.

STATISTICAL ANALYSIS

The research trial was conducted following factorial arrangements under completely randomized design

(CRD). The data collected for each parameter was analyzed using statistical analysis through the analysis of variance technique. Furthermore, a post hoc comparison of means was conducted using the LSD test as described in Montgomery (2017). The results are reported as an average of three replicates.

RESULTS AND DISCUSSION

pH value: During storage, the pH levels depicted declining trend irrespective of treatments, with the mean values showing significant differences. The values for T2, T3, T1, and T4 were 3.85, 3.81, 3.79, and 3.77 respectively. Storage days and treatments illustrated considerable impact on all the jam samples. The significantly lower mean value was recorded for (T4) and higher in (T2) as depicted in Fig.1.

The pH of processed food is crucial protagonist for maintaining its taste, flavor, color, and texture (Kumar *et al*., 2017). An optimal pH level prevents the growth of microbes, thus aids in increasing the self-stability of processed foods (Nafri *et al.*, 2021). In jam making optimum pH is necessary for appropriate gel formation (Souad *et al*., 2012). The results of present research are consistent with previous studies by Mukhtar *et al*. (2022), Guo *et al.* (2018) and Rafique *et al*. (2023) who reported a decreasing trend in pH levels during storage in pH of all treatments in mango jam and karonda-apple jam. The pH value of ber jam revealed decrease during storage which is concordance with earlier findings by Nafri *et al.* (2021) and Rababah et al. (2011) who reported similar decline in pH of papaya jam from 3.6 ± 0.3 to 3.4 ± 0.20, 3.31 to 3.20 in cherry fruit jam. The transformation of sugar into acid during storage is responsible for the decline in pH levels (Bisen and Verma 2020; Rahman *et al.*, 2018). The decline in pH during storage might be due to formation of pectic acids from hydrolysis of pectin (Ninga *et al*., 2021), accrual of free acids (Lekhuleni *et al.*, 2021), production of acidic compound (Shapla *et al.*, 2018) or changes in composition (Souad *et al*., 2012). Formation of hydroxymethyl furfural during processing and storage may also contribute to lowering pH (Rababah *et al.*, 2011).

Total soluble solids (TSS): Statistical analysis showed that both storage and treatment effects were significant for all the samples whereas interaction was non-significant. Total soluble solid content exhibited steady increase during storage from 69.92 to 70.20 °Brix. Mean values were 69.93, 69.98, 70.03, and 70.24 °Brix recorded for T_4, T_1, T_3, and T_2, respectively. The highest mean for TSS was noted in T_2, whereas the lowest for T_4 (see Table 1). Increase in TSS during storage might be attributed to sugar inversion, solubilization of polysaccharides or decline in moisture. Whereas differences among jam samples may be ascribed to genetic makeup of varieties.

In their research, Mukhtar *et al*. (2022) noted that the soluble solid content (TSS) increased from 66.64-69.82 °Brix in karonda-apple jam, Kanwal *et al*. (2017) also found an increase in TSS from 68.07 to 69.68 °Brix in guava jam during a 60-day storage period. The findings of the current study on TSS of ber jam are closely similar to those of previously conducted research by Hoxha and Kongoli (2021), Uddin and Hussain (2012), and Dubey *et al*. (2014). These studies reported TSS values between 66.26 to 67.12, 67.61-67.790, and 70 °Brix in jujube fruit jam.

The TSS of ber jam, was monitored during storage to assess any changes that may occur over time. Results showed a slight increase from 69.92 to 70.20°Brix,

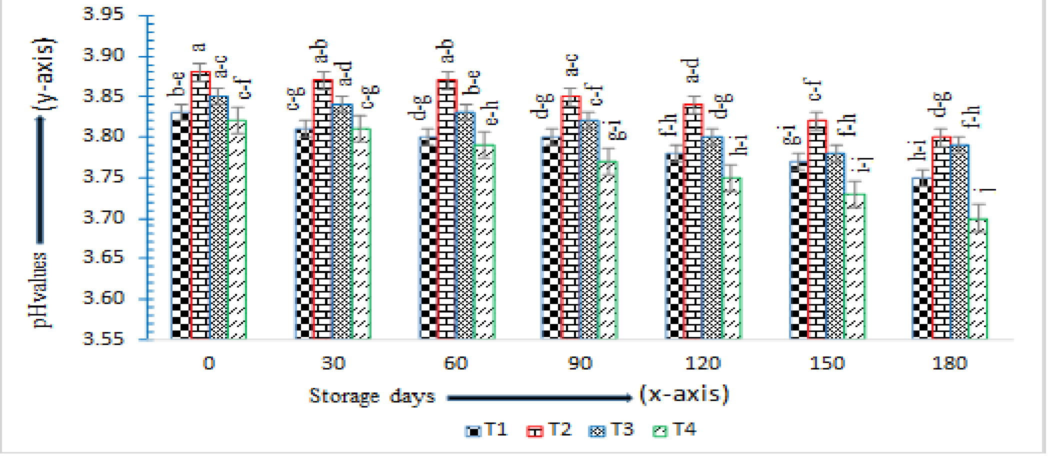

Fig. 1: Treatments and storage period impact on pH of ber jam
T1 = Dil Bahar T2 = Dehli White T3 = Alu Bukhara T4 = Suffan

Table 1. Effect of storage period and treatments on soluble solid content (TSS) of Ber jam.

Treatments	Storage period (days)							Means
	0	30	60	90	120	150	180	
T_1	69.90	69.90	69.90	70.00	70.00	70.10	70.10	**69.98 bc**
T_2	70.10	70.10	70.20	70.20	70.30	70.40	70.40	**70.24 a**
T_3	69.90	69.90	70.00	70.00	70.10	70.10	70.20	**70.03 b**
T_4	69.80	69.80	69.90	69.90	70.00	70.00	70.10	**69.93 c**
Means	**69.92c**	**69.92c**	**70.00bc**	**70.02bc**	**70.10ab**	**70.15a**	**70.20a**	

Values are mean of three replicates and contain different letters vary significantly at ($p<0.05$).

T_1 = Dil Bahar T_2 = Dehli White T_3 = Alu Bukhara T_4 = Suffan

indicating a possible change in the jam's quality. This observation is consistent with previous studies by Sharif *et al*. (2022), Nafri *et al*. (2021), Khan *et al*. (2014), Pavlova *et al*. (2013) and Touati *et al*. (2014), who reported similar increases in TSS levels in other fruit jams, such as jujube, papaya, strawberry, raspberry, peach and apricot. Specifically, the TSS of jujube jam increased from 68.28±0.03% to 70.24±0.05%, papaya jam increased from 63.0 ± 2.0 to 68.3 ± 1.2, and apricot jam increased from 64.42 to 67.30 °Brix during storage. These findings suggest that it is common for the TSS of jam to increase gradually over time, which could affect its taste, texture, and overall quality.

During storage, the total soluble solids (TSS) of jam tend to increase. This might be due to the acid hydrolysis of polysaccharides (gums and pectin) and solubilization of pulp components, which results in the formation of soluble sugars (Kanwal *et al*., 2017; Sharif *et al*., 2022). Additionally, a decrease in moisture content during storage could also contribute to the increase in TSS (Bisen and Verma, 2020). The increase in TSS is more significant during extended storage. However, the TSS of ber jam showed only a slight increase during storage, which is different from the findings of Hoxha and Kongoli (2021), who reported a slight decline in soluble solid content (TSS) of jujube jam.

Acid content: The statistical analysis conducted displayed that both storage intervals and treatment had a notable impact on acid content of all the jam samples. During storage, the titratable acidity increased gradually. The mean values were recorded as 0.64 (T_2), 0.65 (T_1), 0.66 (T_3), and 0.67% (T_4), respectively. The highest mean value for acidity was noted in T_4, while the minimum was for T_2, as given in Fig. 2 . The difference in acid content among treatments might be due to genotypic variation for ber varieties.

Titratable acidity is the measure of the amount of acid present in a solution. Appropriate acid level is crucial for gel formation, texture and overall acceptance of jam

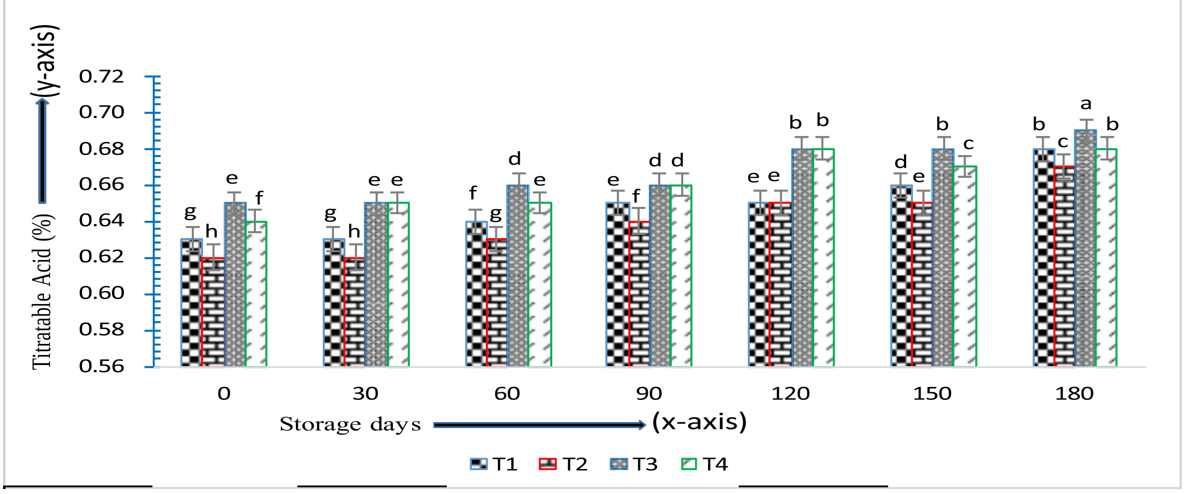

Fig. 2: Treatments and storage period impact on acidity of ber jam

T_1 = Dil Bahar T_2 = Dehli White T_3 = Alu Bukhara T_4 = Suffan

Table 2: Treatment and **storage impact on ascorbic acid content (mg/100g) of Ber jam**

Treatments	Storage Days							Means
	0	30	60	90	120	150	180	
T_1	55.70^{a-c}	55.20^{a-d}	53.60^{a-g}	52.40^{a-h}	51.10^{d-h}	50.56^{e-h}	48.76^{h}	52.47c
T_2	56.50^{a}	56.15^{a-b}	55.40^{a-d}	54.88^{a-e}	54.23^{a-g}	53.58^{a-g}	51.16^{d-h}	54.56a
T_3	56.20^{a-b}	55.75^{a-c}	54.10^{a-g}	53.35^{a-g}	52.05^{b-h}	51.26^{d-h}	49.87^{g-h}	53.23b
T_4	56.10^{a-b}	55.68^{a-c}	54.74^{a-f}	53.52^{a-g}	52.90^{a-h}	51.66^{c-h}	50.45^{f-h}	53.58b
Means	56.13a	55.70a	54.46b	53.54c	52.57d	51.77d	50.06e	53.46

Values are mean of three replicates and contain different letters vary significantly at ($p<0.05$).
T_1 = Dil Bahar T_2 = Dehli White T_3 = Alu Bukhara T_4 = Suffan

(Garrido *et al*., 2015). Acid protects jam from microbial proliferation during extended storage durations (Touati *et al*., 2014). An earlier study by Mukhtar *et al*. (2022) also reported an increase in acid content from 0.64 to 0.76% during the 100-day storage in mango jam samples which is consistent with acid content of ber jam from current study. It is essential to note that the acid content of jam must be kept below one percent, as a higher quantity can cause syneresis, which is the separation of liquid from a gel-like substance. Therefore, it is crucial to maintain the required acid content to achieve a desirable and consistent final product. The rise in acid content during storage might be due to degradation of polysaccharides, disintegration of uronic acids and pectic substances in to respective acids, accrual of week acids and their salts during storage (Khan *et al*., 2017; Kanwal *et al*., 2017). Increasing trend of acid content noticed due to synthesis of soluble sugars from polysaccharide disintegration, oxidation of reducing sugars and rise in concentration of total soluble solids during storage (Safdar *et al*., 2014). Synthesis of organic acids from carbohydrate breakdown and hydrolysis as well as existence of acidophiles might be other possible factors for augmented acid level during storage. Similar trend in acid increase has been reported by Khan *et al*. (2017) and Kanwal *et al*. (2017) for banana-mushroom and strawberry jam. Likewise, Khan *et al*. (2012) reported rise in acid content of strawberry jam from 0.68 to 0.86% during storage.

Ascorbic acid content: The findings of the study revealed that the level of ascorbic acid present in the jam samples declined significantly at subsequent testing intervals during storage. The average scores showed substantial variations irrespective of treatments, with the highest value being observed for T_2 at 54.56 mg/100g and the lowest value being

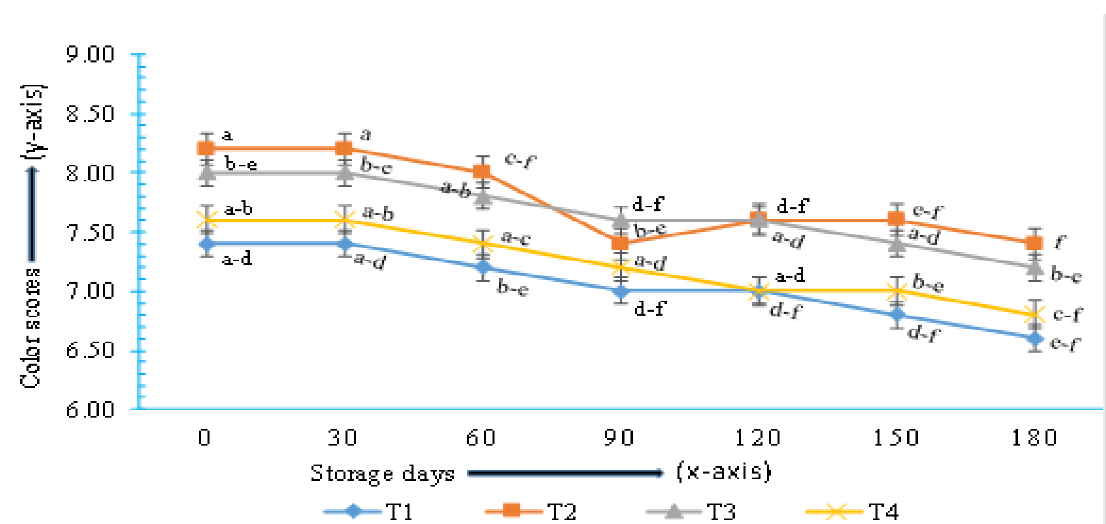

Fig. 3: Treatment and storage period impact on color of ber jam.
T_1 = Dil Bahar T_2 = Dehli White T_3 = Alu Bukhara T_4 = Suffan

Table 3: Treatments and storage period impact on ber jam flavor scores

Treatments	Storage days							Means
	0	30	60	90	120	150	180	
T_1	7.60^{b-e}	7.60^{b-e}	7.40^{c-f}	7.20^{d-f}	7.00^{e-f}	6.80^{f}	6.80^{f}	7.20c
T_2	8.40^{a}	8.40^{a}	8.20^{a-b}	8.00^{a-c}	7.80^{a-d}	7.80^{a-d}	7.60^{b-e}	8.04a
T_3	8.20^{a-b}	8.20^{a-b}	8.00^{a-c}	7.80^{a-d}	7.40^{c-f}	7.60^{b-e}	7.40^{c-f}	7.80b
T_4	7.80^{a-d}	7.80^{a-d}	7.60^{b-e}	7.40^{c-f}	7.20^{d-f}	7.00^{e-f}	7.00^{e-f}	7.40c
Means	8.00a	8.00a	7.82ab	7.60bc	7.35cd	7.30cd	7.20d	7.61

Values are mean of three replicates and contain different letters vary significantly at ($p<0.05$).
T_1 = Dil Bahar T_2 = Dehli White T_3 = Alu Bukhara T_4 = Suffan

52.47mg/100g for T_1. The results have been tabulated for reference. Statistical analysis suggested that both the treatment and storage conditions had a significant impact on ascorbic content of all the samples. The differences in ascorbic acid may be ascribed to genetic variability among ber varieties. Ascorbic acid is lost during storage owing to its sensitivity towards light, heat and oxygen.

The findings obtained from the present research are in higher with the research conducted by Mukhtar *et al*. (2022) reported a decline in ascorbic acid concentration from to 20.71 mg/100 g24.99 to 20.71mg/100g during storage in mango jam made. The higher vitamin C content in jam A was attributed to more quick processing, reducing both oxidative and thermal degradation (Chen *et al*., 2023). These findings highlight the importance of careful processing and storage of jam to maintain its nutritional value. According to a study conducted by Dubey *et al*. (2014), ber jam contains approximately 27.03 and 27.98mg/100g of ascorbic acid, while Goyal *et al*. (2008) reported 27.32 mg/100g of the same. Further research has shown that the vitamin C content of ber jam decreases gradually during storage (Dubey *et al*., 2014). This decline in ascorbic acid content can be attributed to various factors, such as oxidation by reaction with available oxygen in to dehydroascorbic acid and ultimately to ketogulonic acid (Souad *et al*., 2012), high storage temperature (as it is thermolabile), light (Peleg, 2017) or conversion of ascorbic acid into dehydroascorbic acid by ascorbinase enzyme (Sharif *et al*., 2022). Losses of ascorbic acid may also occur due to catalytic activity of enzymes existing in ingredients used or presence of metallic ions (Safdar *et al*., 2014; Mukhtar *et al*., 2022). Sharif *et al*. (2022) also reported a slight decrease in

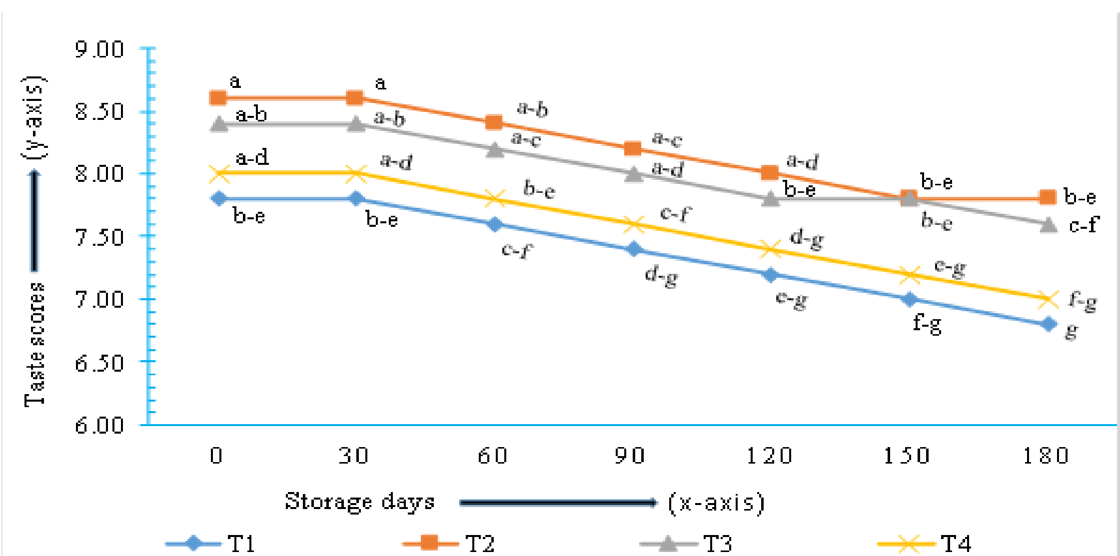

Fig. 4: Treatments and storage period impact on Taste of ber jam.
T_1 = Dil Bahar T_2 = Dehli White T_3 = Alu Bukhara T_4 = SuffanOverall acceptability

ascorbic acid levels from 50.39±0.04 to 49.90±0.03 mg/100g during 90 days of storage. These findings suggest that proper storage conditions are essential to maintain the nutritional value of ber jam.

EVALUATION

Color: The color of food plays a significant role in its appeal to consumers. It is one of the most essential characteristics of food and has a direct influence on whether a product will be accepted by consumers or not (Hoxha and Kongoli, 2021). The color of a food product is also an indicator of its nutritional value and visual quality, allowing consumers to make informed choices (Chen *et al*., 2023). Therefore, food manufacturers need to pay close attention to the color of their products to ensure they are marketable and meet consumers' expectations. Aziz *et al*. (2023) noted the close association between color, flavor, and taste perception, and the quality index of processed jams. Therefore, it is crucial to monitor the color of jams and marmalades during storage to ensure the quality of the final product.

The findings of this study indicate that the color of the samples decreased significantly ($p \leq 0.05$) from 7.8 to 7.0 during the six-month storage period. It was observed that all the treatments had statistically different mean values, with T_2 having the highest mean value of 7.77, followed by T_3 with a mean value of 7.66, T_4 with a mean value of 7.23, and T_1 with the lowest mean value of 7.06. The lowest color score was observed for T_1, while the greatest score was recorded for T_2, as presented in Fig. 3. Furthermore, the statistical findings indicated that both the storage conditions and treatments had a significant effect on all jam samples. These results suggest that the storage conditions and treatments can have a significant impact on the color of samples and it is important to carefully consider these factors when conducting similar experiments.

Several research studies have found a decrease in the color of different types of jams and marmalades during storage. For instance, in mango jam, strawberry jam, and guava jam, a decline in color was observed by Mukhtar *et al*. (2022), Khan *et al*. (2012), and Kanwal *et al*. (2017), respectively. Similarly, Nduko *et al*. (2018) and Aziz *et al*. (2023) suggest that the decrease in color of jam is due to the oxidation of pigments and moisture ingress from the environment. Breakdown of pectin in to pectenic and pectic acids plays a vital role in color changes of jam during storage (Kopjar *et al*., 2009). Oxygen, temperature and pH are main factors responsible for color degradation of food products (Basu *et al*., 2010). Oxidative degradation of natural pigments like carotenoids, anthocyanins and chlorophyll mainly affect color of products (Matheyambath *et al*., 2016). Color change of jam is mostly associated with oxidation of vitamin C, enzymatic browning, occasionally with Malliard's reaction (Safdar *et al*., 2014) and polymerization between polyphenols and anthocyanin (Bekele *et al*., 2020). Chauhan *et al*. (2012) also observed a similar reduction in color scores in coconut jam. The color of product has close association with flavor and taste perception in addition to index for processed jam quality (Aziz *et al*., 2023). It has strong linkage with purchase decision and overall acceptance of products (Mukhtar *et al*., 2022). Specifically, Mukhtar *et al*. (2022) and Kanwal *et al*. (2017) found that the color values declined from 8.64 to 4.66 in mango jam after 100-days, while it decreased from 6.79 to 6.39 in guava jam during 60 days.

Flavor: The results of the study revealed that the flavor score of the product decreased significantly ($p \leq 0.05$) from 8.0 to 7.2 during a six-month storage period. The flavor of all treatment groups varied significantly, with mean values of 8.03, 7.80, 7.40, and 7.20 for T_2, T_3, T_4, and T_1, respectively (as shown in Table 3). The minimum mean score was noted for T_1, while the maximum for T_2. The statistical analysis demonstrated that both the treatment and storage conditions had

Table 4: Treatment and storage period impact on Overall acceptability of ber jam

Treatments	Storage days							Means
	0	30	60	90	120	150	180	
T1	7.60^{b-e}	7.60^{b-e}	7.40^{c-f}	7.20^{d-f}	7.00^{e-f}	7.00^{e-f}	6.80^{f}	7.23a
T2	8.40^{a}	8.40^{a}	8.20^{a-b}	8.00^{a-c}	7.80^{a-d}	7.60^{b-e}	7.60^{b-e}	8.00a
T3	8.20^{a-b}	8.20^{a-b}	8.00^{a-c}	7.80^{a-d}	7.80^{a-d}	7.60^{b-e}	7.40^{c-f}	7.86a
T4	7.80^{a-d}	7.80^{a-d}	7.60^{b-e}	7.40^{c-f}	7.20^{d-f}	7.00^{e-f}	7.00e-f	7.40b
Means	8.00a	8.00a	7.80ab	7.60bc	7.45cd	7.30cd	7.20d	7.62

Values are mean of three replicates and contain different letters vary significantly at ($p<0.05$).

T_1 = Dil Bahar T_2 = Dehli White T_3 = Alu Bukh significant effects on all samples. These findings suggest that the product's flavor may be affected by storage duration and treatment, which could be critical for maintaining its quality and consumer satisfaction. The current study revealed a noteworthy similarity in the flavor of the preserved products with Wasihun *et al*. (2023) and Kanwal *et al*. (2017) findings. The previous studies reported a significant reduction in flavor for Baobab jam from 5.53 to 4.30 and 6.40 to 5.13 in two different formulations after 90 days and for guava jam from 6.86 to 6.42 after 60 days of storage. The gelatinous products were found to spoil rapidly, altering or diminishing the flavor and aroma of the original products, resulting in a lack of taste or even the emergence of unfavorable flavors. Similarly, Nafri *et al*. (2021) noticed a gradual decline in the flavor of papaya jam during storage, which was also reflected in the gradual decrease in flavor scores of ber jam.

Taste: Taste is a vital factor in determining consumer preference for a product. It involves flavor, texture, aroma, and visual appearance. Taste buds detect basic tastes, while texture and aroma influence flavor. Visual appearance creates expectations and affects perceived taste. These factors make taste a key indicator of product quality and consumer satisfaction. The study findings illustrated that during storage, there was a notable decrease ($p \leq 0.05$) in the taste score of the samples, with the mean score decreasing from 8.2 to 7.3. The mean values for all treatments showed a notable difference, with T_2 having the highest mean value of 8.2, followed by T_3 (8.03), T_4 (7.57) and T_1 (7.37), which had the lowest mean value. These findings were presented in Fig. 4. An in-depth statistical analysis indicated that both storage and treatment had significant effects on all the samples tested. The findings indicate that the taste of ber jam decreases over time, in line with prior studies on other types of jam. Similarly, Nafri *et al*. (2021) and Chauhan *et al*. (2012) reported a gradual decline in the taste of papaya jam and coconut jam during storage. These results suggest that the quality of ber jam may deteriorate over time, which should be taken into consideration when storing and consuming this product. Same downturn trend for taste of mango jam from 8.64 to 6.13 (Mukhtar *et al*., 2022) and 8.4-7.9 (Safdar *et al*., 2014), apple jam from 8.6 to 5.9 (Lekhuleni *et al*., 2021) during storage. The decline in taste scores of jam might be ascribed to decreasing pH and variation in sugar acid ratio (Ding *et al*., 2015) which is linearly linked with sensorial perception by judges. The taste buds existing on tip of tongue perceived the sweet taste developed by appropriate sugar acid ratio (Safdar *et al*., 2014) whereas quantitative change in sugar-acid ratio lead to decreased taste perception (Shah *et al*., 2015).

Overall Acceptability: The study investigated the effect of storage on the acceptability of various treatments. Results showed that the overall acceptability rating significantly decreased from 8.0 to 7.2 during storage, indicating that the quality of the treatments deteriorated over time. The mean acceptance scores for all the treatments also differed significantly from the initial rating of 8.0, with T_2 having the highest mean value and T_1 having the lowest. This suggests that some treatments were more susceptible to deterioration than others. The findings are presented in Table 4, which highlights the differences between the mean values of the different treatments. The statistical investigation further disclosed that both storage and treatment had a significant impact on the acceptability of the ber jam samples, emphasizing the importance of appropriate storage environment to maintain the quality of the jam. In a study conducted by Mukhtar *et al*. (2022) on mango jam and, it was found that the overall acceptability of the mango jam decreased from 8.88 to 5.13 over a period of 100 days whereas in guava jam it decreased from 6.94-6.66 (Kanwal *et al*., 2017). This suggests that the quality of the jam deteriorated significantly with time. Similarly, Suri *et al*. (2017) also observed a decrease in the overall acceptability of Akha jam from 8.20 to 7.40 during storage. This indicates that the sensory characteristics of the jam changed over time, affecting its palatability and overall quality.

Studies have revealed that the sensory quality of commercially available apricot and ber jam decreases over time. This decline in quality is consistent with the results of previous studies that examined the impact of storage duration on the quality of papaya and coconut jam. Specifically, Touati *et al*. (2014) found that the overall acceptability of apricot jam decreased during storage at 37 °C. Similarly, Nafri *et al*. (2021), Khan *et al*. (2012) and Chauhan *et al*. (2012) reported that the sensory acceptance scores of papaya, strawberry and coconut jam, respectively, gradually declined with the increase in storage duration. These findings highlight the importance of considering the storage duration of jam products in order to maintain their quality and sensory appeal. Consumer acceptance is crucial factor for product development. Overall acceptance scores declined with increasing storage time diet jam (Lekhuleni *et al*., 2021).

CONCLUSION

The study on ber jam revealed that the Dehli White variety produced the highest quality jam, outperforming the Alu Bakhara and Suffan varieties. This conclusion was drawn based on a comprehensive evaluation of physicochemical parameters, including pH, total soluble solids (TSS), and vitamin C concentration, as well as sensory analysis. The Dehli White variety exhibited a pH of 3.7, indicating slightly higher acidity compared to the other varieties. Dehli White jam had a TSS content of 64.3%, which was significantly higher than that of Alu Bakhara (60.8%) and Suffan (59.5%). The vitamin C content of Dehli White jam was measured at 54.56 mg/100g, slightly higher than Alu Bakhara (53.23 mg/100g) and Suffan (53.58 mg/100g). Sensory evaluation, performed by a panel of expert judges, assessed various attributes such as color, taste, flavor, and overall acceptability. Dehli White jam received the highest scores across most parameters, confirming its sensory superiority. The findings indicate that the Dehli White variety is best suited for producing high-quality ber jam due to its favorable physicochemical properties and consumer preference. These insights provide valuable information for breeders to select superior varieties for product development and offer guidance to farmers in choosing ber varieties optimized for processing. Furthermore, the results open opportunities for future research and innovation in the food industry.

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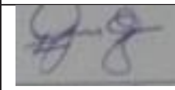
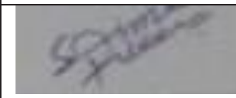
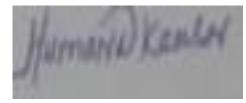
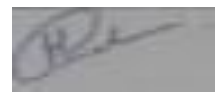
2.	Zafar Iqbal	Interpreted the result and wrote up the manuscript	
3.	Saima Parveen	Analyzed data statistically	
4.	Humaira Kausar	Assisted the research work	
5.	Muhammad Hammad Rashid	Analyzed data statistically	
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