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Protein Fortified Mango and Guava Fruit Bars: Ingredients Optimization, Quality Evaluation and Storage Stability

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A B S T R A C T

The present investigation was carried out with the objective of the production of mango and guava bars fortified with protein having good sensory quality and high nutritional value and suitable for direct eating as a replacement of the confectionary and snacks which has no nutritional value. The results indicated that the optimum concentrations of sugars were 20% and 15% to be blended with mango and guava pulps, respectively followed by drying at 65°C to moisture content of 15-20%. Sulphiting treatment of mango and guava pulps to the levels of 1500 and 1000 ppm, respectively was necessary to produce fruit bars with good natural colors. Testing the food stabilizers data showed that adding 1.5% of pectin to mango pulp and 0.5% carboxy methyl cellulose to guava pulp are the more suitable conditions to produce fruit bars, respectively with good texture and chewability properties. Protein fortification indicated that using milk protein concentrate with concentration of 1.0% was preferred to produce protein fortified mango bar, while in the case of guava 2.0% of whey protein concentration was the more suitable. Sensory evaluation and chemical analysis indicated the possibility of producing protein fortified mango and guava bars with good sensorially properties and high nutritional values due to their high contents of sugar, protein, amino acids, vitamin C, β – carotene and minerals as well as well as fibers. The products showed high storage stabilities chemically, sensorially and microbiologically.

Introduction

Fruits and fruit products are good sources for valuable components included sugars, acids, vitamins and minerals. Moreover, due to their high contents of substances such as fibers and antioxidants that have therapeutic values; the regular consumption of fruits in sufficient amounts could help in the reduction of risk of some chronic diseases such as cancer, cardiovascular diseases, stroke, Alzheimer diseases and cataracts (Kaur and Kapoor, 2001: and Slavin and Lloyd, 2012). Many types of fruits are seasonal in nature and the fresh fruits are perishable crops due to their high contents of moisture. Consequently, there is a need to explore ways for preserving fruits during the peak harvest period to make them available throughout the year and minimize the losses. In addition, the demand for processed food is expected to increase due to various factors like increasing the urbanization, increasing the employment of woman and the desire for more leisure (De Cicco, 2016). Therefore several methods of preservation and processing of fruits have been developed. Several products such as fruit beverages, canned fruits, frozen slices, and dehydrated products are developed from fruits. Fruit bar is a snack or confectionery product prepared by drying fruit pulp after mixing with appropriate quantities of some ingredients such as sugar and pectin (Narayana *et al.*, 2007). Fruit bars are commonly called fruit slabs, roles or leathers (Chauhan, 1993). Fruit bars contain most of the fruit ingredients and are a rich source of vitamins and minerals and form a good nutritional supplement. Overall, fruit bars have a greater nutritional value than the fresh fruits because all the nutrients are concentrated

People, particularly children and youth, consume unhealthy snacks that are available in the market. The snack manufacturers focus their attention on the development of tasty snacks by adding synthetic flavorings and colors rather than on providing balanced nutrients. Fruit products can compensate the poor nutritional value of such snacks by providing consumers with valuable nutrients such as sugars, vitamins, minerals and other important substances. Meanwhile, fruits and their products are poor in their protein content which is considered as one of the most important nutrients. Keeping in view this scenario, fruit bars supplemented with protein were developed using economical raw materials. Such types of fruit bars that formulated for direct eating are not commercially available in Egypt.

With these ideas in mind the present investigation aims to the production of fruit bar fortified with protein; having good sensory quality attributes and high nutritional value. Mango and guava fruits with their nice and exotic flavors, delicious tastes and attractive colors as well as their rich content of vitamins and minerals were selected for this work.

Materials and Methods

Materials

Fully ripe fruits of Mango *(Mangifera indica L.)* and guava (*Psidium guajava L.*) were purchased from the local market, at Fayoum governorate, Egypt.

Ingredients

The ingredients that were used in the present study include food stabilizers; pectin, carrageenan and Carboxy Methyl Cellulose (CMC), protein fortifiers; Soy Protein Isolate (SPI), Milk Protein Concentrate (MPC) and Whey Protein Concentrate (WPC), and sugar were purchased from the local market. Sodium metabisulfite was purchased from the Al-Gomhoria Company for Chemicals, Cairo, Egypt.

Experimental

Preparation of mango and guava pulps

Mango fruits were sorted, washed, peeled, and the stones were removed. The pulp was passed through a mesh screen to remove the coarse fibers and particulates and immediately heated at 85°C for 2 min using water bath to inactivate the enzymes and then rapidly cooled to room temperature. The finished mango pulp was stored at -20°C until use. Guava fruits were sorted, washed, cut into small pieces and mixed in a blender. The pulp was screened to remove seeds, coarse fibrous tissues and stone cells and immediately heated (at 85°C for 2.0 min), cooled and stored at -20°C until further use.

Optimization of processing parameters for the preparation of mango and guava bars

Sugar was evaluated at the concentrations of 10, 15, 20 and 25 %. Sodium metabisulfite was added at the levels of 500, 1000, 1500 and 2000 ppm to mango and guava puree. Food stabilizers i.e. pectin, carrageenan and CMC were evaluated at levels ranged between 0.5 to 2.5 %. Protein fortification was studied by using SPI, WPC and MPC at the level of 1.0 to 3.0 %.

All the ingredients were thoroughly mixed with fruit pulp and the puree was spread on aluminum trays to a depth of 10.0 mm. The trays were placed in an electric oven and the drying process was carried out at the temperature of 65°C until the leathery structure was formed with a moisture content ranged between 12 and 20 % in the final dried product (fruit bar). At the end of drying process, the trays were taken out the oven and the final weight of fruit bar and its moisture content were then accurately determined. Fruit bar was removed from the tray as a sheet with a thickness of about 3 mm and cut into slabs of a suitable size. The slabs were packed (two layers) in a polyethylene bags, heat sealed and stored at 0ºC till analysis.

Chemical Analysis

Minimum of three replicates were made for each the chemical determinations. Moisture, protein, lipids, crude fiber and ash contents were determined as described by A.O.A.C. (2010). Reducing sugars, non - reducing sugars, and total - sugars were determined in the 80% ethanol extract by according to A.O.A.C. (2010).

pH value was measured at room temperature using a Beckman glass electrode pH meter (model 7020). Total titratable acidity was determined by the titration with 0.1 N NaOH solution to the pH of 8.1 using pH meter and the results were expressed as percent of anhydrocitric acid. Minerals were determined using a Perkin Elmer Atomic Absorption Spectrophotometer (Model 2380) as stated in the A.O.A.C. (2010). Vitamin C. was determined using the indophenol-xylene extraction method with formaldehyde condensation procedure described by Robinson and Stotz (1945). β – Carotene was extracted and determined as described by Ranganna (1986) and the concentrations were calculated according to the formulas described by Lichtentaler and Wellburn (1985). Browning Index was determined as described by Ranganna (1986). Individual amino acids were determined according to the method described by Pellet and young (1980) using a Beckman Amino Acid Analyzer (Model 119 CL).

Sensory evaluation

Sensory quality attributes included color, texture, chewability and flavors as well as overall acceptability of mango and guava bars were evaluated on a 10-ponit structured scale to determine the more suitable processing parameters for making fruit bar with good eating quality characteristics. The panelists were requested to rate the samples for their quality attributes according to the following description: Excellent (9-10 points), Very good (7-8 points), Good (5-6 points), Fair (3-4 points) and Poor (1-2 points).

Microbiological survey

Fortified mango and guava bars were examined for total plate count and mold and yeast count during storage.

Storage studies

Fortified mango and guava bars were packed (two layers) in a polyethylene bags, heat sealed and stored at 0°, 5°C and room temperature (25-30°C) for 6 months. Samples were withdrawn at regular intervals for chemical analysis, sensory evaluation and microbiological examination.

Statistical analysis

The statistical analysis was carried out according to SPSS version 12 software program. Means and standard deviation (SD) was measure by L.S.D at 5% level of significant.

Results and Discussion

Chemical composition of mango and guava pulps

Data given in Table 1 showed considerable variations between mango and guava pulps particularly their contents of sugars, vitamin C β- carotene and fibers. Mango pulp contained 12.59, 2.38 and 14.97 % of reducing sugars, non – reducing sugars and total sugars, respectively, while guava contents of these sugars were 5.77, 0.93 and 6.70 %, respectively. These findings are in close agreement with previous findings of Tandon and Kalara (2015). Data showed that guava pulp contained relatively higher concentrations of crude fibers (2.75 %) than mango pulp (0.99 %). The results also showed that vitamin C content of guava and mango pulps were 348.3 and 282.7 mg/100g, respectively while β-carotene contents were 3.86 and 45. 87 mg/100g of guava and mango pulps, respectively. The results also indicated the low protein and lipids contents of mango and guava pulps which were determined by 1.77 and 1.23 % for proteins, respectively, while lipids were 1.47 and 1.01 %, respectively. This is in accordance with Bose, *et al.,* (1999) who found that protein content in guava fruit was as low as only 1.0%. These finding agreed with Khalil (1997). It should be mentioned that there are several variables such as variety, ripening stage, season, environmental conditions and location of cultivation considerably affect the chemical characteristics of different types of fruits (Bashii and Abu Goukh, 2003).

Adjusting sugar concentration

Fruit pulp (mango or guava) was blended with sugar at the levels of 10, 15, 20 and 25% to assess the optimum level to prepare fruit bar with good quality. The mixture was dried at 65°C until the leathery structure was formed. Data shown in Table 2 are the sensory attributes of mango and guava bars prepared with the different concentrations of sugars. Sugar is mainly gives fruit bar sweet taste and balancing the sugar to acid ratio gives good flavor, and to some extent; sugar also contributes to structure of fruit bar. Therefore, it was found that flavors of mango and guava fruit bars were improved as the concentration of sugar increased. These results showed that the highest score values for flavor as well as overall acceptability of mango and guava bars were found at sugar concentrations of 20 and 15%, respectively. These results agreed with Khalil (1997) and Parab *et al.,* (2014).

Adjusting the level of SO_2 concentration

The results already discussed showed that color of mango and guava bars were poor and unaccepted by the panelists. With the objective of assessment the minimum concentrations of SO_2 required to improve the color of mango and guava bars without adverse effect, mango and guava purees were sulphited treatment was carried out at SO_2 level of 500-2000 ppm and fruit bars obtained were evaluated for their quality characteristics (Table 3).

It was noticed that the score values for color of mango bar treated with 500, 1000, 1500 and 2000 ppm SO_2 were 6.8, 7.8, 8.8 and 9.2, respectively indicating that as the level of SO_2 increased, color of mango bar was improved. This observation is confirmed by the values of browning index which decreased from 0.215 at 500 ppm SO_2 to 0.022 at 2000 ppm SO_2. The same trend was also observed with guava bar. These results might be attributed to the role of SO_2 in the prevention of browning reactions. However, the high concentration of SO_2 showed an adverse effect on the quality of mango and guava bars particularly the flavor due to the detection of off-flavor as a result of the relatively high content of the residual SO_2 in the end dried product (fruit bar).

Based on score values for flavor and overall quality, it could be concluded that sulphiting mango and guava pulps with 1500 and 1000 ppm of SO_2, respectively are the more suitable levels to prepare mango bar with attractive natural yellow color and guava bar with creamy white color without noticed darkening with less undesirable effect on flavors.

Optimization of the type and concentration of food stabilizers

Texture is one of the most important criteria determining the overall quality and acceptability of fruit bars which are mainly consumed by direct-eating as a confections or snacks. The aforementioned results indicated that texture of mango baror guava bar was poor based on the low score values for texture property. Several types of food stabilizers are commercially available and widely used in food industry.

Each type of food stabilizers has its own physicochemical characteristics that affect their gelling, thickening, and stabilizing properties. Three types of stabilizers viz., pectin, carrageenan and carboxy methyl cellulose (CMC) were evaluated at different concentrations (0.5 to 2.5%) and the fruit bars obtained were organoleptically evaluated to assess the optimum level of each of the three food stabilizer to improve the structure and texture of mango and guava bars. These experiments showed that, the optimum concentrations of pectin, carrageenan and (CMC) were 1.5, 0.5 and 1.0%, respectively for mango bar and 0.5, 1.0 and 0.5%, respectively for guava bar (Data not shown).

A comparison was made between the three food stabilizers used under their optimum concentrations to select the more preferred and accepted parameters by the panelists to prepare mango bar (Table 4a) and guava bar (Table 4b) with good textures. The results showed that mango bar made by using 1.5% of pectin was significantly preferred with an excellent texture ideal for direct eating with good chewability without any adverse effects on color or flavor while for guava bar it was concluded that using 0.5% of CMC was the more preferred by the panelists (Table 4b).

Optimization of protein fortification of fruit bar

Attempts were made to increase the nutritional value of fruit bar by the supplementation of the product with protein since it is well known that fruit products are poor in protein content. Three commercially available protein preparations were selected as protein fortifiers of mango and guava fruit bars. The selected protein preparations were soy protein isolate (SPI), whey protein concentrate (WPC) and Milk protein concentrate (MPC).

The present experiments were carried out to assessment the optimum conditions of protein fortification of mango and guava bars by the determination of the type of protein fortifier and its level. Three commercially available protein preparations were selected as protein fortifiers of mango and guava fruit bars. The selected protein preparations were soy protein isolate (SPI), whey protein concentrate (WPC) and Milk protein concentrate (MPC). Each of the three protein sources was evaluated at concentrations ranged between

1.0 to 3.0% to determine the optimum levels for protein supplementation of mango and guava bars. The results (data not shown) indicated that for mango bar, the optimum levels of SPI, WPC and MPC were 1.0, 1.5 and 1.0%, respectively while for guava bar the optimum levels these protein fortifiers were 1.0, 2.0 and 3.0%, respectively.

Protein fortified mango bars prepared by using the suitable concentrations of the three evaluated protein sources were subjected to sensory evaluation to assess the highly accepted one by the consumer. Data obtained are summarized in Table (5a). Based on sensory evaluation data, it could be concluded that milk protein concentrate was the highly preferred as protein fortifier with a concentration of 1.0 to produce protein fortified mango bar with good quality characteristics.

Similarly, protein fortified mango bars prepared by using the suitable concentrations of the three protein fortifiers were compared for their sensory properties. In general, all the sensory quality attributes of guava bar fortified with MPC or WPC scored higher values comparing with guava bar fortified with SPI. On the other hand, in spite of the close score values for guava bar fortified with MPC and WPC, the panelists preferred guava bar fortified by 2.0% WPC based on the highest values recorded for texture, chewability, flavor and overall acceptability.

Nutritional value of protein fortified fruit bar

Protein fortified fruit bars made from mango and guava fruits prepared under the predetermined optimum conditions were analysed for their chemical compositions, and their contents of amino acids, minerals, vitamin C and β – carotene (provitamin A) to evaluate their nutritional values.

Chemical composition of protein fortified mango and guava bars

Chemical analysis of protein fortified mango and guava bars indicated their good nutritional values due to their high contents of several valuable components (Table 6). The results showed that moisture content of protein fortified mango bar was 17.04%, while in protein fortified guava bar was 12.52%.

Chemical composition showed that total sugars represented the major constitutes in both mango and guava bars which were determined by about 66.00%. Fiber contents of mango and guava bars were 1.76 and 5.55%, respectively while their contents of ash were 1.95 and 1.25%, respectively.

The results also showed the high protein content of mango bar (10.54%) and guava bar (11.61%) as a result of protein fortification treatment.

Amino acids composition of protein fortified mango and guava bars

Protein fortified mango and guava bars were analysed for their contents of amino acids and data obtained are tabulated in Table 7. The results indicated the presences of the majority of essential and non-essential amino acids in protein fortified guava and mango bars.

It was observed the presence of 5 essential amino acids and 5 non - essential amino acids in protein fortified mango bar while in protein fortified guava bar 13 amino acids were available. Most of amino acids were found with considerable levels. The essential amino acid lysine was found with a concentration as high as 5.17% representing more than 59.0% of the total amino acids found in mango bar and 4.38% which represented about 42.0% of the total amino acids determined in guava bar.

Table.1 Chemical composition of mango and guava pulps

Particular*	Mango pulp	Guava pulp
Moisture (%)	80.4	87.91
Reducing sugars (%)	12.59	5.77
Non-reducing sugars (%)	2.38	0.93
Total sugars (%)	14.97	6.70
Total titratable acidity (%)	2.98	2.97
pH value	4.85	4.66
Crude fiber (%)	0.99	2.75
Protein (%)	1.77	1.23
Lipids (%)	1.47	1.01
Ash (%)	0.4	0.40
Vitamin C (mg/100g)	282.69	348.30
β- carotene (mg/100g)	45.87	3.86

* Wet weight basis

Table.2 Sensory mean scores of mango and guava bars as affected by the concentration of sugar added to pulp

Sugar concentration (%)	Sensory mean scores*							
	Mango Bar				Guava Bar			
	Color	Texture	Flavor	Overall acceptability	Color	Texture	Flavor	Overall acceptability
10	6.8^{a}	7.2^{a}	8.2^{a}	7.2^{a}	6.8^{a}	7.6^{a}	9.0^{a}	7.0^{a}
15	6.4^{a}	7.4^{a}	9.0^{a}	7.1^{a}	**7.0^{a}**	**7.6^{a}**	**9.2^{a}**	**7.8^{b}**
20	**6.6^{a}**	**7.6^{a}**	**9.4^{b}**	**7.6^{b}**	7.0^{a}	7.4^{a}	9.4^{a}	7.4^{a}
25	6.4^{a}	7.2^{a}	9.0^{a}	7.3^{a}	7.2^{a}	8.0^{a}	9.2^{a}	7.2^{a}

*means with different letters in the same column for each fruit bar indicate significant different ($p < 0.05$).

Table.3 Sensory mean scores and browning index (A at 420 nm) of mango and guava bars as affected by the concentration of SO_2

Initial SO2 (ppm)	Sensory mean scores*									
	Mango Bar					Guava Bar				
	Color	Texture	Flavor	Overall acceptability	Browning Index (A at 420nm)	Color	Texture	Flavor	Overall acceptability	Browning Index (A at 420nm)
500	6.8^{a}	7.2^{b}	9.2^{c}	7.0^{b}	0.215	6.0^{a}	7.4^{a}	9.6^{c}	6.8^{a}	0.245
1000	7.8^{b}	7.4^{b}	9.0^{c}	7.2^{b}	0.092	**8.0^{b}**	**7.6^{a}**	**9.4^{c}**	**7.0^{a}**	**0.103**
1500	**$8.8.^{c}$**	**7.4^{b}**	**8.0^{b}**	**7.6^{c}**	**0.030**	8.4^{b}	7.4^{a}	8.6^{b}	6.6^{a}	0.046
2000	9.2^{c}	6.4^{a}	6.8^{a}	6.2^{a}	0.022	9.0^{c}	7.6^{a}	7.8^{a}	6.0^{b}	0.018

*means with different letters in the same column for each fruit bar indicate significant different ($p < 0.05$).

Table.4a Sensory quality characteristics of mango bars* prepared by using the optimum levels of pectin, carrageenan and CMC

Stabilizers	Sensory mean scores**				
	Color	Texture	Chewability	Flavor	Overall acceptability
Pectin (1.5 %)	**9.46^b**	**8.88^b**	**8.92^b**	**9.08^b**	**9.04^b**
Carrageenan (2.0%)	7.04^a	8.08^{ab}	8.25^{ab}	7.96^a	7.96^a
C.M.C (1.0 %)	8.38^a	6.88^a	6.58^a	7.83^a	6.96^a

*Mango pulp was mixed 20% sugar and 1500ppm SO_2 and dried at 65°C.
**means with different letters in the same column for each fruit bar indicate significant different ($p < 0.05$).

Table.4b Sensory quality characteristics of guava bars* prepared by using the optimum levels of pectin, carrageenan and CMC

Stabilizer	Sensory mean scores**				
	Color	Texture	Chewability	Flavor	Overall acceptability
Pectin (0.5%)	9.14^b	9.02^a	8.80^a	8.93^a	9.04^a
Carrageenan (1%)	8.00^a	8.93^a	8.55^a	9.14^a	8.57^b
C.M.C (0.5%)	**9.36^c**	**9.10^b**	**8.93^a**	**8.93^a**	**9.14^a**

*Guava pulp was mixed 15% sugar and 1000ppm SO_2 and dried at 65°C. **means with different letters in the same column for each fruit bar indicate significant different ($p < 0.05$).

Table.5a Sensory quality attributes of protein fortified mango bar* as affected by the type of protein fortifier

Protein Fortifier	Sensory mean score**				
	Color	Texture	Chewability	Flavor	Overall acceptability
SPI (1.0 %)	8.14^a	8.32^a	8.32^a	8.45^a	8.36^b
MPC (1.0%)	**8.68^b**	**8.64^a**	**8.82^a**	**8.77^b**	**8.68^a**
WPC (1.5%)	8.77^b	8.77^a	8.55^a	8.24^a	8.48^b

*Mango pulp was mixed 20% sugar and 1.5% pectin and 1500ppm SO_2 and dried at 65°C.
**means with different letters in the same column for each fruit bar indicate significant different ($p < 0.05$).

Table.5b Sensory quality attributes of protein fortified guava bar* as affected by the type of protein fortifier

Protein Fortifier	Sensory mean scores**				
	Color	Texture	Chewability	Flavor	Overall acceptability
SPI (1.0%)	8.20^a	8.80^a	8.37^a	8.40^a	8.30^a
MPC (3.0%)	9.70^b	9.00^a	8.55^a	9.10^{ab}	9.30^b
WPC (2.0%)	**9.10^b**	**9.20^a**	**8.93^a**	**9.50^b**	**9.30^b**

*Guava pulp was mixed 15% sugar and 0.5% C.M.C and 1000ppm SO_2 and dried at 65°C.
**means with different letters in the same column for each fruit bar indicate significant different ($p < 0.05$).

Table.6 Chemical composition of protein fortified mango and guava bars

Particular	Mango Bar	Guava Bar
Moisture (%)	17.09	12.52
Reducing sugars (%)	59.16	55.15
Non-reducing sugars (%)	6.50	10.57
Total sugars (%)	66.00	66.28
Crude fiber (%)	1.76	5.55
Protein (%)	10.54	11.61
Ash (%)	1.95	1.25
Lipids (%)	3.61	3.29
Total acidity (as anhydro citric acid, %)	2.27	2.75
pH value	4.86	4.75

Table.7 Amino acids contents of protein fortified mango and guava bars*

Amino Acid	Amino acids content				FAO/WHO/ UNU (1985) Reference (g/100g protein)
	Mango bar		Guava bar		
	(g/100g bar)	(g/100g protein)	(g/100g bar)	(g/100g protein)	
Essential					
Lysine (lys)	5.17	59.29	4.38	42.03	1.6
Histadine (HiS)	0.00	0.00	0.09	0.86	1.9
Threonine (Thr)	0.14	1.61	0.36	3.45	0.9
Methionine (Met)	0.00	0.00	0.00	0.00	(Meth + Cyst)
Valine (Val)	0.17	1.95	0.17	1.63	1.3
Isoleucine (Ile)	0.29	3.33	0.15	1.44	1.7
Leucine (Leu)	0.00	0.00	0.88	8.45	1.3
Tyrosine (Tyr)	0.00	0.00	0.18	1.73	1.9
Phenylalanine (Phe)	0.25	2.87	0.31	2.98	(Phenyl. +Tyr)
Non-essential					
Aspartic acid (Asp)	0.68	7.80	1.37	13.15	
Seronine (Ser)	0.19	2.18	0.30	2.88	
Glutamic acid (Glu)	0.96	11.01	1.08	10.36	
Proline (pro)	0.00	0.00	0.00	0.00	
Glysine (Gly)	0.53	6.08	0.47	4.51	
Alanine (Ala)	0.34	3.90	0.68	6.53	
Total	**8.72**	**100**	**10.42**	**100**	

***Protein fortifier is MPC for mango bar and WPC for guava bar

Table.8 Vitamin C, β- Carotene and mineral contents of protein fortified mango and guava bars

Vitamins and Minerals	Mango bar (mg/100g)	Guava bar (mg/100g)
Vitamin C	105.07	260.10
β- Carotene	25.05	4.10
Cupper (Cu)	0.28	0.17
Iron (Fe)	3.21	2.88
Zinc (Zn)	0.78	2.65
Manganese (Mn)	0.09	0.08
Phosphor (P)	0.31	0.19
Potassium (K)	658.73	647.61
Sodium (Na)	35.00	62.53
Magnesium (Mg)	3.07	1.43

Table.9 Chemical composition changes in protein fortified mango bar during storage at different temperatures

Storage-time (month)	Storage-temp. (C◦)	Particular (%)							
		Moisture	Reducing sugars	Non-reducing sugars	Total sugars	Protein	Crude fiber	Ash	pH value
0	**-**	17.09	59.16	6.50	66.00	10.54	3.76	1.95	4.86
2	**0**	17.59	58.69	6.90	65.95	10.44	3.50	1.98	4.89
	5	17.15	58.57	6.87	65.80	10.32	3.67	2.33	5.17
	25-30	16.75	58.20	6.84	65.40	10.35	3.10	2.35	5.07
4	**0**	16.26	58.40	6.67	65.42	10.16	3.50	1.10	5.33
	5	16.82	58.67	6.44	65.45	10.21	3.83	1.97	4.87
	25-30	16.33	58.45	6.42	65.21	10.15	3.61	1.15	4.91
6	**0**	16.22	58.91	6.47	65.72	10.07	3.80	1.26	5.35
	5	16.90	58.80	6.46	65.60	10.15	3.77	1.28	5.12
	25-30	16.17	58.26	6.40	65.00	10.15	3.83	1.22	5.00

Table.10 Chemical composition changes in protein fortified guava bar during storage at different temperatures

Storage-time (month)	Storage-temp. (C◦)	Particular (%)							
		Moisture	Reducing sugars	Non-reducing sugars	Total sugars	Protein	Crude fiber	Ash	pH value
0	**-**	12.52	55.15	10.57	66.28	11.61	5.55	1.25	4.75
2	**0**	12.50	57.25	8.79	66.50	11.21	5.79	1.19	4.77
	5	11.60	57.14	8.80	66.40	11.30	5.70	1.22	4.75
	25-30	12.45	57.81	9.21	67.50	11.23	5.60	1.20	4.85
4	**0**	12.93	56.72	8.82	66.00	11.14	5.81	1.21	4.77
	5	11.71	57.36	9.16	67.00	10.86	5.63	1.25	4.75
	25-30	12.78	56.36	9.16	66.00	10.59	5.55	1.20	4.95
6	**0**	13.00	56.66	8.87	66.00	11.07	5.85	1.26	4.77
	5	12.05	57.08	9.33	66.90	10.70	5.67	1.28	4.75
	25-30	13.09	55.93	9.47	65.90	10.55	5.60	1.22	5.15

Table.11 Changes in vitamin C and β – carotene contents of protein fortified mango and guava bars during storage at different temperatures

Storage – Time (month)	Storage – temp (°C)	Mango Bar		Guava Bar	
		Vitamin C (mg/100g)	β –carotene (mg/100g)	Vitamin C (mg/100g)	β –carotene (mg/100g)
0	**-**	105.07	25.05	269.30	4.19
2	**0**	103.35	24.64	255.70	3.98
	5	102.61	24.46	255.43	3.97
	25-30	95.14	22.68	220.63	3.43
4	**0**	102.54	24.39	248.50	3.87
	5	102.13	24.35	248.35	3.86
	25-30	84.06	20.04	180.98	2.82
6	**0**	102.31	24.03	246.71	3.84
	5	100.18	23.89	240.05	3.73
	25-30	69.54	16.58	142.46	2.22

Taking into consideration the protein reference (FAO/WHO/UNU, 1985), it could be concluded the good nutritional value of protein determined in protein fortified mango and guava bars.

Vitamin C, β- carotene and mineral contents of protein fortified mango and guava bars

Protein fortified mango and guava bars contents of Vitamin C, β- carotene and minerals are presented in Table 8. The results showed the high contents of vitamin C which was determined by 260.10 and 105.07 mg/100g of guava and mango bars, respectively. β- carotene content of mango bar was found to be 25.05 mg/100g of mango bar while guava bar contained only 4.10 mg/100g Similar results were reported by Khali (1997) and Mercadante and Rodriguez-Amaya (1998).

Mineral composition indicated the presence of all the eight minerals determined viz., Cu, Fe, Zn, Mn, P, K, Na and Mg**.** Potassium showed the highest content among the minerals found in mango and guava bars with concentration around 650 mg/100g fruit bar followed by sodium which was determined by 35.00 and 62.53 mg/100g of mango and guava bars, respectively. Iron contents mango and guava bar were 3.21 and 2.65 mg/100g of mango and guava bars, respectively.

Storage stability of protein fortified fruit bar

Protein fortified mango and guava bars were stored at three different temperatures 0, 5°C and room temperature (25-30°C) for 6 months to study the storage. Samples were withdrawn at periods of two months for chemical composition, vitamin C and β – carotene contents to assess the shelf – life of fruit bar as a function of storage temperature.

Chemical composition changes

Data presented in Tables 9 and 10 summarize the changes in chemical composition of protein fortified mango and guava bars during storage at different temperature. No considerable changes could be observed in the chemical composition during storage even after 6 months storage at room temperature. No considerable changes could be detected in moisture, sugars, fibers and ash contents while protein content slightly decreased during storage of fruit bar at the different temperatures. These observations indicated the high storage stabilities of protein fortified mango and guava even during storage at room temperature. Similar results were found by Munir *et al.*, (2016).

Changes in vitamin C and β – carotene contents

The results given in Table 11 show changes in vitamin C and β – carotene contents of protein fortified mango and guava bars during storage at different temperatures

No considerable changes in vitamin C and β – carotene contents of samples stored at low temperatures. Meanwhile, storage at room temperature showed a considerable degradation of vitamin C and β – carotene which increased as the storage time prolonged.

At the end of 6 months storage at room temperature, the initial content of fresh guava bar of vitamin C decreased from 269.3 to 142.46 mg/100g. Also, vitamin C content of mango bar decreased from 105.07 mg/100g of fresh sample to 69.54 mg/100g in sample stored for 6 months at room temperature while β – carotene decreased from 25.05 to 16.54 mg/100g.

Microbiological survey

Over the entire period of 6 months storage, molds and yeasts were not detected while the total bacterial counts showed gradual negligible increases as the storage period prolonged particularly in the samples stored at room temperature. No gross signs of microbial spoilage were observed in the samples during storage at the different temperatures. These results indicated that mango and guava bars were microbiologically sound for direct consumption. The microbiological stability of samples may be due to the osmotic pressure of the high sugar contents of the samples which suppressed the growth of microorganisms.

The present investigation was carried out with the objective of producing protein fortified fruit bar with high nutrition value and good sensory characteristics of color, texture, chewability and flavor and suitable for direct eating. The results indicated that optimum concentrations of sugars were 20% and 15% to be blended with mango and guava pulps, respectively and drying at 65 C for moisture about 15 – 20%. The results also indicated the importance of sulphiting treatment to SO_2 of 2000 and 1500 ppm to produce mango and guava bars, respectively with good colors.

Testing the food stabilizers data showed that using 1.5% of pectin and 0.5% carboxy methyl cellulose the more suitable conditions to produce mango and guava bars, respectively with good texture and chewability properties.

Protein fortification indicated that using milk protein concentrated with concentration of 1.0% was preferred to produce protein fortified mango bar, while in the case of guava 2.0% of whey protein concentration was the more suitable.

The results indicated the improved and high nutritional value of protein fortified mango and guava bar as a result of protein fortification which resulted in increasing protein content and amino acidsof fruit bars in addition to their high contents of the valuable contents included, sugar, vitamin C, β – carotene, minerals as well as fibers.

The study showed the high storage stability of protein fortified mango and guava bars as indicated from the chemical, sensory and microbiological stability of the products during storage at different temperature for 6 months.

References

A.O.A.C. 2010.Official Methods of Analysis.19th Edition, Revision 3, Association of Official Analytical Chemists, Washington DC.

Bashii, H.A and Abu-Goukh, A. 2003.Compositional changes during guava fruit ripeing. *Food Chem.*, 80(4): 557-563.

Bose, T. K., Mitra, S. K., Farooqui, A. A. and Sandhu, M. K. 1999. Tropical Horticulture 1st ed. *Nava Prokash Publication, Kolkata.*, Pp. 297.

Chauhan, S. K., Joshi, V. K and Lal, B. B. 1993.Apricot soy fruit bar – a new protein enriched product. *J Food Sci Technol.*, 30(6): 457–458.

De Cicco, A. 2016. The fruit and vegetable sector in the EU - a statistical overview. Eurostat Statistics Explained. Data extracted in July and August.

FAO/WHO/UNU. 1985. Energy and protein requirements. Report of joint FAO/WHO/ UNU. Expect consultation, World Health Organization. *Technical Report Series., 724, WHO, Geneva.*

Kaur, C. and Kapoor, H. C. 2001. Antioxidants in fruits and vegetables and the millennium's health. *International Journal of Food Science and Technology*. 36: 703±725.

Khalil, E. K. 1997. Optimization of processing parameters and storage stability of mango and guava leathers. *Menofiya J. Agric. Res.*, 22(3): 831-856.

Lichtenthaler, H. K. and Wellburn, A. R. 1985. Determination of Total Carotenoids and Chlorophylls A and B of Leaf in Different Solvents. *Biol. Soc. Trans.*, 11: 591-592.

Mercadante, A. Z. and Rodriguez-Amaya, D. B. 1998. Effects of Ripening, Cultivar Differences, and Processing on the Carotenoid Composition of Mango. *J. Agric. Food Chem.*, 46 (1): 128–130.

Munir, M., Nadeem, M., Qureshi, T. M., Jabbar, S., Atif, F. A. and Zeng, X. 2016. Effect of protein addition on the physicochemical and sensory properties of fruit bars. *J. Food Proc. and Preserv.*, 40(3): 559-566.

Narayana, C. K., Mustaffa, M. M. and Sathiamoorthy, S. 2007. Standardization of process for preparation of banana fruit bar. *Indian J. Hort.*, 64(3): 349-350.

Parab, A. Y., Relekar, P. P. and Pujari, K. H. 2014. Studies on preparation of mango (*Mangifera indica* L.) bar from frozen Alphonso mango pulp. *Asian J. Hort.*, 9(1): 243-247.

Pellet, L. P. and Young, R. V. 1980. Nutritional evaluation of protein foods. *The United Nation University*, WHTR.3/UNDP-129, Tokyo.

Ranganna, S. 1986. Handbook of Analysis and Quality Control for Fruit and Vegetable products" 2nd edn. *Tata Graw-Hill pul. Ltd., New Delhi.*

Robinson, W. B. and Stotz, E. 1945. The indophenol-xylene extraction method for ascorbic acid and modification interfering substance. *J. Biol. Chem.*, 160: 217.

Slavin, J. L. andLloyd, B. 2012. Health benefits of fruits and vegetables. *National Institutes of Health.*, 3(4): 506.

Tandon, D. K. and Kalara, S. K. 2015. Changes in sugars, starch and amylase activity during development of mango fruit cv Dashehari. *Journal of Horticultural Science.*, 58(3): 449-453.

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