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Research Article

Quality attributes of mixed fruits leather prepared from mango, pineapple and papaya pulp

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ABSTRACT

Four different formulated mixed fruits leathers from mango, pineapple and papaya pulp were prepared by cabinet drying method. The present study was aimed to evaluate the proximate and physicochemical properties of those formulated leathers. The total soluble solid (TSS) was higher in mango pulp. Although the moisture content of fruit pulp was around 80%, it was reduced until 10-15% in the dried leather. The amount of fat content was very negligible in the prepared leathers. However, high amount of crude fiber (6%) was found in all the samples. The reducing sugar in the sample was around 11%. As no other preservative was used except a small amount of sodium benzoate, so the fungal test was positive for all the samples. However, the formulated leathers by changing the fruit ratio did not influence hugely on moisture content, ash content and other proximate compositions. Therefore, all the four types of mineral rich formulated leathers could be consumed depending on the preference of consumers' taste. The simple and cost-effective leather could be an effective way to reduce post-harvest losses of ripe fruits.

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1. INTRODUCTION

Mango (*Mangifera indica*) is a delicious and popular fruit in Bangladesh, which is also called the king of fruits (Tharanathan *et al.*, 2006). Bangladesh is one of the major mangoes producing countries along with India, Pakistan, Mexico, Brazil, the Philippines, etc. (Alam *et al.*, 2006). In Bangladesh, it occupies an area of 37,830 hectares of land with an annual production of 116,1685 metric ton (MT) (BBS, 2016). However, the loss is as high as 18% due to lack of proper post-harvest maintenances (Baloch and Bibi, 2012).

Papaya framing has been getting popularity among farmers in Bangladesh for last few years, as many farmers found the occupation as an important source of income generation leading to their economic self-reliance (Bhattacharyya, 2008). Besides high medicinal value, it is a rich source of vitamins (vitamin A, B and C) and minerals (phosphorus and calcium). Jam, soft drinks, dessert, ice-cream flavoring etc. can be prepared from ripe papaya and green papaya is used as vegetables (Saran and Choudhary, 2013).

Pineapple is one of the most important commercial fruit crops in the world including Bangladesh (Liu *et al.*, 2012). It is the third most important tropical fruit in the world, pineapple ranks the 4th in terms of total cropping

area and production (BBS, 2009). The world pineapple demand has been expanding rapidly. Pineapples have exceptional juiciness and a vibrant tropical flavor that balances the tastes of sweet and tart, which is an excellent source of vitamin C and manganese (Hossain *et al.*, 2015). It is also a very good source of copper, vitamin B_1, vitamin B_6, dietary fiber, folate and pantothenic acid (Pratt and Del Rosario, 1913).

Fruits are highly perishable items and not be fresh for longer time after harvesting (Atanda *et al.*, 2011). So, adequate preservation facilities are necessary to reduce the damage/spoilage of valuable fruits at peak season. Fruit leather, a traditional dried food product, is one of the preservation processes of ripe fruits. It is a very thin layer of fruit pulp to produce a product with a texture similar to soft leather (Azeredo *et al.*, 2006). Thus, the name becomes 'Leather'. The simple and low-cost preparation method can save money. Fruit leathers made without using sugars are a healthy choice for diabetic adults and children (Slavin and Lloyd, 2012). Traditionally, sun drying is employed for preparing mango leather from ripe mango pulp. However, the major limitations of sundried leather are discoloration, unhygienic and lengthy process. Therefore, mechanical dehydration such as cabinet drying has been carried out for making mango leather, which made a better colored and flavored product (Diamante *et al.*, 2014). Besides, the low temperature used in cabinet dryer retains a good number of vitamins and other major constitutions in leather. Therefore, the aims of this study were to (i) develop mixed fruits (mango, pineapple and papaya pulp) leathers by using cabinet dryer and to (ii) analyze the physicochemical composition, mineral content and microbial load of those products.

2. MATERIALS AND METHODS

Collection of samples

Ripe mango, pineapple and papaya fruits were collected from Zawtala bazar of Chattogram district.

Preparation of mango, pineapple and papaya pulp

Fresh ripe fruits were taken and washed with potable water for removing dust and foreign particles. Fruits were then peeled and cut into small pieces. After peeling and cutting, the fruits edible parts (except seed and core) were blended in a blender (PHILIPS HR7761, China). Blanching of blended pulp was done at 80°C for 10 min. The prepared blanched pulp was cooled at ambient temperature (around 30°C) for 10 min. Four different types of leathers were prepared based on different fruits ratio (Table 1).

Processing of mixed fruits leather

All the raw materials were mixed properly according to the formulation (Table 1). After a proper mixing of fruits pulp, other materials were also added and blended until mixer became smooth. The mixer of fruits pulp was made immediately to avoid excessive browning. Blended mixer was placed in the top of an induction cookware. Water was added into the bottom. Pan was covered and steamed for 15-20 min. Mixer was poured and spread on aluminum foil in a tray and transferred to cabinet dryer (GENLAB, UK) for drying at 60°C. The mixer was dried by using cabinet dryer with constant temperature 60°C and a maximum period of 18 hours. The dried mixed leathers were packed with high density polyethylene bag and stored at room temperature.

Analysis of raw materials and final products

Determination of Total Soluble Solids

Total soluble solids (TSS) of the samples were estimated by the standard AOAC method using a refractometer (HR SERIES- MILATO) (AOAC, 2003). In short, few drops of distilled water were placed on the prism to check the refractometer (the value should be zero) and then cleaned the chamber with muslin cloth. A drop of sample was placed on the prism. Percentage of dry substance in it read directly at 20°C. All the experiments were done in three replications.

Determination of pH

The pH of samples was measured by the standard AOAC method using a pH meter (JENWAY) (AOAC, 2003). Briefly, 10 g of each sample was suspended in 75 mL of distilled water and allowed to macerate for 30 min. The suspension was filtered and the pH of the dispersion obtained was measured.

Determination of titratable acidity

The titratable (or total) acidity of samples was estimated by the standard AOAC method (AOAC, 2003). A total 10 g of samples were suspended in 75 mL of distilled water and allowed to macerate for 30 min. Then the mixture was filtered and 10 ml aliquots were titrated with 0.1 N NaOH using phenolphthalein indicators for end-point determination.

$$N(\%) = \frac{n \times v}{V} \times 100$$

Where, N is the acidity percentage; n is the normality of NaOH; v is the quantity of 0.1 N NaOH needed for acid titration; and V is the volume of sample taken for estimation.

Analysis of proximate compositions

Moisture content, ash content (total mineral), crude protein, crude fat and crude fiber were estimated by the standard AOAC method (AOAC, 2016).

Determination of reducing sugar

Reducing sugar content for prepared sample was determined adopting the AOAC (2005) method. The method was as follows: Reagents (Fehling's solution A, Fehling's solution B, Methylene blue indicator, 45% neutral lead acetate solution and 22% potassium oxalate solution).

Preparation of sample to determine reducing sugar

The sample of 10 g was mixed wih 100 mL of distilled water and 5 mL of neutral lead acetate solution. The prepared mixture was kept for 10 min and mixed properly. The blended material was transferred to a 250 mL volumetric flask. The volume was made up to the mark with distilled water. The solution was filtered.

Titration for reducing sugar

Fehling's solution of 10 mL of mixed was taken in a 250 mL conical flask and 250 mL distilled water was added to it. Purified sample solution (filtrate) was taken in a burette. Conical flask containing mixed Fehling's solution was heated on a hot plate. Three to five drops of methylene blue indicator were added to the flask when boiling started and titrated with solution taken in the burette. The end point was indicated by decolorization of indicator. Percent reducing sugar was calculated according to the following formula:

$$\% \text{ Reducing sugar} = \frac{I \times D \times 100}{T \times W \times 100}$$

Where, I is invert sugar required to reduce known volume of Fehling's solution; D is dilution factor, T is titration value; W is weight of sample

Determination of mineral contents

The contents of Fe, Mg, Ca and K were measured after digestion in HNO_3/H_2O_2 by atomic absorption spectrophotometry (AAS) (AA-7000, Shimadzu, Japan) similar to a study carried out by AOAC (2016). Briefly, leathers were cut into small pieces and then dried in drying oven at 105°C until a constant weight. After that 0.2 g dry leather samples were weighed into digestion vessel. Then 5 mL HNO_3 and 2 mL 30% H_2O_2 were added. Vessels were then closed and placed in holder. Vessel holder was then placed in microwave oven and exposed to defined program parameters 250 watts for 3 min, 630 watts for 5 min, 500 watts for 22 min and final 0 watts for 15 min. After taking out and cooling, vessels were then opened and rinsed down lid and walls into container. The solution was then transferred to 25 mL volumetric flask and dilute to mark with deionized water. Then solution was transferred to plastic container. For blank, same procedure was carried out. Further dilution for test solution was done with 3 M HNO_3. The concentration of Fe, K, Mg and Ca were determined by Flame techniques in AAS.

Microbial analysis

Total viable count

Total viable count also known as (TVC) was performed by standard method recommended by APHA, (2001). A series of test tubes each containing of 9 mL diluents were taken. Sample (50 g/mL) was then homogenized in 450 mL diluents and making suspension in a beaker. From the original sample, 1 mL was transferred in the test tube no. 1 and mixed thoroughly. Again, 1 mL from 1st test tube was transferred to 2nd test tube and continued up to last one and 1mL was discarded from the last test tube at the end. From each test tube 3 petri dishes were taken containing plate count agar (PCA) media. Then 0.5 mL mixture was transferred from each of the test tube to the corresponding petri dish separately. The petri dishes were marked (sample no, date etc.) and kept in incubator in inverted position at 37°C for 2-3 days. After 1-day interval up to 3 days after incubation the colonies were observed. The petri dish which had the colony 30-300 was included to count the colony and other plates were discarded. The colony of each petridish was counted and made average of them. Average count was multiplied to that multiplying factor which resulted the number of organisms.

Fungal test

Fungal test was done following the method of Fung (1994). For fungal test Sabouraud Dextrose Agar (SDA) was used. For agar preparation, 65 g agar was dissolved in 1 L distilled water. It was then boiled completely and sterilized by autoclaving at 121°C for 15 min. It was then poured onto the petri dish. A small amount of sample was set up in center of the petri dish and incubated at 25°C for 7 days. After incubation, the results were observed.

Statistical analysis

Data were stored in Microsoft Excel 2013 and then exported into Statistical Package for Social Science (SPSS 16th version) for statistical analysis. Descriptive analysis was performed by using mean and standard

deviation for different variables. Finally, one-way ANOVA and Tukey's post-hoc test was used to identify the statistically differences between different treated values. The statistical analysis was conducted for at 5% level of significant ($p < 0.05$).

3. RESULTS AND DISCUSSION

Analysis of chemical compositions of raw materials

Table 2 shows the chemical composition of raw materials. TSS content for mango was highest (17.33°Brix) and lowest (11.67°Brix) in papaya. However, the TSS contents, regardless of fruit types in the present study were higher than the study reported by Addai *et al.* (2013); Zuhair *et al.* (2013). The moisture content in pineapple was highest (87.53%) and the value was lowest for mango (74.57%). Moisture contents of papaya fruits were similar to the result of Addai *et al.* (2013) and lower than reported by Moreno *et al.* (2004). Highest pH was found in papaya pulp (4.71) and lowest pH was found in pineapple (3.7). As pineapple is more acidic than mango and papaya, so it is rational to obtain the lowest pH than others. Several studies also reported almost similar type of results (Shamsudin *et al.* 2007; Rincon and Kerr, 2010; Addai *et al.* 2013; Zuhair *et al.*

Table 1. Formulation of mixed fruits leather

Ingredients	Samples			
	F_1	F_2	F_3	F_4
Mango pulp (%)	40	45	48	35
Pineapple pulp (%)	25	19	14	30
Papaya pulp (%)	19	20	22	19
Pectin (%)	1	1	1	1
Sugar (%)	14.75	14.75	14.75	14.75
Sodium benzoate (%)	0.25	0.25	0.25	0.25

Table 2. Chemical compositions of raw materials

Quality Parameters	Mango	Pineapple	Papaya
TSS (°Brix)	17.33 ± 0.58^{a}	15.33 ± 1.53^{a}	11.67 ± 1.15^{ab}
Moisture content (%)	74.57 ± 0.62^{b}	87.53 ± 1.35^{a}	85.13 ± 1.75^{a}
pH	4.64 ± 0.8^{a}	3.7 ± 0.90^{b}	4.71 ± 1.2^{a}
Acidity (%)	0.80 ± 0.24^{b}	1.74 ± 0.16^{a}	1.20 ± 0.18^{ab}

a-b means different subscript alphabets in each row are significantly different ($p<0.05$) for all raw materials

Table 3. Proximate and chemical compositions of mixed fruits leather

Proximate and chemical compositions	F_1	F_2	F_3	F_4
Moisture content (%)	10.33 ± 0.25^{b}	11.43 ± 0.31^{ab}	13.33 ± 0.31^{a}	10.25 ± 0.15^{b}
Crude protein (%)	3.58 ± 0.10^{a}	1.85 ± 0.07^{b}	1.78 ± 0.09^{b}	1.78 ± 0.18^{b}
Crude fat (%)	0.03 ± 0.00^{a}	0.03 ± 0.00^{a}	0.03 ± 0.00^{a}	0.03 ± 0.00^{a}
Reducing sugar (%)	10.66 ± 0.05^{a}	11.35 ± 0.04^{a}	10.43 ± 0.03^{a}	9.55 ± 0.03^{a}
Ash content (%)	1.78 ± 0.03^{a}	1.71 ± 0.04^{a}	1.64 ± 0.18^{ab}	1.51 ± 0.08^{b}
Crude fiber (%)	6.02 ± 0.04^{a}	6.02 ± 0.02^{a}	6.13 ± 0.02^{a}	6.14 ± 0.03^{a}
TSS (°Brix)	37 ± 1^{a}	29.67 ± 0.8^{b}	30 ± 1^{ab}	35 ± 1^{ab}
pH	4.25 ± 0.8^{ab}	4.59 ± 0.6^{a}	4.19 ± 0.7^{b}	3.96 ± 0.5^{b}
Acidity (%)	2.36 ± 0.02^{b}	2.20 ± 0.01^{c}	2.46 ± 0.13^{b}	2.81 ± 0.21^{a}

a-b means different subscript alphabet in each row are significantly different ($p<0.05$) for all raw materials

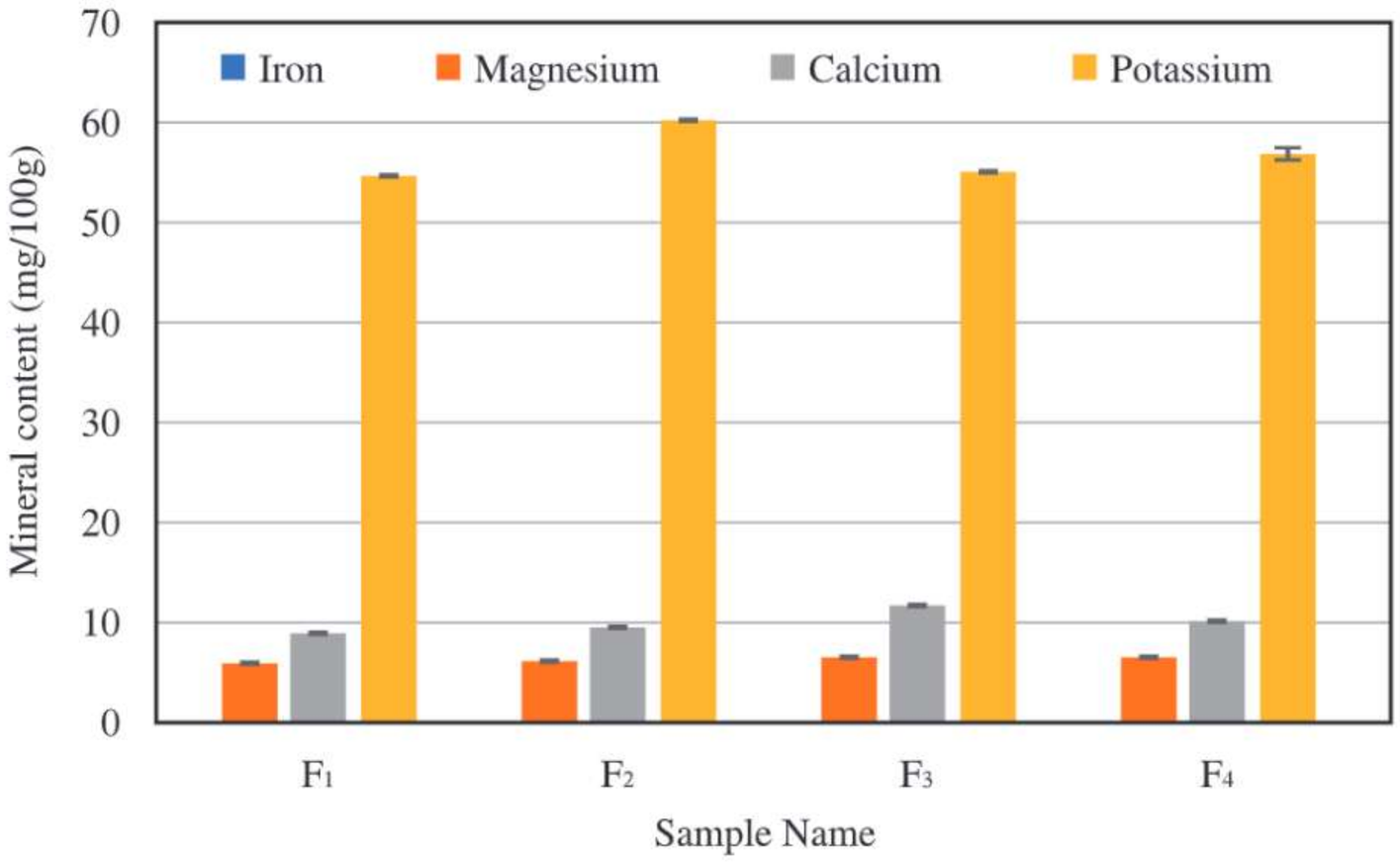

Figure 1. Mineral contents in mixed fruits leather

Table 4. Microbiological analysis of mixed fruits leather

Test	F_1	F_2	F_3	F_4
TVC	Negative	Negative	Negative	Negative
Fungal	Positive	Positive	Positive	Positive

2013). The variations of current results with previously reported values might be due to the variety of fruits, cultivation conditions (soil type, fertilizers used etc.) and environmental conditions (temperatures, relative humidity etc.).

Analysis of proximate and chemical compositions of mixed fruits leather

Table 3 shows the proximate and chemical compositions of mixed fruits leather. Although identical moisture content was found in the formulation of F_1, F_2 and F_4 (near 10%), but the highest amount was noticed in F_3 (around 13%). Moisture content is one of the important precursors of any food product, which influences the shelf-life of that product. The high moisture content leads the product to spoil faster than the product with low moisture content. Therefore, it can be assumed that F_3 will be spoiled faster than other samples. Although the drying temperature was fixed for all the samples, but the drying conditions of final product was checked manually. The drying condition might influence to obtain such kind of result instead of the addition of fruit pulp to prepare fruit leather. Some researchers reported the different value of moisture content in mixed fruits leather (Offia-Olua and Ekwunife, 2015; Kumar *et al.* 2008), which might be due to addition of different types of fruits and drying method. As fruits pulp contain less amount of protein and fat, therefore it is rational to obtain less amount in the prepared leathers. The ash content in sample F_1 was found higher than other samples. The initial ash content in fresh mango and pineapple pulp was higher than papaya pulp, which may consequence to get the highest ash content in sample F_1. The TSS was also found highest in sample F_1 than other samples. As initial TSS content in mango pulp and pineapple pulp was higher than papaya pulp, so the higher ratio of mango and pineapple pulp in F_1 may show this result. The reducing sugar content was highest in sample F_2 (11.35%) and the lowest in sample F_4 (9.55%). However, no significant differences were noticed between different samples in terms of reducing sugar.

Mineral contents in mixed fruits leather

The major minerals determined in the fruits leather were iron, magnesium, calcium and potassium. However, iron content of mixed fruits leather was negligible in comparison to other mineral contents (Figure 1). Overall potassium level was high, however potassium and calcium were the highest in sample F_2 and F_3, respectively. As fruits are rich of mineral contents (Davey *et al.*, 2009), therefore mixed fruits leather could be a good source to consume mineral contents.

Microbiological quality

Total viable count was not found positive in all the samples (Table 4). However, fungal test showed positive for all the samples. As moisture content was quite low (around 15%) in all the samples, therefore it is rational not to find bacterial load. Bacteria needs more water activity to grow than fungus. The incubation temperature (25°C) also influenced fungal growth. Refrigeration may be provided to extend the shelf-life of the prepared leathers.

4. CONCLUSIONS

The low temperature of cabinet dryer used in this study protects from discoloration of the samples. Although, the moisture content, ash content and other proximate compositions were variable, all those four formulated leathers could be prepared and consumed depending on consumers' preferences. The physicochemical properties of mixed fruits leather depended on the physicochemical properties of used fruits pulp. However, the shelf-life of the prepared leathers might be extended by the addition of preservatives and further investigations might be continued regarding this.

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