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Original Research Article

FORMULATION AND DEVELOPMENT OF JAMS PRODUCT OF LOCAL FRUITS HAVING POTENTIAL NUTRITIONAL VALUE

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ABSTRACT

Apple, guava and strawberry are important fruits extensively grown in Pakistan. Owing to their considerable nutritional significance, often marketed as "super-fruits". Due to inappropriate handling, transportation and processing 40-45% of the fruits are spoiled. These losses of the seasonal surplus of the fruits can be avoided by processing and preserving the fruit into different products like mixed jam, juice, nectar and jelly. Keeping in view the perishable nature of fruits, current study was designed with an objective to prepare different treatments of mixed jam having acceptable quality parameters as well as consumer acceptability. For this purpose, five treatments of jam were prepared at laboratory scale. After preliminary analysis of fruits, all the five treatments were analyzed for physico-chemical (pH, TSS, Titratable acidity, reducing sugars and non-reducing sugars), and sensory analysis for an interval of 7 days during 1 month storage period. The results of different treatments of jam showed a highly variable trend. pH, non-reducing sugars and all sensory parameters showed a decreasing trend during storage. Opposite is the case with acidity, total soluble solids, as well as reducing sugars. Sensory analysis indicated that the order of preference for jam treatments was $T_4>T_3>T_2>T_0>T_1>T_5$. Study suggests that losses in fresh fruits can be curtailed by processing it into mixed jam.

Keywords: Apple fruit, Jam, Nutritional Value, seasonal fruits

INTRODUCTION

The perishable fruit and vegetables are provided in large quantities during specific duration of the year in various parts of the country and are wasted in huge amount due to the lack of facilities and knowledge about their proper handling, storage, distribution and marketing. Quality of fruits in pre and post-harvest influences the consumer acceptance. The changes that occur in chemical and physical attributes determine the quality and in turn the economic returns to the producers and processors. Post-harvest losses in fruits and vegetables (F/V) are estimated to nearly 40-45% due to simple methods of preservation, processing and transport to other places. Fruit processing is vitally important and necessary when it ensure good return to the producer. As well as, it also helps to mitigate the problem of unemployment during off-seasons in the agricultural sectors. Food preservation has played a considerable role in the better utilization and conservation of vegetables and fruits in order to avoid the glut and utilize the extra during the offseason. It is important to apply latest methods to increase shelf life for proper distribution and process to preserve them for use in the offseason.

At present, there is a significant demand for fresh fruits and their processed products. As several kinds of fruits are seasonal and have limited shelf life, their processing becomes necessary to keep the quality (1). The fatalities of the cyclic surplus of the guava fruit can be avoided by processing and preservation skills at both farmer and industrial level. If guava fruits are not preserved appropriately they cannot be held in reserve for long time. So, products from these are not accessible in the market. Therefore some appropriate techniques are required to be developed for preserving these fruits into various products that could be made accessible all the year round for the consumers as

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well as for producers use. Consequently it will benefit both producer and consumer (2). One of the popular methods to preserve perishable fruits is jam processing (3). Apple jam is a product that is prepared from the processing of the edible portion of apple fruit mixed with water, sugar, pH adjusters, jellifying agents, and other additives. It is heat processed till reached the desired consistency and packed for storage (4).

Commercial preservation of fruit jams is subject to standard formulations of fruit type, sugar content, pectin content and adjusted acidity. Jam is defined as a semisolid food made from not more than 55% sugar and 45 % fruit (5). Flavoring and coloring agents may be added. Pectin and acid may be added to meet the deficiencies that occur in the fruit itself. Standards for formulations are developed according to their end product utilization, preferences of consumer, demand in market, food laws, buyer's specifications and economic utilization of inputs required.

Realizing the importance of fruits, their cost, nutritious value, perishable nature and seasonal availability, it was decided to develop a jam for human consumption throughout the year.

The study in this project was planned to check the acceptability of apple jam supplemented with strawberry and guava fruit and to assess its nutritional value for maximum conservation and better utilization of strawberry and guava fruit to avoid glut.

MATERIALS AND METHODS

Procurement of raw material

Fully ripened apple, strawberry and guava were procured from local market of Sargodha, Pakistan. Fruits which were used for the preparation of jam were free of damage, diseases and insect attack, and with no sign of fermentation, etc.

Other raw materials (sugar, pectin, citric acid, sodium benzoate, lids, and glass bottles) were procured from the local market of Lahore, Pakistan.

Preparation of apple, strawberry and guava pulp

The fruits were washed with tape water to remove any adhering foreign material. Peel was removed manually with the help of steel knife. Apple and guava were cut into two halves to remove the stones. Fleshy part of the fruits were cut into small pieces and pulp was extracted by electric blender by adding measured amount of water (50 % weight of fruits) to facilitate pulping operation. Fruit pulp was passed through a fine mesh (0.3 mm) to remove any foreign matter or pieces of peel.

Finally the pulp obtained from these three fruits were filled in pre-sterilized air tight PET bottles for further use and processing for making mix fruit jam.

Preparation of mix fruit jam

Mix fruit jam was prepared according to the formulations as given in the Table 1. Fruit pulps were taken in different kettles according to formula to prepare different treatments. About 75 % sugar and total citric acid was added at the start of pulp cooking. The rest of sugar was added with pectin when soluble solids of the mixture reached to 55° brix. Sodium benzoate was used as preservative and was added near the end point. The blend was cooked to about 68° Brix. Jam was filled in pre-sterilized wide mouth glass jars. The jars were allowed to cool and molten wax was applied at the top of each jar. Then the jars were closed with lids. The jars were labeled and stored for 28 days at room temperature at the laboratory shelf. The jam was offered for sensory evaluation to a panel of 20 semi trained judges comprising faculty members, M-Phil and Ph.D students.

Table 1. Different formulations used for the preparation of mix fruit jam

Treatments	Apple pulp (mL)	Strawberry pulp (mL)	Guava pulp (mL)	Sugar (g)	Pectin (g)	Citric acid (g)	Sodium Benzoate (g)	Color (g)
T0	1000	0	0	850	10	10	2	1
T1	0	1000	0	850	10	10	2	1
T2	0	0	1000	850	10	10	2	
T3	333.3	333.3	333.3	850	10	10	2	1
T4	750	120.5	120.5	850	10	10	2	1
T5	500	250	250	850	10	10	2	1

Determination of pH

The pH of the mix fruit jam was measured using a pH meter (Hanna Model 8520, Italy) as described in AOAC (6).

Determination of titrable acidity (TA)

Titratable acidity (%) of the jams was measured by the method no. 942.15 as described in AOAC (6). 25 g sample was taken in a 400 mL beaker, in which 200 mL hot water was added and boiled for 20 minutes. Then the boiled solution was transferred to 250 mL volumetric flask, cooled and volume was made to the mark. The solution was filtered through What-man No. 41 filter paper and this filtrate was then used to determine the total titratable acidity.

50 mL aliquot from the filtrate was taken into 250 mL beaker, in which 100 mL water was added with addition of 2-3 drops of phenolphthalein. The solution was titrated against 0.1 N NaOH to faint pink color end point that persisted for 30 seconds. The volume of NaOH used was noted and multiplied with the citric acid factor (0.064) to get the value of acid (in grams per 100 mL).

The acidity of the sample was calculated as percent by using the following formula.

$$\% \text{ Titratable acidity} = \frac{1}{10} \times \frac{\text{Equiv. wt of acid} \times \text{Normality of NaOH} \times \text{titer}}{\text{Wt. of sample}}$$

Determination of total soluble solids (TSS)

Total soluble solids were measured by hand-refractrometer and corrected to the equivalent reading at 20^{o} C as stated in AOAC (6).

Determination of reducing and total sugars (TS)

Reducing and total sugars were determined according to Lane and Eynon method as described in method No. 925-36 of AOAC (6).

Sensory characteristics

Mix-fruit jam was evaluated by a panel of twenty semi-trained judges including teaching staff and students, through nine point hedonic scale ranking method after 0, 7, 14, 21 and 28 days of storage at room temperature for sensory attributes as color, flavor, taste, texture and overall acceptability as described by Larmond (7). Six coded samples and score sheet was also provided to each judge to record their judgment.

Statistical analysis

Statistical analyses were performed by using Minitab statistical software (version 16,

Minitab Inc., State College, PA, USA) and by using two way analyses of variance (ANOVA) and Fisher's Least Significant Difference (LSD) test (LSD) multiple comparison test. Treatments of mix fruit jam (random variable), age/ storage period of mix fruit jam (fixed variable) and interaction between treatments and age were used as classification factors in the statistical model. All determinations for chemical analyses were carried out in triplicates. For all comparisons, the level of significance was set to $P< 0.05$.

RESULTS AND DISCUSSION

Effect of treatments and storage period on the pH

The results regarding pH are given in Table 2. The highest pH was observed in the samples of T_4 (4.05) while the minimum was observed in the samples of T_0 (3.58). The results showed that the pH of the treatments was affected significantly during storage time of mix fruit jam. Treatments showed a decreasing trend during storage (Table 2). The pH of mix fruit jam during storage time ranged between 4.05-3.58. The results regarding the decrease in pH during storage time are in accordance with Hussain and Shakir (8) and Safdar *et al*. (9).

Table 2. Effect of treatments and storage on pH of mix fruit jam

Days	T0	T1	T2	T3	T4	T5
0	3.70	3.78	3.99	4.04	4.05	4.01
7	3.67	3.75	3.96	3.91	3.99	3.95
14	3.65	3.73	3.91	3.86	3.94	3.89
21	3.61	3.69	3.87	3.71	3.91	3.78
28	3.58	3.64	3.82	3.68	3.88	3.71
MEANS	3.64f	3.71e	3.91b	3.84d	3.95a	3.86c

Effect of treatments and storage period on the titratable acidity

The results regarding titratable acidity are presented in Table 3. The highest titratable acidity value was observed in the samples of T_0 while the minimum was observed in the samples of T_5. The results showed that treatments were highly significantly during storage time of mango-mandarin squash. Treatments showed an increasing trend during storage (Table 3). The acidity of mix fruit jam during storage time ranged between 0.85-0.51. The increase in acidity might be attributed due to acid formation, degradation of polysaccharides and oxidation of reducing sugars or by break down of pectin in to pectenic acid. The results regarding the increase in acidity during storage time are in accordance with the findings of Shakir *et al*. (10) and Hussain and Shakir (8).

Table 3. Effect of treatments and storage on titratable acidity of mix fruit jam

Days	T0	T1	T2	T3	T4	T5
0	0.64	0.60	0.59	0.56	0.55	0.51
7	0.67	0.62	0.60	0.57	0.58	0.55
14	0.71	0.67	0.65	0.61	0.64	0.58
21	0.76	0.72	0.69	0.67	0.68	0.64
28	0.85	0.83	0.80	0.77	0.73	0.70
MEANS	0.726a	0.688b	0.666c	0.636d	0.636e	0.596f

Effect of treatments and storage period on the total soluble solids (TSS)

The results regarding TSS are presented in Table 4. The highest TSS value was observed in the samples of T_0 (70.12), whereas, the minimum value was observed in the samples of T_3 (60.89). The results showed that treatments were highly significant during storage time of mix fruit jam. Treatments showed an increasing trend during storage time (Table 4). The TSS of mix fruit jam during storage time ranged between 70.12-60.89. The jams having high value of TSS indicated that they have more sugar contents. Safdar *et al*. (9) also found a gradual increase in total soluble solids content of mango jam throughout the storage period of 150 days. Muhammad *et al*. (11) developed diet apple jam using different nonnutritive sweeteners and reported that TSS of diet jam significantly

increased from 11.54 to 17.70 during 90 days storage.

Table 4. Effect of treatments and storage on total soluble solids (TSS) of mix fruit jam

Days	T0	T1	T2	T3	T4	T5
0	67.12	63.50	62.11	60.89	64.78	61.09
7	68.01	63.99	64.30	61.99	65.78	64.35
14	69.11	65.47	65.70	63.44	65.79	65.87
21	70.12	66.98	65.58	65.89	67.34	66.87
28	71.23	67.57	66.93	67.94	69.32	68.97
MEANS	69.11a	65.50c	64.92e	64.03f	66.60b	65.43d

Effect of treatments and storage period on the reducing sugars (RS)

The results regarding RS are given in Table 5. The highest RS was observed in the samples of T_5, whereas, the minimum value was observed in the samples of T_0. The results showed that treatments were highly significant during storage time of mix fruit jam. Treatments showed increasing trend during storage time (Table 5). The RS of mix fruit jam during storage time ranged 16.11-36.66. These results are in accordance with Shakir *et al*. (12) who found an increasing trend in reducing sugar of apple and pear mixed fruit jam during storage interval of 90 days. They found that reducing sugar content was increased from 16.62 to 42.99 after 90 days storage. Similarly, Riaz *et al*. (13) recorded an increasing tendency in reducing sugars of jam prepared from strawberry fruit during 3 months storage. The increase in reducing sugars may be owing to the inversion of non-reducing sugars *i.e.* sucrose to reducing sugars *i.e.* glucose and fructose in storage. The inversion of non-reducing sugar might be because of the presence of acids for instance citric and malic acids which together with elevated temperatures speed up the inversion process. Increase in reducing sugar may also be due to prolong storage and hydrolysis of sugars with increase in acidity and decrease in pH.

Table 5. Effect of treatments and storage on reducing sugar (RS) of mix fruit jam

Days	T0	T1	T2	T3	T4	T5
0	16.51	16.06	16.22	16.45	16.44	16.11
7	17.65	19.86	21.50	20.17	21.01	20..03
14	18.06	23.67	26.64	26.72	24.26	23.76
21	20.86	26.75	31.76	30.98	30.70	30.65
28	24.01	32.02	36.24	36.66	37.22	35.92
Means	19.418c	23.672b	26.472a	26.196a	25.926a	26.610a

Effect of treatments and storage period on the non-reducing sugars

The results regarding RS are given in Table 6. The highest RS was observed in the samples of T_1, whereas, the minimum value was observed in the samples of T_2. The results showed that treatments were highly significant during storage time of mix fruit jam. The mean values of non-reducing sugars for storage periods decreased from 44.77 to 28.78 at 0 and 28 days respectively. Decrease in non-reducing sugar may be because of the conversion of non-reducing sugar to reducing sugar.

Muhammad *et al*. (11) who found that the means value of non-reducing sugar of diet apple jam significantly ($p<0.05$) decreased from 7.33 at 0 day to 3.46 at 90 days. The results are also in agreement with Hussain and Shakir (8) for non-reducing sugars of apricot jam who found a decrease in non-reducing sugar content from 43.20 at initial day to 19.46 at 60th day.

Table 6. Effect of treatments and storage on non-reducing sugar of mix fruit jam

Days	T0	T1	T2	T3	T4	T5
0	45.42	46.02	43.20	44.10	44.24	45.67
7	42.40	40.80	37.09	38.89	39.67	41.34
14	38.20	37.11	31.69	33.92	35.02	37.21
21	34.30	38.89	26.78	34.78	30.50	31.99
28	28.20	39.28	20.52	30.60	24.88	29.20
Means	37.704b	40.420a	31.856e	36.458c	34.862d	37.082b

Effect of treatments and storage period on the sensory characteristics

The results regarding sensory characteristics are presented in Table 7. The sensory evaluation score showed that treatment T_4 was highly acceptable as tested by the sensory panel even after 28 days storage. The maximum score for color was observed in the samples of T_4, whereas, the minimum score was observed in the samples of T_5. The treatments showed a decreasing trend for color during storage. The score for color of mix fruit jam during storage ranged between 7.30 to 6.79 at 0 and 28 days respectively showing a significant effect of storage on color of jam. The color of fruit pulp tends to decrease periodically. Change in flavor is supposed to be due to change in the flavoring compounds that are usually destroyed during storage. There was a significant effect of different storage intervals on flavor of jam treatments. However, there was a non-significant effect of treatment and storage interaction on flavor of jam (Table 8). During processing the heat is applied that is also a cause in the reduction of flavor. Reduction in taste all through storage may be due to the instability in pH, acids and sugar/acid ratio.

Table 7. Effect of treatments and storage on color of mix fruit jam

Days	T0	T1	T2	T3	T4	T5
0	7.28	7.34	7.37	7.32	7.56	6.96
7	7.17	7.2	7.28	7.21	7.34	6.56
14	7.05	7.12	7.16	7.01	7.25	6.30
21	6.94	7.04	7.08	6.97	7.12	6.12
28	6.85	6.89	6.97	6.91	7.14	6.01
Means	6.9e	7.1c	7. 2b	7.0d	7.3a	6.4f

Table 8. Effect of treatments and storage on flavor of mix fruit jam

Days	T0	T1	T2	T3	T4	T5
0	7.38	7.16	7.46	7.51	7.76	7.34
7	7.26	7.03	7.41	7.36	7.57	6.88
14	7.18	6.99	7.32	7.28	7.48	6.82
21	7.04	6.91	7.15	7.14	7.36	6.76
28	6.92	6.87	7.01	6.92	7.19	6.64
Means	7.1d	6.9e	7.3b	7.2c	7.5a	6.8f

Flavor is the blend of taste and smell perceptions, it is judged when the food is in the mouth. The overall flavor impression is the result of the tastes perceived by the taste buds in the mouth and the aromatic compounds detected in the nose (14). The maximum score for flavor was found in the samples of T_4, whereas, the minimum score was observed in the samples of T_5. The treatments showed a decreasing trend during storage. Bajwa *et al.* (15) who recorded a reduction in flavor of grapefruit apple marmalade during storage study of 60 days. They observed that mean values for flavor of marmalade decreased from 8.84 at initial day to 8.00 at 60 days. Similarly, Inam *et al.* (16) found a reduction in flavor of mixed fruit marmalade during 6 months of storage.

The maximum score for taste was observed in the samples of T_4, whereas, the minimum score was observed in the sample of T_5 (Table 9). The treatments showed a decreasing trend for taste during storage. The score for taste of mix fruit jam during storage ranged between 7.23 to 6.63 at 0 and 28 days respectively showing a significant decrease in taste of jam during storage.

Table 9. Effect of treatments and storage on taste of mix fruit jam

DAYS	T0	T1	T2	T3	T4	T5	MEANS
0	7.81	6.96	7.26	7.08	7.84	6.47	7.23a
7	7.56	6.62	6.68	7.01	7.75	6.38	7.00b
14	7.48	6.35	6.37	6.95	7.62	6.26	6.83c
21	7.34	6.19	6.26	6.84	7.52	6.18	6.72d
28	7.22	6.11	6.23	6.75	7.44	6.03	6.63e
MEANS	7.5b	6.4e	6.6d	6.9c	7.6b	6.3f	

The maximum score for overall acceptability was observed in the samples of T_4, whereas the minimum score was observed in the sample of T_5 (Table 10). The treatments showed a decreasing trend during storage. The score for overall acceptability of mix fruit jam during storage ranged between 7.37 to 6.89 at 0 and 28 days respectively showing a significant decrease in overall acceptability of jam during storage.

Table 10. Effect of treatments and storage on overall acceptability of mix fruit jam

Days	T0	T1	T2	T3	T4	T
0	7.28	7.33	7.39	7.24	7.81	7.1
7	7.24	7.26	7.21	7.13	7.69	7.0
14	7.17	7.19	7.01	6.98	7.51	6.9
21	7.09	7.04	6.93	6.64	7.47	6.8
28	7.03	6.92	6.79	6.45	7.35	6.8
Means	7.1d	7.0e	7.2c	7.4b	7.6a	6.9

CONCLUSION

The perishable fruits and vegetables are available as seasonal surplus during certain parts of the year in different regions and are wasted in large quantities due to the absence of facilities. Fruits and vegetables are for want of simple technologies of processing, preservation and transport to various places of need have suffered post-harvest losses, estimated to nearly 40-45%. The results related to total soluble solids of jam showed an increasing trend with increasing storage days. There was a significant effect of storage period on total soluble solids of jam while it was non-significant among different treatments. The pH of jam showed a decreasing trend with increase in storage days. The acidity of jam treatments increased during storage due to decrease in pH. In conclusion the development of different treatments of mixed fruit jam at laboratory scale indicated that fruits can be best preserved by its processing into jam.

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