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Evaluation of quality characteristics and storage stability of mixed fruit jam

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Abstract

Diversification of food is the key factor for enhancing physicochemical properties, nutritional status and consumer satisfaction. Hence, mixed fruits jam was developed from coconut and pineapple pulps in varied ratios (1:1, 3:1 and 1:3). Moisture, lipid, protein, fiber, ash and total carbohydrate contents of different jam samples varied significantly ($p \leq 0.05$) and found values in the ranges 26.78-29.15%, 4.12-10.81%, 0.56-1.13%, 1.51-3.12%, 0.30-0.37% and 62.69-67.91% respectively. Storage stability of the jam samples was analyzed for 6 months keeping under refrigerated (4°C) and room (30°C) temperatures. Physicochemical properties such as total soluble solids, acidity, pH and reducing sugar content were evaluated at 2-months intervals. The parameters were changed variedly due to compositional variances, packaging materials and storage temperatures. Total soluble solids, acidity and reducing sugar content increased gradually while pH declined upon extension of storage period. Sensory properties for color, taste, flavor, texture and overall acceptability of jam samples were tested where sample with pineapple and coconut in the ratio 3:1 showed the best result than others. Samples were also analyzed for yeast and mold count at the end of the storage period and positive result was found in case of samples packed in plastic containers kept under room temperature. The study yields diversified jam samples with better nutritional and sensory properties with satisfactory shelf life.

1. Introduction

Jam is a popular food item due to its low cost and high organoleptic profiles (Gałkowska *et al.,* 2010). Jam should contain approximately 67-68% total soluble solids (TSS) along with 45% fruit pulp at least, while according to the 'Codex Alimentarius Commission' jam need to contain TSS approximately greater than 65% (Baker *et al.,* 2005). It tends to apprehend shape, but normally less firm compared to jelly. Jam has prolonged shelf life so that it can be available round the year. Production of jam requires ingredients (fruit pulp, acid, pectin and sugar) of correct quantities for having desired finished product. Raw material quality and process of manufacturing are the exponents to the quality of finished goods (Nindo *et al.,* 2005). Citric acid is considered necessary to create a network between sugar and pectin, which is needed to form jam. Sugar functions as a dehydrating agent that makes a closer connection between molecules (Suutarinen, 2002). Pectin is purified polysaccharide generally extract from the peel of citrus fruits. Pectin is a thickening agent since it brings changes in the texture and flow behavior of the finished product (Javanmard and Endan, 2010).

Coconut palm is one of the economically important trees. Several traditional foods are processed from coconut due to its admissibility, quality and mercantile viability (Kumar *et al.,* 2007). The major fatty acid of coconut is Lauric acid which has antibacterial, antiviral and antiprotozoal functions. Coconut pulp consists of soft flesh and sweet redolent juice. It contains a high content of minerals as iron, phosphorus and zinc. Coconut pulp can be used to process food preserves such as jam.

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Pineapple is popular torrid regional fruit under the family Bromeliaceae (Coppens *et al.,* 2003) which is consumed as fresh, juice, candies, cooked foods and incorporated with desserts (Ackom and Tono-Debrah, 2012). It is a rich principium of dietary fiber, minerals and vitamins, particularly manganese and vitamin C (Ackom and Tono-Debrah, 2012). Moreover, it provides an array of organoleptic attributes like color, mouthfeel, flavor, texture etc. which give the delectation of consumption (Othman, 2011).

Sensory science is a discipline to measure and evaluate people's appeal to products perceived through the 5 senses such as sight, smell, touch, taste and sound. In food product development, sensory evaluation not only provides a clear understanding of consumer acceptability but also reduces the risk of product failure.

Mixed jam associates the characteristics of two or more fruits with better nutritional status and excellent sensory profile. The purpose of the study is to utilize coconut pulp in association with pineapple pulp to fulfill the following objectives: to prepare mixed fruits jam from coconut and pineapple, to evaluate the physicochemical properties and sensory attributes of the prepared mixed fruits jam, and to analyze the storage stability of mixed fruit jam under room and refrigerated conditions using different packaging materials.

2. Materials and methods

2.1 Collection of raw materials

The experimental samples coconut, pineapple (Honey Queen), sugar, citric acid and pectin were collected from Mymensingh and Jashore, Bangladesh regional market. Analytical grade reagents were used for testing.

2.2 Formulation of mixed fruits jam

Three mixed fruit jam samples M, CP and PC were prepared with different fruit pulp combinations as presented in Table 1.

Table 1. Mixed fruit jam formulations

Sample	Fruit pulp concentration	
	% Coconut	% Pineapple
M	50	50
PC	25	75
CP	75	25

2.3 Preparation of mixed fruits jam

At first Fruits pulp were mixed in standardized proportions. 45% fruits pulp, 55% sugar along with 1% pectin were mixed in a stainless-steel pan. The mixture was heated and stirred under a low flame gas stove. 1% citric acid was added when the mixture attained TSS to 60°Brix. Heating was postponed when TSS of the concentrate reached to 67- 68°Brix. Finally, the hot finished good was filled in sterilized glass and plastic containers.

2.4 Proximate composition analysis of fruits and jam samples

Moisture, ash, fat, protein and fiber content of fresh fruits and prepared jam samples were analyzed as per AOAC (2016) method. Total carbohydrate content was calculated according to Pearson (1970), i.e. total carbohydrate = 100 - (protein + fat + ash + moisture). Triplicate determination was followed and outcomes were represented as the mean ± standard deviation.

2.5 Storage stability of jam

Jam samples were packed in glass and plastic containers and total soluble solids (TSS), acidity, pH and reducing sugar contents were tested for a period of 6 months at 2 months intervals keeping under room (30°C) and refrigeration (4°C) temperature. TSS was measured by digital refractometer (Model: DR 301-95, A. KRUSS Optronic Company, Germany), pH was tested using pH meter (Model: PH500, CLEAN Instruments Co. Ltd., Shanghai, China), titratable acidity and reducing sugar of jam was analyzed according to AOAC (2016) method.

2.6 Yeast and mold count

Colony forming units (CFU) of yeast and mold were counted using standard plate count (SPC) method. Potato Dextrose Agar was used as media and plates were decorated by the pour plate method. Distilled water was dispensed 9 mL into 10 tubes and sterilized in an autoclave. Jam samples were used in several dilutions to have CFU in the range 20-200. The sterilized potato dextrose agar was poured on Petri dishes along with 10% tartaric acid. Then pouring was done with sample of several dilutions and gently mixed for ensuring that the medium covered the plate evenly. After that the agar gel was allowed to solidify and the petri dishes were sealed with lids. The plates were then incubated at inverted position at 30°C for 72 hrs.

2.7 Organoleptic test

The organoleptic properties of all samples for color, flavor, taste and overall acceptability were analyzed by 9 -point hedonic rating test using a panel team consisting of 10 trained members (Begum *et al.,* 2018).

2.8 Statistical analysis

The obtained data were analyzed using Microsoft Office Excel 2013 for standard deviation, single factor and two factor Analysis of Variance (ANOVA). Fisher's LSD Multiple Comparison Test procedures of the Method of Statistical (MSTAT) system was performed to determine the significant difference among the various samples by taking 5% level of significance according to Gomez and Gomez (1984).

3. Results and discussion

3.1 Proximate composition of coconut and pineapple

Proximate composition of coconut and pineapple are represented in Table 2.

The highest moisture and carbohydrate content were found in the case of pineapple (86.28% and 12.61%) than coconut (51.93% and 10.47%). On the contrary, coconut contained highest protein (3.24%), fat (33.45%) and ash (0.89%) content than pineapple (0.53%, 0.19% and 0.47%). Nutritional status of pineapple and coconut is nearly similar as proposed by Unaegbu *et al.* (2016) and Amarasiri *et al.* (2006) respectively.

3.2 Proximate composition of mixed fruit jam samples

Chemical composition of jam samples is represented in Table 3.

The moisture content of the sample PC was higher (29.15%,) followed by the sample M (28.52%). The lowest moisture content was found in the case of sample CP (26.78%). Moisture content variations observed might be because of the heating process involved in processing. Water removal during the processing of jam resulted in a change in the concentration of food nutrients (Saka *et al.,* 2007). Moisture content has a greater impact on the shelf life of products (Eke-Ejiofor and Owuno, 2013). Inam *et al.* (2012) showed moisture content variation of mixed fruit marmalade in the range 26.63-27.71%, Naeem *et al.* (2017) in the range 31.23–33.36% and Mahdi *et al.* (2019) in the range 3.55-36.86%.

The crude fat percentage of jam samples were in the range 4.12-10.81%, where sample CP and PC showed the highest (10.81%) and the lowest (4.12%) values respectively. The data observed are comparable as claimed by Olugbenga *et. al.* (2018) for jam processed from a mixture of pineapple, banana and watermelon in the range 0.25-3.85%.

The crude protein content of the sample CP was the highest (1.13%), while sample PC gave the lowest value (0.56%). Naeem *et al.* (2017) reported crude protein content of different fruit jam samples in the range 0.27–0.41%. Eke-Ejiofor and Owuno (2013) showed protein content of pineapple and jackfruit mixed jam in the range 0.46-0.19% and Anuradha *et al.* (2017) claimed protein content of papaya and pineapple jam in the range 5.4-5.41%.

Fiber contents of the mixed fruit jam samples were significantly different from each other. Sample CP had the highest (3.12%), while sample PC had the lowest (1.51%) fiber content. Olugbenga *et al.* (2018) reported fiber content of jam processed from mixture of pineapple, banana and watermelon in the range 1.25-3.03%. Naeem *et al.* (2017) reported crude fiber content of different fruit jams in the range 0.09–0.54%.

Ash content of jam samples found in the range 0.30-

Table 2. Proximate composition of coconut and pineapple

Sample	Proximate composition (%)				
	Water	Protein	Fat	Ash	Carbohydrate
Coconut	51.93±0.18[b]	3.24±0.07[a]	33.45±0.095[a]	0.89±0.031[a]	10.47±0.222[a]
Pineapple	86.28±0.132[a]	0.53±0.045[b]	0.19±0.007[b]	0.47±0.015[b]	12.61±0.177[b]

Values are expressed as mean±standard deviation of three replicates. Values with the same superscript within column indicates no significant difference (p>0.05).

Table 3. Proximate composition of jam samples

Proximate composition (%)	Jam sample		
	M	PC	CP
Moisture	28.52±0.131[b]	29.15±0.192[a]	26.78±0.12[c]
Crude Fat	7.59±0.035[b]	4.12±0.04[c]	10.81±0.05[a]
Crude Protein	0.86±0.025[b]	0.56±0.015[c]	1.13±0.025[a]
Crude Fiber	2.31±0.036[b]	1.51±0.042[c]	3.12±0.035[a]
Ash	0.34±0.015[ab]	0.30±0.0159[b]	0.37±0.008[a]
Total Carbohydrate	62.69±0.136[b]	65.86±0.208[a]	67.91±0.049[c]

Values are expressed as mean±standard deviation of three replicates. Values with the same superscript within row indicates no significant difference (p>0.05).

0.37%. Sample CP had the highest ash content (0.37%) followed by the sample M (0.34%), while sample PC had the lowest value (0.30%). Ash content of different samples is comparable to the works reported by Monika *et al.* (2018) in the range 0.32-0.34% and Naeem *et al.* (2017) in the range 0.12–0.25%.

Sample CP showed the highest carbohydrate content (67.91 %) compared to the sample PC (65.86%) and sample M (62.69%). Naeem *et al.* (2015) reported total carbohydrate content of different fruit jams in the range 65.99–67.65%, Olugbenga *et al.* (2018) reported carbohydrate content of jam prepared from a mixture of pineapple, banana and watermelon in the range 70.62-85.32%. So, our found data are correlated with other researchers.

3.3 Change of physicochemical characteristics of mixed fruit jam during storage

3.3.1 Total soluble solids (TSS)

Primary TSS of sample M, PC, CP were 67.0°Brix, 67.7°Brix, 67.5°Brix which increased to 69°Brix, 68.9° Brix, 69°Brix; and 68.5°Brix, 68.8°Brix, 68.7°Brix when packed in glass container stored under room and refrigeration temperature respectively. Again, TSS increased to 68.9°Brix, 68.7°Brix, 68.8°Brix; and 68.3° Brix, 68.4°Brix, 68.6°Brix when packed in plastic container stored under room and refrigeration temperature respectively (Figure 1). The possible cause of raising of TSS due to the formation of mono and disaccharides resulted from hydrolysis of polysaccharides (Satkar *et al.,* 2012). An incessant increase in TSS of jam during storage stability evaluation was reported by several workers such as Sindumathi and Amutha (2014) for coconut-based jam, Inam *et al.* (2012) for mixed fruit marmalade and Patel *et al.* (2015) for banana - pineapple blended jam.

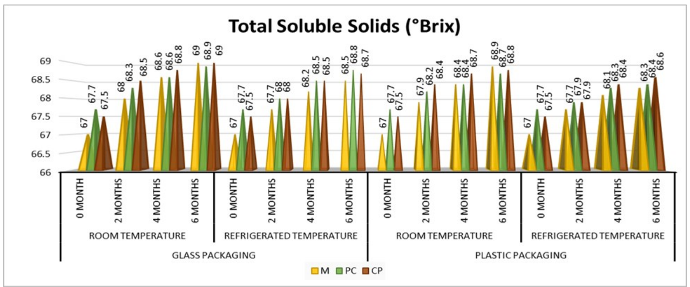

Figure 1. Change of TSS of jam samples during storage

3.3.2 Acidity

Initial acidity of sample M, PC, CP were 0.55%, 0.65%, 0.53% which increased to 0.74%, 0.85%, 0.78%; and 0.68%, 0.79%, 0.7% when packed in glass container stored under room and refrigeration temperature respectively. Again, acidity increased to 0.73%, 0.85%, 0.78%; and 0.68%, 0.79%, 0.7% when packed in plastic container stored under room and refrigeration temperature respectively (Figure 2). The results are comparable to the works of Inam *et al.* (2012) for mixed fruit marmalade, Sindumathi and Amutha (2014) for coconut-based jam, Hussain and Shakir (2010) for apricot apple mixed fruit jam and Anuradha *et al.* (2017) for Paniol fruit jam and jelly

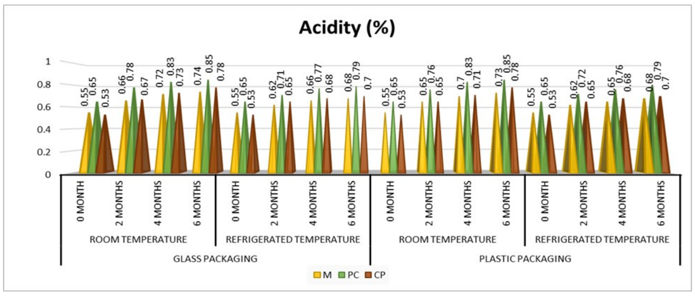

Figure 2. Change of acidity of jam samples during storage

3.3.3 pH

Initial pH of sample M, PC, CP were 2.96, 2.92, 2.97 which decreased to 2.87, 2.83, 2.85; and 2.91, 2.85, 2.89 when packed in glass container stored under room and refrigeration temperature respectively. Again, pH decreased to 2.87, 2.83, 2.85; and 2.91, 2.83, 2.89 when packed in plastic container stored under room and refrigeration temperature respectively (Figure 3). The outcomes are correlated with the works of Inam *et al.* (2012) for mixed fruit marmalade, Sindumathi and Amutha (2014) for coconut-based jam.

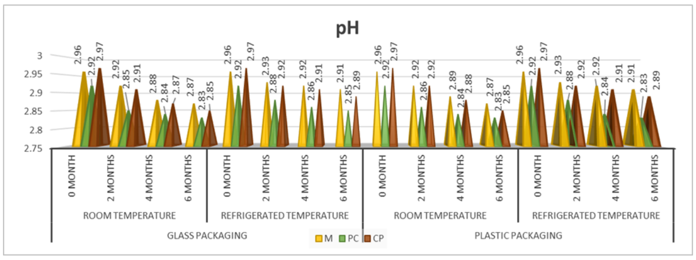

Figure 3. Change of pH of jam samples during storage

3.3.4 Reducing sugar

Reducing sugar quantity of jam samples gradually rise with the prolonged storage period. It was observed that raising of reducing sugar level for the samples stored under refrigerated temperature was considerably lower than the samples of room temperature. Reducing sugar content of the sample M, PC, CP were 16.76 (g/100 g), 16.22 (g/100 g), 17.1 (g/100 g) which increased to 18.12 (g/100 g), 18.08 (g/100 g), 18.13 (g/100 g); and 17.8 (g/100 g), 18.02 (g/100 g), 17.95 (g/100 g) when packed in glass container stored under room and refrigeration temperature respectively. Again, reducing sugar content increased to 18.06 (g/100 g), 17.95 (g/100 g), 18.02 (g/100 g); and 17.65 (g/100 g), 17.73 (g/100 g), 17.86 (g/100 g) when packed in plastic container stored under room and refrigeration temperature respectively (Figure 4). Similar kind of results was reported by Sindumathi and Amutha (2014) for coconut-based jam, Hussain and Shakir (2010) for apricot and apple jam and Vidhya and Narain (2011) for wood apple fruit preserve. Raising of reducing sugar content of jam samples might be because of formation of glucose and fructose resulted from inversion of disaccharides such as sucrose.

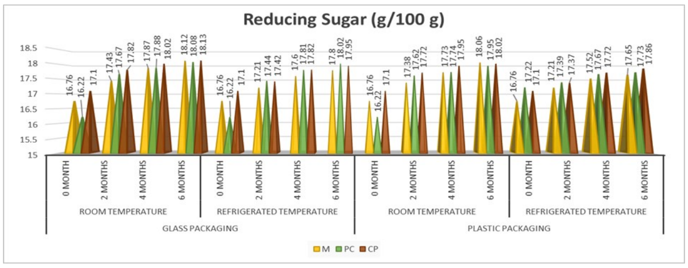

Figure 4. Change of reducing sugar of jam samples during storage

3.4 Organoleptic test

There was significant difference in preference of color, flavor, taste and overall acceptability among the different samples as represented in Table 4.

Table 4. Sensory evaluation of jam

Proximate composition (%)	Jam sample		
	M	PC	CP
Color	8.1±0.738[ab]	8.8±0.422[a]	7.7±0.483[b]
Taste	8.2±0.632[ab]	8.7±0.483[a]	7.9±0.738[b]
Texture	7.6±0.516[a]	7.3±0.483[ab]	6.9±0.738[b]
Flavor	8.4±0.699[ab]	8.5±0.707[a]	7.8±0.632[b]
Overall acceptability	8.1±0.738[ab]	8.5±0.527[a]	7.71±0.483[b]

Values are expressed as mean±standard deviation of three replicates. Values with the same superscript within row indicates no significant difference ($p>0.05$).

Sample PC secured the highest scores in case of color (8.8±O.422), taste (8.7±0.483), flavor (8.5±0.707) and overall acceptability (8.5±0.527), while in case of texture sample M showed the highest score (7.6±0.516). On the contrary, sample CP showed the lowest scores for color (7.7±0.483), flavor (7.8±0.632), taste (7.9±0.738), texture (6.9±0.738) and overall acceptability (7.71±0.483).

The evaluation is in accordance with the reports of Sindumathi and Amutha (2014) in case of coconut-based jam, Rajkumar *et al.* (2018) in case of rose petal jam and Gagan and Aditya (2018) for rose petal jam.

3.5 Yeast and mold count

The results of yeast and mold counts are depicted in Table 5. Plate counts of 2.6×10^2, 2×10^2 and 2.3×10^2 were found in case of samples M, PC and CP respectively packed in plastic container stored under room temperature. It was noticed that colony forming units were reduced with the increasing of samples acidity level. Inam *et al.* (2012) and Brandão *et al.* (2018) also found an opposite relation with samples acidity to the mold colony forming units.

Table 5. Yeast and mold count of jam

Jam Samples	Yeast and Mold Count (CFU/mL)			
	Room Temperature		Refrigerated Temperature	
	Glass Container	Plastic Container	Glass Container	Plastic Container
M	0	2.6×10^2	0	0
PC	0	2×10^2	0	0
CP	0	2.3×10^2	0	0

4. Conclusion

The prepared mixed fruit jam samples with different fruit concentrations showed excellent taste, high nutritive values and good sensory acceptability. Sample with pineapple and coconut pulp in 3:1 ratio showed better result compared to others. Storage stability analysis presented a gradual increase in TSS, acidity and reducing sugar, where increase rate was relatively slower in case of refrigerated temperature storage compared to room temperature storage. The pH of the samples declined with the storage time extension. The samples found negative for yeast and mold count except samples packed in plastic containers stored under room temperature. Therefore, further research is necessary in this field with compositional diversification and storage study.

Conflict of interest

The authors declare no conflict of interest.

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