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Study on the Development of Tamarind and Plum Blended Jam Stored at Ambient Temperatures

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Abstract

The aim of this study was to analyze the influence of various treatments on the quality of plum tamarind jam stored at ambient temperature. The treatments were PT0 (plum 100%), PT1 (plum 90%: Tamarind10%), PT2 (Plum 80%: Tamarind20%), PT3 (Plum70%: Tamarind30%), PT4 (Plum 60%: Tamarind40%), PT5 (Plum50%: Tamarind50%). All treatments were studied physiochemically for TSS, PH, Titratable acidity, vitamin C, reducing, a non-reducing sugar, organoleptic properties like color, taste, texture, and overall acceptability with 15 days gap during total storages period of 90 days. A significant increase was observed in TSS (66.48% to 69.65%), % acidity (0.73% to 0.89%), reducing sugar (18.63% to 25.02%). A significant decrease in PH (3.89 to 3.73) , non-reducing sugar (43.26 to 26.66), vitamin (35.35 to 25.89), color (8.3 to 5.35), texture (8.3 to 5.51), taste (8.53 to 5.46), and over all acceptability (8.45 to 5.63) was observed. During the physicochemical and sensory evaluation, it was observed that PT5 followed by PT4 was of good quality.

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Introduction

Plum is a deciduous fruit generally recognized as stone fruit which is cultivated in temperate areas whereas some cultivars are grown in sub-tropical areas of Khyber Pakhtunkhwa (KPK), Quetta and Qallat divisions of Baluchistan in Pakistan [1]. In Pakistan plum are cultivated on an area of 6.7 thousand hectares, in which Khyber Pakhtunkhwa and Baluchistan include 3.0 and 3.7 thousand hectares. In Pakistan total plum production was 56.2 thousand tons, in which KPK and Baluchistan contribute 27.0 and 28.9 thousand tons correspondingly [2].

Plum is very tender and perishable fruit having high percentage of water content (86.6%), protein (0.5g), carbohydrates (12.3g), Niacin (0.5mg), Riboflavin (0.03mg), calcium (12mg), P (18mg), Fe (0.5mg), Na (1mg) and K (170mg) per 100 grams of edible portion. All this composition makes plum a good nutritious fruit [3]. It improves the competency of the immune system in combating free radicals, and it has good antioxidant characteristics. Plum also has aesthetic importance and recover skin conditions [4]. It has health benefits for the immune system, nervous and muscular system because it has a great amount of fiber, potassium, magnesium, vitamins, antioxidants and avoids stress [5]. It contains a high amount of iron, vitamin A, vitamin C and fiber, being used as fresh, dehydrated and conserved into jam and jellies. Plum is also a key ingredient in preparing cakes, pies, desserts, and marmalade [6].

The pulp of Tamarind generally has 20.6% water, 3.1% protein, 0.5% fat, 70.8% CHO, 3.0% fiber and 2.1% ash. It contains high tartaric acid, citric acid, vitamin C and sugar [7]. It contains sugars in the form of fructose, sucrose, glucose, and maltose and minute quantity of protein, lipid, acids, and polysaccharides. Tamarind contains a great amount of vitamin C, sugar and minerals. It has a significant amount of pectin and organic acid in which 98% is tartaric acid [8]. Tamarind is widely utilized in medical practice to treat many diseases and skin disorders. It enhances appetite and used as a gargle for sore throats, dressing of wounds and is said to aid the restoration of sensation in cases of paralysis [9]. It is generally used in food and beverage products such as juices, syrup, concentrates and exotic products such as curries, pickles, and chutneys. It is used in many foods products for its sour taste and antioxidant characteristics [10].

Sugar constitutes more than 40% of total weight, an effect that is essential for the physical, chemical and microbiological stability, improves appearance and makes gelation of pectin. The added sugar acts as a dehydrating agent for the pectin molecules, permitting closer contact between chain molecules reduces water activity to below 0.8, thus spoilage organisms in jam do not survive [11]. Pectin is the gelling agent responsible for gel formation in presence of sucrose during fruit jam manufacture. The number of junction zones increased with pectin concentration. Consequently, the number of elastically active polymeric chains within the gel network increased with pectin concentration and the structure network formation within the gel, therefore became more rigid [12]. Citric acid is considered necessary to correct the balance, which is needed in jam and jelly production. Lime and lemon juice are high in citric acid, therefore, they can be used as a replacement for citric acid in jam manufacture [13].

Jam is a semi-solid mixture, obtained upon cooking of fruits or vegetables with sugar, citric acid, and pectin. Jam is an intermediate moisture food prepared by boiling fruit pulp with sugar (sucrose), pectin, acid and other ingredients (preservative, coloring and flavoring materials) to a reasonably thick consistency, firm enough to hold the fruit tissues in position. Jam should contain more than 65% or above total soluble solids (TSS) and at least 45% fruit pulp. Jams are of two kinds, one prepared from a single fruit and another prepared from a combination of two or more fruits [28]. The aim of this research was to analyze the influence of various treatments on the quality of plum tamarind jam stored at ambient temperature.

Materials and Methods

Preparation of samples

Plum and tamarind were peeled and then heated in water to soften pulp. Heated plum and tamarind were placed in the pulping machine. Then plum and tamarind blended jam were prepared with a different ratio.

Proposed plan of the study

Tamarind and plum blended jam were formulated with below ratios.

TP0: plum pulp (100%) +1kg sugar /kg pulp
TP1: Plum pulp (90%) + Tamarind pulp (10%) +1kg sugar /kg pulp
TP2: Plum pulp (80%) + Tamarind pulp (20%) +1kg sugar /kg pulp
TP3: Plum pulp (70%) + Tamarind pulp (30%) +1kg sugar /kg pulp

TP4: Plum pulp (60%) + Tamarind pulp (40%) +1kg sugar /kg pulp
TP5: Plum pulp (50%) + Tamarind pulp (50%) +1kg sugar /kg pulp

Packaging and storage of jam
Jam samples were placed in hermetically sealed containers at ambient temperature and were examined for physicochemical and sensory assessments at every 15 days gap for 3 months.

Physicochemical Analysis
Physiochemically all samples were balanced with each other for pH, total soluble solids, percent acidity, vitamin C, reducing and non-reducing sugar according to the standard method of AOAC 2012 [14].

Sensory evaluation
Plum tamarind jam was analyzed for organoleptic assessments like color, taste, texture and overall suitability. Different trials were inspected by 10 judges by using 9 hedonic scales as explained by Larmond (1977).

Statistical Analysis
The data was analyzed by using two factorial CRD and means were separated by applying LSD test at 0.05% significant level as described by Steel and Torrie (1997) [15].

Results and discussion

Total soluble solid (TSS)
Influence of storage gaps and various treatments on the TSS of jam are given in **Table 1**. Statistical analysis demonstrated that TSS of plum Tamarind jam enlarged considerably throughout keeping time. TSS of jam on the first day from TP0 to TP5 was 66.6, 66.4, 66.3, 66.5, 66.6, and 66.5. TTS regularly got higher to 69.7, 69.8, 69.3, 69.3, 69.2, and 69.6 throughout keeping time. Mean TSS value was noted 66.48 at 1st day, whereas 69.65 at 90th day. TP0 demonstrated the highest mean value (68.02) while TP5 had the lowest (67.55). The high enlargement was experienced in TP2 (4.87) while least was in TP4 (3.75). The current conclusions are nearly similar to Shakir *et al*. (2007) [16], who exposed a growing movement in TSS (68.5-71.2) during keeping time. Likewise, Khan *et al*. (2012) [17] experienced an enlargement in TSS (66.5-68.8). Raise in TSS might be due hydrolysis of starch into simple sugar.

pH
Table 2 showed the influence of treatment and storage gaps on plum tamarind jam. pH of plum tamarind blend jam decreased during 90 days of storage time. The first day values of the samples were 3.9, 3.95, 3.93, 3.88, 3.89, and 3.81 from T0 to T5 which steadily decline to 3.78, 3.75, 3.74, 3.71, 3.73, and 3.67 during three months. Mean value at 1st day was noted 3.89 which reduced to 3.73. Peak mean 3.88 was experienced in T0, where least 3.75 were in T6. Peak fall (5.06) was noted in T1 however slightest was in T0 (3.07). Statistical figures demonstrated that pH is extensively affected by storing jam. Current results are alike to the study of Ehsan et al. (2002) [18], who inspected a decline in pH of jam. pH of fruit is extremely essential because in gel development it plays a vital role. Increase in acidity caused due to the development of an acidic compound which is basic for the decline in pH. Likewise, prior writings sustain current study because diminished in pH was also experienced by them [16].

Acidity
Table 3 revealed influences in acidity of plum tamarind jam. The acidity of jam demonstrated considerable variation throughout keeping time. Acidity of the jam samples were 0.75, 0.73, 0.75, 0.71, 0.74, and 0.74 from T0 to T5 at initial day, while showed an increasing trend of 0.97, 0.91, 0.92, 0.85, 0.88, and 0.86 likewise. Mean acidity value on 1st day was 0.73 which improved to 0.89. Highest mean value (0.85) was experienced in TP0 while smallest (0.77) was observed in TP3. Peak enlargement in acidity (22.68) was noted in TP0 while TP5 (13.95) demonstrated the lowest. The results of the current study are similar to the study of Anjum *et al*. (2000) [19] who observed an enlargement in acidity. In the same way raise in acidity was experienced by Khan *et al*. (2012) [17]. Ehsan *et al*. (2002) [18] noted swell in acidity of jam. Shakir *et al*. (2007) [16] examined the raise in acidity. The high acidity of jam might be due to hydrolysis of pectin and degradation of ascorbic acid. Raise in acidity also caused by a raise in TSS of jam [20].

Reducing sugars
Effect of storage gaps in reducing sugar is presented in **Table 4**. The values of reducing sugars from TP0 to TP5 at 1st day were 18.74, 18.71, 18.54, 18.56, 18.65, and 18.58. Reducing sugar of jam enlarged progressively (30.92, 30.86, 29.42, 28.65, 28.07, and 27.28). Mean value at 1st day was 18.63, which enlarged to 25.02. Treatments TP0 explained the highest mean value of 24.55 yet lowest of 22.26 was noted at TP5. Highest enlargement (39.39) was observed in TP0 whereas smallest of 31.89 was in TP5. Statistical examination revealed that reducing sugar of plum tamarind jam is notably affected by

treatments and storage gaps. Studying reducing sugar of jam during keeping period demonstrated growing tendency, thus proves current data [21]. Enlargement in reducing sugar is because of transfer of sucrose to glucose and fructose, due to temperature and acidic condition [22].

Non-reducing sugars

The non-reducing sugars condensed greatly on storage and treatments (**Table 5**). Practiced value from TP0 toTP5 at 1st day was 41.4, 43.1, 41.2, 45, 44.5, and 44.36 respectively, which diminished periodically to 21.56, 24.8, 24.26, 28.08, 29.77, and 31.54. The mean value for non-reducing sugar at 1st day was noted 43.26 which additional declined to 26.66. TP5 experienced the highest mean value (38.36) whereas TP0 showed the smallest (32.25). Treatment TP0 observed highest % declined (47.92) however TP5 (28.89) showed the minimum % decrease. The current data closely similar to the data of Riaz *et al*. (1999) [21] who noted reduce in non-reducing sugar of jam. Fall in non-reducing sugars was examined in grape and apple marmalade during keeping time [23]. Likewise, Shakir *et al*. (2007) [16] examined fall in non-reducing sugar. Swell in non-reducing sugar is because of transfer of sucrose to glucose and fructose, due to temperature and acidic condition [22].

Ascorbic acid

It was noted that ascorbic acid of jam condensed noticeably on treatments and storage (**Table 6**). Ascorbic acid content on 1st day from TP0 to TP5 were 32.10, 34.40, 34.87, 35.80, 37.13, and 37.80 respectively, which substantially decreased to 22.40, 24.98, 24.98, 26.15, 28.13, and 28.70. Mean ascorbic acid value of 35.35 was experienced at the 1st day which falls to 25.89. The highest mean value of 33.04 was recorded by treatment TP4 whereas the smallest mean value of 27.31 was observed at TP0. Highest fall of 30.21 was noted at TP0 whereas the lowest was recorded in TP5 (24.07). Ascorbic acid of Plum and Tamarind jam was notably changed during keeping time. Vitamin C content is highly sensitive to light. Ascorbic acid is a major nutrient which signifies a quality characteristic of produce and is great loss during processing and storage.

Color

Sensory values for the color of plum tamarind jam fall notably during keeping period (**Table 7**). On 1st-day color value of treatments from TP0 to TP5 was 7.7, 8, 8.1, 8.7, 8.7, and 8.8 which decreased drastically to 2.5, 4.6, 5.3, 6.2, 6.6, and 6.9. The mean score of color on 1st day was 8.3 which fall to 5.35. Highest value TP8 was recorded whereas the lowest was TP0 5.34. Peak decline 67.53 was examined in TP0 whereas least was recorded TP5 (21.59). Likewise, Khan *et al.* (2012) [17] inspected that color was diminished in jam. The color of food produce is a chief factor concerning client view. Throughout store time the color of jam was drastically changed.

Taste

Statistical values on behalf of judge's scores fall drastically (**Table 8**). The sensory digit for a taste of plum tamarind jam on 1st day was 7.1, 7.8, 8.8, 9.2, 9.1, and 9.2 from TP0 to TP5 which steadily reduced to (2.3, 4.9, 5.7, 6.2, 6.5, and 7.2). The mean taste scores on the 1st day of storage were examined 8.53 which largely fall to 5.46. The highest mean score for taste was noted in TP5 (8.37) while smallest was in TP0 (5.04). Peak fall 78.60% was experienced in $TP0_0$ whereas least 21.73 in TP5. The current data are related to the findings of Muhammad et al. (2009) [24] who also determined the decline in taste. Fall in taste digit might be due to variations in acids or decrease in pH [25].

Texture

Mean sensory values for the texture of jam diminished drastically (**Table 9**). On 1st day plum tamarind jam texture value from TP0 to TP5 was 7.9, 8, 8.1, 8.5, 8.6 and 8.7 which regularly decline to 3.8, 5, 5.3, 5.9, 6.3, and 6.8. Mean texture score on 1st day was experienced 7.84 which fall to 5.51. The highest score of 7.84 was noted in TP5 whereas the smallest 5.98 were in TP0. Peak fall in the texture of jam was noted in TP0 (51.89) whereas the lowest fall of 21.83% was examined in TP5. The current data are alike to the study of Suutarinen et al. (2000) [2] who determined regular fall in the texture of strawberry jam. This data for somewhat are lesser than the data of Ehsan et al. (2003) [23] who examined fall in the texture of marmalade.

Overall Acceptability

Overall suitability of jam condensed drastically on treatments and storage (**Table 10**). Overall acceptance of plum tamarind jam on 1st day from TP0 to TP5 were 7.8, 8, 8.2, 8.8, 9, and 9 which diminished to 3.6, 5, 5.4, 6.1, 6.6, and 7.1 during store era. Mean overall acceptance at 1st day was 8.46 which fall to 5.63. The highest score of 8.2 was examined in TP5 whereas least 5.85 were noted in TP0. Peak fall 53.84 was noted in TP0 whereas smallest fall 21.11 was noted in TP5. Overall tolerability of grape apple marmalade diminished, hence sustaining current data [23]. Khan *et al*. (2012) [17] also demonstrated alike answers of decline movement in general tolerability in jam.

Table 1: Influence of treatments and storage intervals on total soluble solids of Plum and Tamarind blended jam

Treatments	Storage intervals (Days)							% Increase	Means
	0	15	30	45	60	75	90		
T0	66.6	67	67.4	67.9	68.5	69.1	69.7	4.44	68.02
$T1_1$	66.4	66.7	67.1	67.7	68.3	69	69.8	4.87	67.85
T2	66.3	66.6	67	67.5	68.1	68.7	69.3	4.32	67.64
T3	66.5	66.8	67.1	67.5	68.1	68.7	69.3	4.04	67.71
T4	66.6	66.9	67.2	67.6	68.1	68.6	69.2	3.75	67.74
T5	66.5	66.7	67	67.3	67.7	68.1	69.6	4.45	67.55
Means	66.48	66.78	67.13	67.58	68.3	68.86	69.65		

Note: Mean followed by different letters or significantly different from each other.

Table 2: Influence of treatments and storage intervals on pH of Plum and Tamarind blended jam

Treatments	Storage intervals (Days)							% Decrease	Means
	0	15	30	45	60	75	90		
T0	3.9	3.97	3.94	3.9	3.86	3.82	3.78	3.07	3.88
T1	3.95	3.92	3.89	3.86	3.83	3.79	3.75	5.06	3.85
T2	3.93	3.91	3.88	3.85	3.82	3.78	3.74	4.83	3.84
T3	3.88	3.86	3.83	3.8	3.77	3.74	3.71	4.38	3.79
T4	3.89	3.8	3.85	3.82	3.79	3.76	3.73	4.11	3.80
T5	3.81	3.8	3.78	3.76	3.73	3.7	3.67	3.67	3.75
Means	3.89	3.87	3.86	3.83	3.8	3.76	3.73		

Note: Mean followed by different letters or significantly different from each other.

Table 3: Influence of treatments and storage intervals on the acidity of Plum and Tamarind blended jam

Treatments	Storage intervals (Days)							% Increase	Means
	0	15	30	45	60	75	90		
T0	0 .75	0 .78	0 .81	0 .84	0 .88	0 .92	0 .97	22.68	0.85
T1	0 .73	0 .75	0 .77	0 .8	0 .83	0 .87	0 .91	19.78	0.80
T2	0 .75	0 .77	0 .79	0 .82	0 .85	0 .88	0 .92	18.47	0.82
T3	0 .71	0 .73	0 .75	0 .77	0 .79	0 .82	0 .85	16.47	0.77
T4	0 .74	0 .76	0 .78	0 .8	0 .82	0 .85	0 .88	15.90	0.80
T5	0 .74	0 .75	0 .77	0 .79	0 .81	0 .83	0 .86	13.95	0.79
Means	.73	.75	.77	.80	.83	.86	.89		

Note: Mean followed by different letters or significantly different from each other.

Table 4: Influence of treatments and storage intervals on reducing sugar of Plum and Tamarind blended jam

Treatments	Storage intervals (Days)							% Increase	Means
	0	15	30	45	60	75	90		
T0	18.74	20.08	22.67	24.95	26.44	28.05	30.92	39.39	24.55
T1	18.71	20.43	22.37	24.15	26.37	28.62	30.86	39.37	24.50
T2	18.54	19.46	20.83	22.34	23.95	26.36	29.42	36.98	22.98
T3	18.56	19.69	21.12	22.83	24.55	26.48	28.65	35.21	23.12
T4	18.65	19.72	21.04	22.55	24.13	25.82	28.07	33.55	22.85
T5	18.58	19.36	20.41	21.78	23.26	25.17	27.28	31.89	22.26
Means	18.63	19.79	21.40	23.1	24.78	26.75	25.02		

Note: Mean followed by different letters or significantly different from each other.

Table 5: Influence of treatments and storage intervals on non-reducing sugar of Plum and Tamarind blended jam

Treatments	Storage intervals (Days)							% Decrease	Means
	0	15	30	45	60	75	90		
T0	41.4	39.28	36.2	32.95	29.28	25.11	21.56	47.92	32.25
T1	43.1	40.45	37.67	34.56	31.12	27.66	24.8	42.45	34.19
T2	41.2	39.64	37.05	34.17	30.92	27.65	24.26	41.11	33.55
T3	45	43.75	41.07	37.21	34.11	31.23	28.08	37.6	37.20
T4	44.5	42.78	40.38	39.05	35.83	32.55	29.77	33.10	37.83
T5	44.36	42.77	40.95	38.73	36.36	33.85	31.54	28.89	38.36
Means	43.26	41.44	38.88	36.11	32.93	29.67	26.66		

Note: Mean followed by different letters or significantly different from each other.

Table 6: Influence of treatments and storage intervals on ascorbic acid of Plum and Tamarind blended jam

Treatments	Vitamin C (Days)							% Decrease	Means
	0	15	30	45	60	75	90		
T0	32.10	30.80	28.183	27.4	25.60	24.70	22.40	30.21	27.31
T1	34.40	33.20	31.13	30.20	28.18	26.30	24.98	27.38	29.77
T2	34.87	32.70	31.14	29.70	27.30	25.77	24.98	28.36	29.49
T3	35.80	34.30	32.14	31.30	29.80	27.30	26.15	26.95	30.97
T4	37.13	36.70	34.86	33.30	31.30	29.90	28.13	24.13	33.04
T5	37.80	35.70	34.50	32.20	30.40	29.90	28.70	24.07	32.74
Means	35.35	33.73	31.99	30.68	28.76	27.31	25.89		

Note: Mean followed by different letters or significantly different from each other.

Table 7: Influence of treatments and storage intervals on the color of Plum and Tamarind blended jam

Treatments	Storage intervals (Days)							% Decrease	Means
	0	15	30	45	60	75	90		
T0	7.7	7.2	6.5	5.6	4.5	3.4	2.5	67.53	5.34
T1	8	7.6	7.2	6.8	6.1	5.4	4.6	42.5	6.52
T2	8.1	7.8	7.5	7.1	6.6	6	5.3	34.56	6.91
T3	8.7	8.4	8.1	7.7	7.3	6.8	6.2	28.73	7.74
T4	8.7	8.4	8.1	7.8	7.5	7.1	6.6	24.13	7.74
T5	8.8	8.6	8.4	8.1	7.8	7.4	6.9	21.59	8
Means	8.3	8	7.63	7.18	6.63	6.01	5.35		

Note: Mean followed by different letters or significantly different from each other.

Table 8: Influence of treatments and storage intervals on the taste of Plum and Tamarind blended jam

Treatments	Storage intervals (Days)							% Decrease	Means
	0	15	30	45	60	75	90		
T0	7.1	6.6	6	5.4	4.4	3.3	2.3	67.60	5.04
T1	7.8	7.5	7.1	6.7	6.2	5.6	4.9	37.17	6.54
T2	8.8	8.5	8.1	7.7	7.2	6.6	5.7	35.22	7.51
T3	9.2	8.9	8.5	8	7.5	6.9	6.2	32.60	7.88
T4	9.1	8.8	8.5	8.1	7.6	7.1	6.5	28.57	7.95
T5	9.2	9	8.8	8.5	8.2	7.7	7.2	21.73	8.37
Means	8.53	7.04	7.83	7.4	6.85	6.2	5.46		

Note: Mean followed by different letters or significantly different from each other.

Table 9: Influence of treatments and storage intervals on the texture of Plum and Tamarind blended jam

Treatments	Storage intervals (Days)							% Decrease	Means
	0	15	30	45	60	75	90		
T0	7.9	7.5	7	6.2	5.3	4.2	3.8	51.89	5.98
T1	8	7.7	7.3	6.8	6.3	5.7	5	37.5	6.68
T2	8.1	7.8	7.5	7.1	6.6	6	5.3	34.56	6.91
T3	8.5	8.2	7.9	7.5	7	6.5	5.9	30.58	7.35
T4	8.6	8.3	8	7.7	7.3	6.8	6.3	26.74	7.57
T5	8.7	8.5	8.2	7.9	7.6	7.2	6.8	21.83	7.84
Means	8.3	8	7.65	7.2	6.68	6.06	5.51		

Note: Mean followed by different letters or significantly different from each other.

Table 10: Influence of treatments and storage intervals on overall acceptability of Plum and Tamarind blended jam

Treatments	Storage intervals (Days)							% Decrease	Means
	0	15	30	45	60	75	90		
T0	7.8	7.3	6.8	6.1	5.3	4.1	3.6	53.84	5.85
T1	8	7.7	7.4	7	6.4	5.8	5	37.5	6.75
T2	8.2	7.9	7.5	7.1	6.6	6	5.4	34.14	6.95
T3	8.8	8.5	8.1	7.7	7.2	6.7	6.1	30.68	7.58
T4	9	8.7	8.4	8	7.6	7.1	6.6	26.66	7.91
T5	9	8.8	8.6	8.3	8	7.6	7.1	21.11	8.2
Means	8.46	8.15	7.8	7.36	6.85	6.21	5.63		

Note: Mean followed by different letters or significantly different from each other.

Conclusions

Jam was produced from plum tamarind pulp and was examined for physicochemical and organoleptic assessments at 15 intervals for 90 days. It was confirmed that storage has great influence on the quality of plum tamarind jam. From the study of various factors, it was determined that treatment TP_5 plum, tamarind (5:5) followed by TP_4 plum, tamarind (6:4) were of fine qualities among the treatments during analysis of physicochemical and organoleptic properties.

The present research was conducted at room temperature; hence, further research should be carried out in a control storage condition. Additionally, microbial count during storage and effect of packaging materials on plum and tamarind jam are still the aspects to be revealed.

Conflict of Interest

All authors have disclosed no conflicts of interest.

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