Comparisons of proximate composition, sensory evolution and bioactive compounds of mixed fruit bar from mango, pineapple and papaya

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Abstract - Fruits contain various macronutrient as well as natural antioxidants and secondary metabolites which play an important role in human health. Mixed fruit bar is a convenient substitute for fresh fruit. In this study, proximate analysis, various physiochemical such as lycopene, anthocyanin, β-carotene content, flavanoid content, total phenolic content and antioxidant activity of various fresh fruit and mixed fruit bars (mango, pineapple and papaya) were compared. The sample which secured highest score for overall acceptability and ranked as "like very much" (LVM) by a taste testing panel which sample contained 14.55% moisture, 1.15% ash, 1.07% protein, 1.30% fibre, 52.07% total sugar and 10.40 mg/100g of vitamin C. This sample contained the highest amount of total phenolic content among all the tested fresh fruit blend and mixed fruit bars., mango contained the highest amount of total phenolic content for the commercial fruit juice having total phenol content 41.85 mg/100g GAE, total flavanoid content 37.63 mg/100g Rutin equivalent (RE), anthocyanin content 4.51 mg/100g dry basis, lycopene content 0.02mg/100 g, β-carotene content 0.03 mg/100g dry basis and Antioxidant activity (DPPH) 1.12 μM/g of Trolox equivalents. The present study demonstrates the potential value of commercial mixed fruit bar as the replacement of fresh fruit.

Keywords - Proximate; Sensory; Physiochemical; Phenol; Flavanoid; Antioxidant; Mixed fruit bar; Mango; Pineapple; Papaya;

1 Introduction

Today's consumers expect more and more pleasure from various confectionery foods. They want it to be low in fat and calories in order to maintain their health conditions [1]. Further, the customers prefer foods that benefit in preventing diseases due to increasing health awareness. The above factors are collectively are responsible for creation of new market for health and functional food segments with colossal opportunities.

Mango (Mangifera indica L.), pineapple (Ananas comosus) and papaya (Carica papaya L.) are good sources of natural antioxidants [2] [3]. In addition to the usual nutrients, such as minerals and vitamins, mango, pineapple and papaya are also rich in flavanoid and phenolic compounds [4]. Contribution of the role of antioxidants in human health has promoted research in the field of food processing and science to evaluate fruit and vegetables antioxidants and to determine whether their content and activity can be maintained or even improved through processing, preservation, crop breeding, cultural practices, post-harvest storage [5].

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Bioactive compounds such as phenol, flavanoids, lycopene, β – carotene and anthocyanin are important nutritional parameters for fruits and vegetables. Evaluation of the antioxidant status after processing of food products is a challenge. In this context, insufficient information is available regarding the effects of heat on changes of vitamin C, phenol content, flavanoids, lycopene, β – carotene, anthocyanin and free radical scavenging activity of confectionary product, particularly mixed fruit bar. Therefore, this study was undertaken to investigate the proximate analysis, percentage acidity, total sugar content, crude fibre content, phenol, flavanoids, lycopene, β – carotene, anthocyanin, free radical scavenging activity and sensory evolution of mixed fruit bars.

2 Materials and methods

2.1 Raw Materials and Preparation of Fruit Bar

Ripened *mangifera indica* (Mango, var - Fazili), *Ananas comosus* (Pineapple, var - Giant Kew) and Carica papaya (papaya, var - Kashimpuri) fruit were used to carry out this study. Proper matured, and uniform in size and shape were purchased from the local market of Dinajpur, Bangladesh and procured. Sugar was used as sweetener and starch was added to modify the texture and as a binding agent. Sodium benzoate was used as preservatives as much as permitted levels. Mango and papaya were peeled off after

washing with tap water, and the masocarps (pulp) were separated from the seed with the help of a knife. Afterward the pulp was blended in an electrical blender. The pulp was then blanched for 10 minutes at 80^0C and cooled immediately. Pineapple juice was extracted with a juicer after peeling off and core removal and bleached in the same way as mango and papaya. Mango and papaya pulp and pineapple juice were blended in four different combinations (Table 2.1) with a mixing machine. Other ingredients (Sugar, starch, sodium benzoate) were added to the fruits blend and mixed thoroughly and heated at 80^0C for 5 minutes for gelatinization of starch. After mixing and heating, the mixture was converted into a sheet of 0.25-inch thickness on a stainless-steel table with a rolling pin. Mixed fruit bars (3 x1 inch) were cut with the help of stainless-steel cutting blades which were adjusted to 1-inch width and 3 inches in length. The thickness of bars was adjusted by moving up and down stainless-steel strips frame, and each bar was packed individually in aluminum foil.

Table 2.1 the basic sample for preparation formulation of mixed fruit bar

Ingredient	Sample			
	S_1	S_2	S_3	S_4
Mango pulp	40%	45%	50%	35%
Pineapple pulp	24%	19%	14%	29%
Papaya pulp	20%	20%	20%	20%
Sugar	14.75%	14.75%	14.75%	14.75%
Starch	1%	1%	1%	1%
Sodium benzoate	0.25%	0.25%	0.25%	0.25%

2.2 Physicochemical Properties

2.2.1 Proximate composition

Moisture, crude protein, and ash content of mango, pineapple, papaya, and mixed fruit bars were determined by official methods [6].

2.2.2Determination of percentage acidity

The acidity of the fruit bar was determined by using the method as recommended by Ranganna (1977) [7]. 10 ml pulp/ juice were taken in a 100 ml conical flask. A few drops of 1% phenolphthalein solution (indicator) were added to the flask and titrated with 0.1N NaOH solution from a burette until a light pink color appeared and persisted for 15 seconds. The titration was done for several times for accuracy. Percent of titratable acidity was calculated using the following formula:

$$\%\, Titrable\ acidity = \frac{T \times N \times V \times E}{Vs \times W \times 1000} \times 100$$

Where,
T = Titre
N= Normality
V= Volume made up
E = Equivalent weight of acid
Vs = Volume of sample
W = Weight of sample

2.2.3 Determination of reducing sugar

Estimation of reducing sugar of samples was carried out using Lane and Eynon (1923) method, as described by Asaduzzaman et al. (2013) [8] [9]. The following formula calculated the reducing sugar is:

$$\%\, Reducing\ sugar = \frac{Factor\ for\ fehling's olution \times Dilution \times 100}{Titre\ value \times Weight\ of\ powder}$$

2.2.4 Determination of non-reducing sugar

50ml purified solution was taken in a conical flask, 50ml distilled water and 5 ml of citric acid were added to it. Then the conical flask was heated for 10 minutes for the addition of sucrose and finally cooled. The sample was then neutralized by 0.1 N NaOH solution using phenolphthalein as an indicator. The volume was made up to 100 ml with distilled water. The mixed Fehling's solution was titrated using a similar procedure as for reducing sugar from which the present non-reducing sugar is calculated as follows:

% Non-reducing sugar = %invert Sugar - %reducing sugar

2.2.5 Estimation of total sugar

Total sugar can be calculated as follows:

% Total sugar = %Reducing sugar + % Non-reducing sugar

2.2.6 Determination of total soluble solids (TSS)

Two drops prepared pulp was taken in a refractometer (Model no. HI 96801) plate and the total soluble solids of the juice were read directly from the refractometer.

2.2.7 Determination of pH

An electrolytic call composed of two electrodes (caramel and glass electrode) was standardized with a buffer solution of pH 4.0. Then the electrodes were dipped into the test sample. A voltage corresponding to the pH of the solution was developed, and directly, one can read the pH of the solution indicated by the instrument (potentiometer).

2.2.8 Determination of vitamin – C content (Ascorbic Acid)

Ascorbic acid was determined by using the method as recommended by Ranganna (1977) [7].

2.2.9 Determination of crude fiber

Crude fiber content was determined using AOAC (1989) [10].

2.2 Phytochemicals Properties

2.2.1 Determination of phenol content

Determination of the phenolic content was done by Saikia et al. (2012) method with some modifications [11]. Mango pulp, pineapple juice, papaya pulp, and mixed fruit bars (1g) was extracted with 20 ml of 25% ethanol for 15 min. Then filtered through Whatman no. 2 filter paper. After that, with 1 g sample, 1 ml Folin reagent, and 5 ml Sodium carbonate (Na_2CO_3) were transferred to a volumetric flask. Allowed to rest it for one hour and taken absorbance at 765 nm using spectrophotometer (T80 U/VIS, United Kingdom). Total phenols were calculated based on standard curves of gallic acid and expressed as mg/100 g.

2.2.4 Determination of flavanoid

The flavonoid content was measured using a modified colorimetric method as described by Ali and Chang (2008) and Asaduzzaman et al. (2013) [12] [9]. 10 mg of mango pulp, pineapple juice, papaya pulp, and mixed fruit bars was taken in a conical flask, and 10 ml of methanol was added. From this solution, 1 ml was taken into a test tube. Then 5ml distilled water and 0.1 ml of potassium acetate (CH_3COOK) were added. After 5 min. 0.3 ml of $AlCl_3$ was added. Then the solution was kept for 30 min. At room temperature, the absorbance was taken at 415 nm using spectrophotometer (T80 U/VIS, United Kingdom). The flavonoid content was determined using Rutin standard curve and was expressed as mg/100 g.

2.2.5 Determination of lycopene content

Content of total lycopene was determined by using the modified method given by Kalpana and Kulsange (2015) [13]. 0.1 gm dried sample was taken and soaked into each of the 8 ml solvent solution ethanol acetone-hexane (2:1:1) mixture in a tube. After 10 minutes vortexes, 1.0 ml water added in the tube and vortexed again. The extraction process was carried out for 10 minutes. Then absorbance was measured at 510 nm using spectrophotometer (T80 U/VIS, United Kingdom). The lycopene content was calculated based on the following equation.

$$\text{Lycopene content (mg/gm of fresh weight)} = \frac{A \times m \times S \times V}{w \times M}$$

Where,
A= Absorbance of 503nm spectrum
m= Molecular weight of lycopene ($C_{40}H_{56}$, 537 g/mol)
S= the volume of mixed solvent (8 ml)
V= the volume ratio of the upper layer to the mixed solvents (0.55)
w= Sample weight (0.10 g)
M= the molar extraction co-efficient (172 mM^{-1})

2.2.6Determination of β-carotene

β-carotene was determined according to the method of Nagata and Yamashita (1992) [14]. The dried methanolic extract (100 mg) was vigorously shaken with 10 ml of the acetone-hexane mixture (4:6; v:v) for 1 min. Then filtered through Whatman No. 4 filter paper. The absorbance of the filtrate was measured at 453, 505, and 663 nm. Contents of β-carotene ware calculated according to the equation

$$\beta - \text{Carotene}\left(\frac{\text{mg}}{100\text{g}}\right) = 0.216 \times A_{663} - 0.304 \times A_{505} + 0.452 \times A_{453}$$

2.2.7 Determination of anthocyanin content

Content of total anthocyanin was determined by using the modified method given by Giusti and Wrolstad (2001) [15]. To determine anthocyanin from mango pulp, pineapple juice, papaya pulp, and mixed fruit bars, 1 gm dried sample powder was taken and soaked into each of the 40 ml 50% ethanol. The pH of the solvents was maintained at three (3), and the extraction process was carried out at 50^0C for 60 minutes. The anthocyanin extracts obtained from each of the extraction was filtered through a muslin cloth to remove coarse particles. Then vacuum filtration with what man filter paper (no.1) was also performed to remove the other dissolve minute particles. Filtrated sample solution (15ml) was centrifuged at 4000 rpm for 20 minutes. Then 0.5 ml of aliquot was diluted with 4 ml of methanol, and absorbance was measured at 530 nm using spectrophotometer (T80 U/VIS, United Kingdom).The anthocyanin content was calculated based on the following equation.

$$\text{Anthocyanin content (mg/100gm of dry weight)} = \frac{A \times MW \times DF \times 1000}{€ \times W}$$

Where,
A= Absorbance
MW= Molecular weight of cyanidin-3 glucoside chloride ($C_{21}H_{21}ClO_{11}$, 449.2)
DF= Dilution factor (8)
€= Molar absorptivity (26900)
W= Sample weight

2.3 Antioxidant Assays

2.3.1 Determination of free radical scavenging activity

The scavenging effects of samples for 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical were monitored according to the modified method of the previous report by Yen and Chen (1995) [16]. Mango pulp, pineapple juice, papaya

pulp, and mixed fruit bars, 0.1 gm sample powder, and 4ml ethanol were mixed with 1 ml of methanolic solution, which is containing 0.2mM DPPH. The mixture is vortexed for 1 min and rests for 30 min in the dark camber. Then its absorbance was read at 517 nm by spectrophotometer (T80 U/VIS, United Kingdom). The DPPH content was determined using the Trolox standard curve and was expressed as μM/g.

2.4 Sensory evaluation

Sensory evaluations of the entire sample mixed fruit bar were done by taste testing panel. The taste testing panel was made up with of 10 test panelists. They were asked to evaluate color, flavor, texture, taste and overall acceptability by a scoring rate on a nine (9) point hedonic scale where 9= Like extremely, 8= Like very much, 7= Like moderately, 6= like slightly, 5- neither like nor dislike, 4= Dislike slightly, 3= Dislike moderately, 2- Dislike very much and 1= Dislike extremely. The preference differences were evaluated by statistical analysis of the data for variance and consequently, Duncan's Multiple Range Test (DMRT). Procedures of the Statistical Analysis System (SAS, 1985) were used for statistical analysis.

2.5 Statistical analysis

The results were expressed as the mean, standard error of the mean (SEM), and coefficient of variation of each species for each parameter was determined. Data were statistically analyzed (R statistical software 3.4.1) by one-way analysis of variance (ANOVA). Mean comparisons were performed using Duncan's multiple range tests for significant effect at $P < 0.05$.

3 Result and Discussion

3.1 Composition of fresh mango pulp

The mango pulp was prepared as per the method. The mango pulp was analyzed for moisture, ash, acidity, vitamin C, total soluble solid and total sugar. The results are shown in the mango pulp contained 80.2% moisture, 0.55% ash, 0.19% acidity, 45 mg per 100 g vitamin C, 15.9% total soluble solid and 13.7% total sugar. The results were more or less similar to those reported by Singh (1968) who showed that mango contained 75 to 82% moisture, 8.7 to 20% sugar0.51% protein, 8.5 to 50 mg per 100 g vitamin C and 0.38 to 0.63% ash (Table 3.1) [17].

3.2 Composition of fresh pineapple juice

The pineapple juice was analyzed for moisture, ash acidity, vitamin C, total soluble solid and total sugar. The results are shown in the pineapple juice contained 83.6% moisture, 0.46% ash, 0.62% acidity, 3.70 pH, 8.3 mg per 100 g vitamin C, 11.7% total soluble solid and 12.1% total sugar (Table 3.1).

This study is nearly in agreement with the findings of anonymous (1960) who reported that the pineapple contained moisture content 75%, vitamin C 8.76mg/100g, ash 0.56%, acidity 0.64%, pH 2.57, total soluble solid 13%, reducing sugar 3.06%, non-reducing sugar 6.88% and total sugar 9.94% [18]. The composition of two juices varies due to use of different variety and different environmental condition.

3.3 Composition of fresh papaya pulp

The papaya pulp was analyzed for proximate analysis and vitamin C, total soluble solid, and total sugar content. The results are shown in the papaya pulp contained 89.4% moisture, 0.45% ash, 0.15% acidity, 4.3 pH, 38.2 mg per 100 g vitamin C, 9.75% total soluble solid and 7.6% total sugar (Table 3.1).

The results are more or less similar to Akin *et al.,* (2008) reported that papaya contained moisture 92.1%, ash 0.66%, fat 0.10%, protein 1%, and total carbohydrate 6.2% [19].

Table 3.1 composition of mango pulp, pineapple juice and papaya pulp

Parameter	Mango	Pineapple	Papaya
Moisture (%)	80.2 ± 0.01	83.6 ± 0.01	89.4 ± 0.01
Vitamin C (mg/100g)	45.0 ± 0.01	8.30 ± 0.01	38.2 ± 0.01
Ash (%)	0.55 ± 0.01	0.46 ± 0.01	0.43 ± 0.01
Total soluble solid (%)	15.9 ± 0.00	11.7 ± 0.00	9.75 ± 0.00
Acidity (%)	0.19 ± 0.00	0.62 ± 0.01	0.15 ± 0.00
Total sugar content (%)	13.7 ± 0.04	12.1 ± 0.03	7.6 ± 0.06

All values are express as mean ± SD.

3.4 Composition of mixed bar prepared from mango pulp, pineapple juice and papaya pulp

The composition of mixed bars from mango pulp, pineapple juice, and papaya pulp was analyzed for moisture, ash, acidity, vitamin C, total sugar, and fiber. The results presented in table 3.2. Sample S_1 contain moisture 13.80%, ash 1.09%, fibre 1.1%, total sugar 52.34% and vitamin C 8.80 mg/100g; sample S_2 contained moisture 14.25%, ash 1.05%, fibre 1.20%, total sugar 52.40% and vitamin C 9.40 mg/100g; sample S_3 contained moisture

14.55%, ash 1.15%, fibre 1.30%, total sugar 52.07% and vitamin C 10.40 mg/100g and sample S_4 contained moisture 15.30%, ash 1.10%, fibre 1.09%, total sugar 52.60% and vitamin C 7.35 mg/100g (Table 3.2). It was found that sample S_4 contained the highest amount of moisture, and sample S_1 had the lowest level of moisture. Sample S_2 and S_3 retained a higher amount of vitamin C. Sample S_4 contained the highest amount of sugar, and sample S_3 contained the lowest level. In the case of fiber, sample S_3 posed the highest amount, and other sample had similar levels.

These results more or less similar to P. Karmoker (2009) showed that formulation S_1 contained moisture 11.92%, ash 1.13%, protein 0.3%, fibre 1.497 mg/100g and total sugar 54.08%; formulation S_2 contained moisture 12.67%, ash 1.36%, protein 0.48%, fibre 1.15%, total sugar 55.13% and vitamin C 19.44 mg/100g; formulation S_3 contained moisture 12.48%, ash 1.13%, protein 0.33%, total sugar 55.38% and vitamin C 6.48 mg/100g; and formulation S_4 contained moisture 12.80%, ash 1.24%, protein 0.31%, fibre 1.20%, total sugar 55.09% and vitamin C 5.4 mg/100g. The composition of two juices varies due to use of different variety [20].

Table 3.2 Composition of mixed fruit bar from mango, pineapple and papaya

Parameter	Sample			
	S_1	S_2	S_3	S_4
Moisture (%)	13.80 ± 0.01^{d}	14.25 ± 0.01^{c}	14.55 ± 0.02^{b}	15.30 ± 0.01^{a}
Vitamin C (mg/100g)	8.80 ± 0.01^{ab}	9.40 ± 0.02^{ab}	10.40 ± 0.01^{a}	7.35 ± 0.01^{b}
Ash (%)	1.09 ± 0.04^{ab}	1.05 ± 0.02^{b}	1.15 ± 0.03^{a}	1.10 ± 0.03^{ab}
Total sugar content (%)	52.34 ± 0.53^{a}	52.40 ± 0.57^{a}	52.07 ± 0.50^{a}	52.60 ± 0.97^{a}
Acidity (%)	0.30 ± 0.01^{a}	0.19 ± 0.01^{ab}	0.15 ± 0.00^{b}	0.25 ± 0.01^{ab}
Fibre	1.10 ± 0.03^{b}	1.20 ± 0.06^{ab}	1.30 ± 0.02^{a}	1.09 ± 0.01^{b}

Sample S_1: Mango (40%) + Pineapple (24%) + Papaya (20%)
Sample S_2: Mango (45%) + Pineapple (19%) + Papaya (20%)
Sample S_3: Mango (50%) + Pineapple (14%) + Papaya (20%)
Sample S_4: Mango (35%) + Pineapple (29%) + Papaya (20%)
All values are express as mean ± SD.
Mean followed by different superscript letters in each raw are significantly different ($p<0.05$).

3.5 Total phenolic contents

Total phenolic content (TPC) of the examined mango pulp, pineapple juice, papaya pulp, and different mixed fruit bar samples are presented in Figure 3.1. Variations were found within the mixed fruit bar samples, ranging from 38.57 to 41.85 mg /100 g GAE, with mixed fruit bar sample S_4 (38.57 mg/100 g) having the lowest value while the highest value came from sample S_3 (41.85 mg/100 g) while mango pulp contains the highest value of phenolic compound is 55.29 mg/100g. This result showing similarity to that obtained by Vasco et al. (2008) and Reddy et al. (2010), was in the range of 60 to 307 mg/100 g gallic acid equivalent (GAE) of ripe mango pulp [21] [22]. Another study showed that the total phenolic content of mango pulp extract was 652 mg/100 g GAE by Silva et al. (2014) [23]. Addai et al. (2016) reported 62.59 mg GAE/100 g d.b. for p*apaya* fruit bar (Malaysia), which is higher than the levels reported here [24]. Beta et al. (2011) reported that total phenolic content might vary because of moisture content [25].

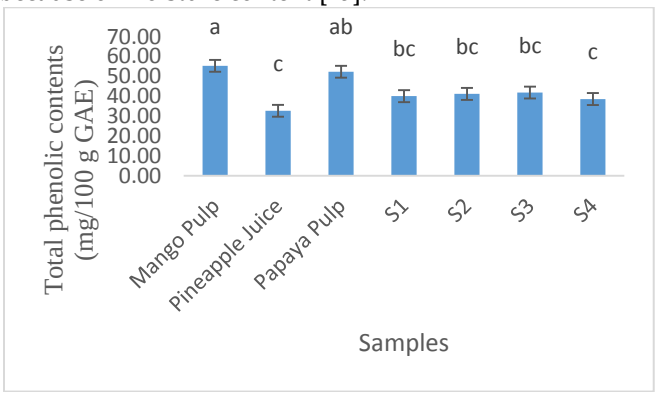

Figure 3.1: Total phenolic content among mango pulp, pineapple juice, papaya pulp and 4 samples. Different superscript letters above the bars indicate statistically significant differences at $p<0.05$.

3.6 Flavanoid content

Figure-3.2 shows flavanoid contents among mixed fruit bar samples were varied from 37.63 to 40mg /100g RE. Sample S_3 had the lowest value (37.63mg/100g RE) while the highest value (40 mg/100g RE) came from sample S_4. The variation of flavonoid content in different samples may be affected by fruit variation and quantity. The flavonoid content of the mango pulp, pineapple juice, and papaya pulp are 25.82 mg/100g RE, 54.19 mg/100g RE, and 89.91 mg/100g RE respectively. Addai et al. (2016) reported 45.40 mg QE/100 g d.b. for papaya fruit bar (Malaysia), which is higher than the levels reported here [24].

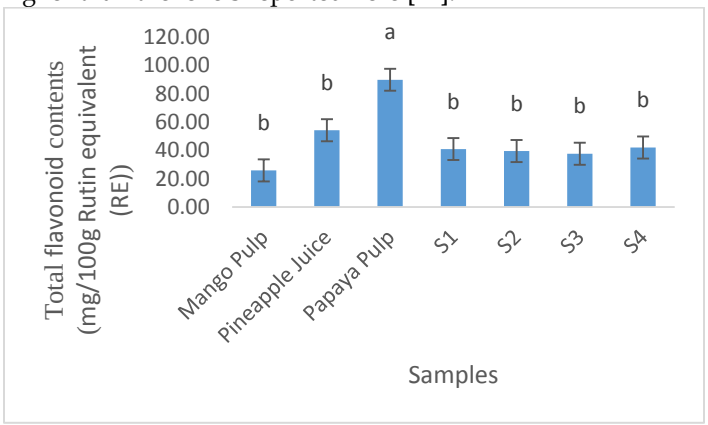

Figure 3.2: Total flavonoid content among mango pulp, pineapple juice, papaya pulp and 4 samples. Different superscript letters above the bars indicate statistically significant differences at $p<0.05$.

3.7 Lycopene and β-carotene

The Lycopene and β-carotene of mango pulp, pineapple juice, papaya pulp, and different samples of mixed fruit bar are represented in Figures 3.3 and 3.4. The study showed that the value of lycopene in different samples between 0.02 to 0.24 mg/100 g (Figure 3.3). However, sample S_2 had the highest lycopene value while the lowest value found in sample S_3. The β-carotene in different samples was 0.02 to 0.44 mg/ 100g dry basis (Figure 3.4). Sample S_2 had highest β-carotene value while the lowest value found in sample S_3.

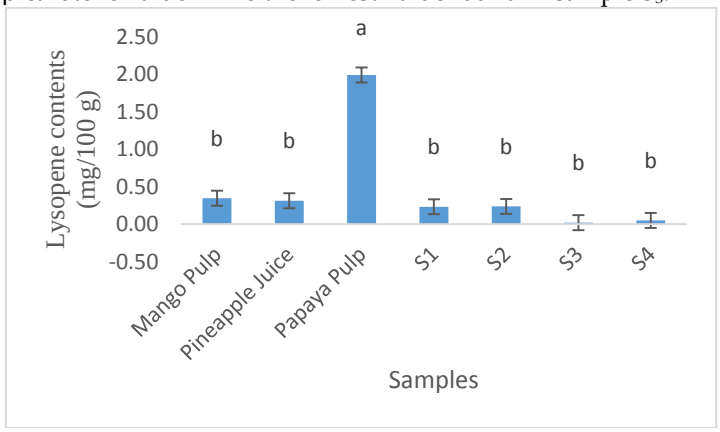

Figure 3.3: Lycopene content among mango pulp, pineapple juice, papaya pulp and 4 samples. Different superscript letters above the bars indicate statistically significant differences at p<0.05.

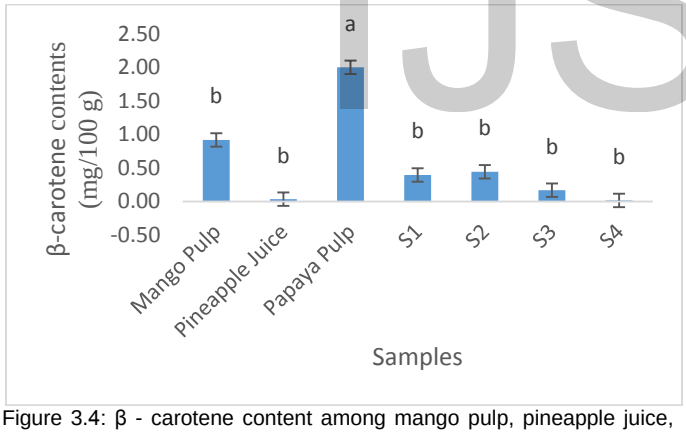

Figure 3.4: β - carotene content among mango pulp, pineapple juice, papaya pulp and 4 samples. Different superscript letters above the bars indicate statistically significant differences at p<0.05.

3.8 Anthocyanin content

The results for anthocyanin content are shown in Figure 3.5. Anthocyanins are brightly-colored compounds responsible mainly of the red, blue, and purple coloring of fruits. They are mainly present in berries such as blueberries and blackcurrants [26]. Variations were found within the mixed fruit bar samples, ranging from 4.51 to 5.34 mg /100 g dry basis, with mixed fruit bar sample S_3 (4.51 mg/100 g) having the lowest value while the highest value came from sample S_1(5.34 mg/100 g) while pineapple juice contains the highest value of anthocyanin content is 10.76 mg/100g. This result was similar to that obtained by Silva et al. (2014), was in the range of 11.62 to 13.82 mg/100 g dry basis of ripe pineapple juice [23].

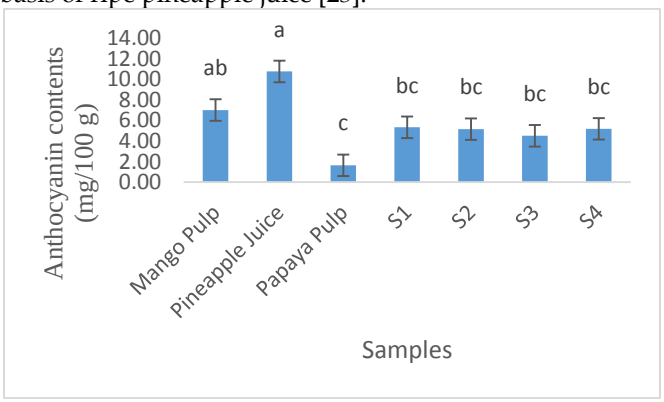

Figure 3.5: Anthocyanin among mango pulp, pineapple juice, papaya pulp and 4 samples. Different superscript letters above the bars indicate statistically significant differences at p<0.05.

3.9 1,1-diphenyl-2-picrylhydrazyl (DPPH) assay

Figure 3.6 shows DPPH assay contents among mixed fruit bar samples were varied from 1.10 to 1.59mg /100g μM/g of Trolox equivalents. Sample S_4 had the lowest value (1.10 μM/g of Trolox equivalents) while the highest value (1.59μM/g of Trolox equivalents) came from sample S_2. The variation of DPPH assay content in different samples may be affected by fruit variation and quantity. The DPPH assay content of the mango pulp, pineapple juice, and papaya pulp are 2.87, 1.36, and 2.07μM/g of Trolox equivalents, respectively. Addai et al. (2016) reported 89.47 μM/g of Trolox equivalents d.b. for papaya fruit bar (Malaysia)) which is higher than the levels reported here [24].

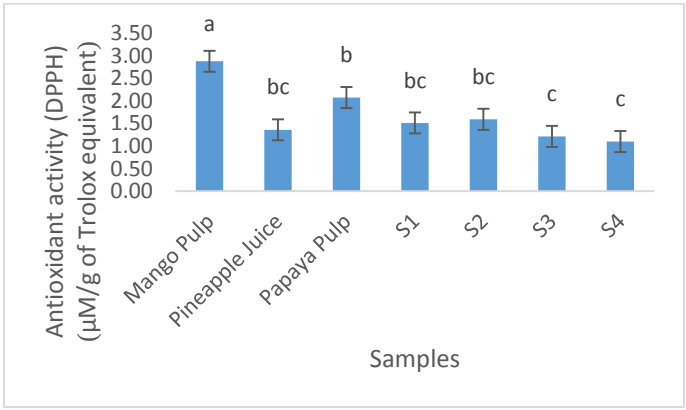

Figure 3.6: Antioxidant activity (DPPH) among mango pulp, pineapple juice, papaya pulp and 4 samples. Different superscript letters above the bars indicate statistically significant differences at p<0.05.

3.10 Sensory evaluation

A panel of 10 judges tested the color, flavor, texture, and overall acceptability of fruit bar made from mango, pineapple, and papaya in the various ration. The mean

scores for color, flavor, texture, and overall acceptability of different types of bar sample such as S_1, S_2, S_3, and S_4 are presented in table 3.3.

A two-way analysis of variance ANOVA was carried out for color preference, and results revealed that there was significance ($p<0.05$) difference in color acceptability among the fruit bars. The results of DMRT showed that there was no significance for color difference among the formation of S_1 and S_4 (Table 3.3).

In the case of color preference among the sample, the sample S_3 was more acceptable than sample S_1, S_2, and S_4. Sample S_3 secured the highest score of 7.7 and ranked as "Like very much." Sample S1 and S4 are rated as "Like slightly" and obtaining rating 5.5 and 5.4 respectively. The mixing ratio of mango, pineapple, and papaya pulp in sample S_3 was composed of 50%, 14%, and 20% respectively.

In case of flavor preference among the sample, ANOVA analysis showed that there was significance ($p<0.05$) difference in flavor acceptability among the fruit bars. From table 3.3, it is seen that sample S_3 secured the highest score 8.1 for flavor and was ranked as "Like very much" and followed by the sample S_2 and S_4obtaining score 7.0 and 6.1. The sample S_1 scored 5.7 and classified as "Like slightly."

In the case of texture preference among the sample showed that there was significance ($p<0.05$) difference in texture, as shown in table 3.3. Sample S_3 secured the highest score of 8.2 for composition and was ranked as "Like very much." The sample S_4 scored 5.8 and listed as "Like slightly."

In the case of taste preference among the sample showed that there was significance ($p<0.05$) difference in taste, as shown in table 3.3. Sample S_3 secured the highest score of 8.4 for taste and ranked as "Like very much." The sample S_1 scored 6.1 and posed the lowest score.

It was apparent from the results of the ANOVA there was significance ($p<0.05$) difference in overall acceptability of the sample tested as the calculated F value (31.988) is higher than the tabulated F value (2.960). This indicates that so far as overall acceptability is a concern, the samples were not equally acceptable. It can be seen from table 3.3 that the sample S_3 is the most acceptable product receiving 8.1 out of 9.0 composed to the other sample and ranked as "Like very much." The sample S_2 securing 7.1 and was ranked as "Like moderately." However, S_1 and S_4 securing 6.1 and 5.5 respectively and ranked as "Like slightly."

Sample S_3 secured the highest score for color, flavor, texture, taste, and overall acceptability among all the samples and was closely followed by sample S_2. So, the sample S_3 product may be regarded as the best product.

Table 3.3 Mean score for colour, flavour, texture and overall acceptability of mixed fruit bars

Sample code	Sensory attributes				
	Colour	Flavour	Texture	Taste	Overall acceptability
S_1	5.5^c	5.7^c	7.3^b	6.1^c	6.1^c
S_2	6.8^b	7.0^b	6.1^c	6.4^c	7.1^b
S_3	7.7^a	8.1^a	8.2^a	8.4^a	8.1^a
S_4	5.4^c	6.1^c	5.8^c	7.5^b	5.6^c
LSD (P<0.05)	0.375	0.577	0.547	0.533	0.569

Sample S_1: Mango (40%) + Pineapple (24%) + Papaya (20%)
Sample S_2: Mango (45%) + Pineapple (19%) + Papaya (20%)
Sample S_3: Mango (50%) + Pineapple (14%) + Papaya (20%)
Sample S_4: Mango (35%) + Pineapple (29%) + Papaya (20%)
Mean followed by different superscript letters in each raw are significantly different ($p<0.05$).

4 Conclusion

In this study, the physiochemical, the antioxidant activity and phytochemicals properties, sensory evaluation, and storage ability of mixed fruit bars were investigated. The results show that diverse fruit bars exhibit good physiochemical characteristics. Phytochemicals in mixed fruit bars have recently been ascribed to positive nutritional properties. Every year in Bangladesh, a large amount of mango, pineapple, and papaya are spoiled due to inadequate processing and prevention facilities. The fruit bar preparation is a simple technique for prevention and suitable for cottage and small-scale enterprises. Insufficient and improper processing and prevention facilities for many important fruits like mango, pineapple, and papaya are responsible for increasing post-harvest losses of these commodities. Proper utilization and value addition of these essential fruits through the preparation of mixed fruit bars may help encourage the development of cottage and small-scale industries in the country.

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Compliance with Ethical Standards

Conflict of Interest: MD. Asaduzzaman declares that he has no conflict of interest.

Ethical approval: This article does not contain any studies with human participants or animals performed by any of

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