

Studies on Fortification of Solar Dried Fruit bars

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ABSTRACT

The fruit bars specially Mango bars, processed in the novel and unique Solar Cabinet Dryer, Designed and Developed by Society for Energy, Environment & Development have become very popular in India. The technology developed in processing the recipe of the bars is studied in its Physico-Chemical properties, Nutritional facts and Organoleptic properties. To further improve the nutritional values Mango bar and Guava bars are fortified with proteins of Whey, Soya and Peas, Beta-carotene with carrot blending, ascorbic acid (Vitamin-C) and calcium compounds. The characteristics of solar dried bars and the enriched nutritional values were studied. The result of these investigations are reported and discussed. The sensory properties were also evaluated.

In light of hard structure formed with various proteins, whey protein is found more acceptable. Calcium fumarate and ascorbic acid were preferred for enrichment of mango bar. For guava bar, Beta- Carotene enrichment was done through carrot, forming fruit- Veg bar. Some of the results are being incorporated in commercialized bars by enriching the SEED Mango bar.

Introduction

In SEED since last 20 years a number of products were processed in solar dryer using renewable green energy with zero energy cost in a clean & hygienic environment. Most popular and common among the products are fruit bars, dried fruits & vegetables. With the advent of solar dryer technology a variety of fruit bars were developed using different fruits & fruit blends. Pulp fruits are mostly used in making the fruit bars. Mango bar is a snack product prepared using mango pulp, sugar, citric acid, pectin & potassium meta bi sulphite. Nutritionally the bar is very low in protein and fat contents. But the product is rich in sugar yielding considerable number of calories for energy. Some have tried on protein enrichment of mango bar using various protein sources like rice flour & shrimp protein, whey protein isolate, coconut powder etc.

Nutrient losses are bound to occur during food processing & storage. Food fortification has come into picture several decades back & refers to the addition of essential nutrients which are originally deficient or lost during processing. Foods can be fortified with nutrients either in powder or liquid form. Water soluble vitamins especially are very sensitive to external factors such as humidity, heat, light, oxygen, pH, oxidizing & reducing agents. Level of nutrient fortification generally ranges between 15%-25% of Recommended Dietary Allowance (RDA) and the nutrients added should be sufficiently stable in food in packing, storage, distribution and use. The nutrients added must not impart undesirable characteristics to the food, change color, taste, smell, texture, cooking properties and should not shorten shelf life. The additional cost of fortification should be reasonable for the consumer. At present there is good demand is for solar dried fruit bar and the research and development is making new strides.

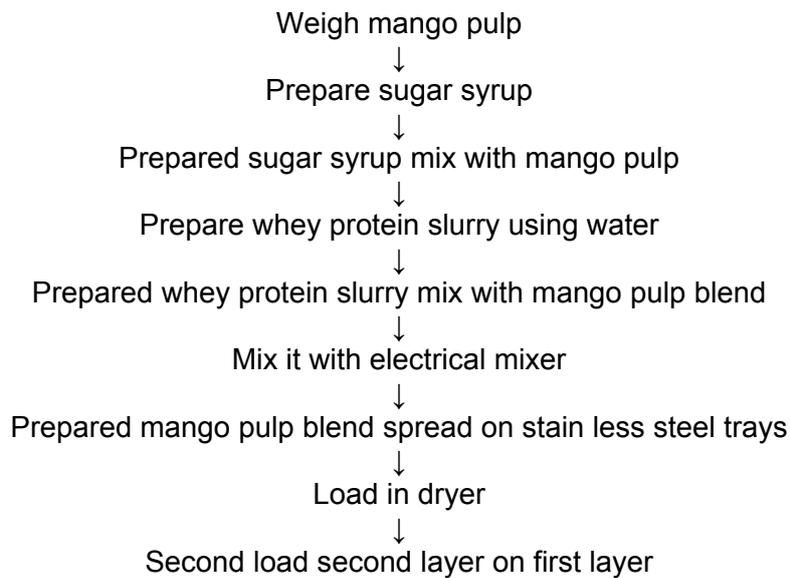
But the fruit bars processed in solar dryer were not fortified with any of the nutrients. Hence the present project is under taken to fortify or enrich the fruit bars with selected nutrients & to promote good nutrition among the consumers. Nutrient enrichment of fruit bar with nutrient rich vegetables has also been studied through a DST supported project. This technology not

only improves the nutrient intake of consumers but also helps the women to start a small scale production unit at home level to supplement their incomes by enabling self employment in rural sector.

Methodology:

Solar dried mango bar was selected as a vehicle for nutrient fortification. The basic mango bar recipe was slightly modified by changing the composition of sugars used, as the sugar level is slightly high. Instead of 30 % sugar & glucose, only 20 % was used and the remaining 10% was made up with maltodextrin. The mango bar (process details in flow chart 1) thus prepared was soft in texture and was highly acceptable.

Flow Chart 1: Mango Bar processing



The per cent composition of basic and new mango bar recipe are given in table 2. Formation of quality bars in terms of set & appearance, texture, colour, appeal etc are important criteria chosen for the developing of the nutrient fortified mango bar. In addition the fortification was based on the Recommended Daily Nutrient Allowances (RDA) of ICMR, India. The new mango bar recipe (Composition table 1) was fortified with 5% Protein using – Soy Protein Isolate, Whey Protein & Pea Protein Concentrates (Formulation & Composition table 2),

Table 1: Composition of different Protein sources Fortified of Mango Bars

Parameters	Soy protein Isolate*	Whey protein concentrate *	Pea protein concentrate *
Moisture %	5.5	5.5	-----
Protein%	90.0	74.0	82.0
Fat%	5.5	7.0	-----
Ash %	5.0	3.5	-----
PH	7.3-7.7	6.1-6.7	-----
Colour	Cream	White to cream	Cream to yellow
Flavour	Bland	Bland	Bland

Table 2: Formulation & Composition of Protein Fortified Mango Bars

Ingredients	Mango bar Recipe		Soy protein Isolate	Whey protein conc.	Pea protein conc.
	Basic	New			
Mango pulp (%)	70	70	70	70	70
Sugar & glucose (%)	30	20	20	20	20
Maltodextrin (%)	-----	10	10	10	10
Citric acid (%)	0.2	0.2	0.2	0.2	0.2
Pectin (%)	0.1	0.1	0.1	0.1	0.1
Potassium meta bi sulphite (%)	0.2	0.2	0.2	0.2	0.2
Protein (%)			3.0	3.0	3.0

Composition of Calcium Fortified Mango bars:

New mango bar recipe is separately added with different types of calcium compounds to provide 500mg Ca. The Calcium used for fortification was from three different sources and in different levels to supply 500mg to meet RDA. The sources are a) Calcium phosphate (tri basic), (b) Calcium carbonate, (c) Calcium citrate & (d) Calcium fumarate (imported from USA). Repeated trials were made to obtain a standard product .The formulations/ composition are given in table 3.

Table 3: Formulation & Composition of Calcium Fortified Mango Bars

Ingredients	Mango bar Recipe	Calcium Phosphate	Calcium Carbonate	Calcium Citrate	Calcium fumarate
Mango pulp (%)	70	70	70	70	70
Sugar & glucose (%)	20	20	20	20	20
Maltodextrin (%)	10	10	10	10	10
Citric acid (%)	0.2	0.2	0.2	0.2	0.2
Pectin (%)	0.1	0.1	0.1	0.1	0.1
Potassium meta bi sulphite (%)	0.2	0.2	0.2	0.2	0.2
Calcium (%)	--	0.5	0.5	0.5	0.5

Composition of Vitamin- C fortified Mango Bar:

The composition of mango bar added with 200mg of vitamin C is in given below in Table 4.

Table 4: Formulation & Composition of Mango Bar Fortified with Vitamin- C

Ingredients	Mango bar Recipe	Mango bar with Vitamin C
Mango pulp (%)	70	70
Sugar & glucose (%)	30	30
Citric acid (%)	0.2	0.2
Pectin (%)	0.1	0.1
Potassium meta bi sulphite (%)	0.2	0.2
Vitamin-C (%)	---	0.2

Processing of Guava + Carrot bar rich in Beta -Carotene (Pro vit-A) & study of organoleptic, Physico chemical and shelf life qualities:

Mango fruit has originally high amount of betacarotene. Naturally the Fruit bar prepared using mango pulp contains abundant amount of beta carotene. Hence alternatively guava fruit is chosen

to process fruit bar as it contains negligible beta carotene content. Commercially processed guava

fruit pulp was procured and used in the production of guava fruit bar. Carrot (vegetable) exceedingly high in betacarotene is selected to blend with & fortify guava fruit bar. The Composition of guava + carrot fruit bar rich in beta carotene (pro vitamin A) is presented in table 5.

Table 5: Composition of Guava + Carrot Fruit Bar

Ingredients	Composition of Carrot puree		
	10%	15%	20%
Guava pulp (%)	60	55	50
Carrot Puree (%)	10	15	20
Sugar & glucose (%)	30	30	30
Citric acid (%)	0.4	0.4	0.4
Pectin (%)	0.1	0.1	0.1
Potassium meta bi sulphite (%)	0.2	0.2	0.2

Flow Chart 2- Method of processing guava + carrot fruit bar:

Weigh separately guava fruit pulp & carrot puree- 10% /15% /20 % into three stainless steel containers.



Weigh sugar, liquid glucose and all other ingredients separately.



Prepare sugar syrup using sugar & liquid glucose.



Dissolve citric acid & pectin in little hot water & add to the syrup



Dissolve potassium meta bi sulphite in little water & add to pulp mixture.



Blend the mixture well using a hand mixer



Spread on stainless steel trays evenly & load in solar dryer (first layer)



Repeat the procedure on the second day & spread on the first layer which is already dried. (Second layer)



On drying remove from the trays & cut in to uniform size cubes for toffees, three inch size bars or roll to desired shapes & pack in LDPE film (Primary pack).

After processing in solar dryer the quality of the mango bars as well as the retention of nutrients and their acceptability were examined in he laboratory.

Physico chemical analysis: All fruit bars were analysed for moisture, pH, Titratable acidity, Brix, Reducing & Total sugars following standard procedures.

Nutrient Analysis: Where necessary nutrients - Protein, Calcium, Ascorbic acid & Beta Carotene were estimated by adopting standard techniques.

Organoleptic Evaluation: All the finished products were assessed for various sensory attributes- appearance, colour, texture & taste & flavour which appeal the acceptability of the fruit bar.

RESULTS

The findings of the study are presented in the following few tables along with photographs. The Physico- chemical characteristics of Protein enriched mango bars are given in table 6.

Table 6: Physico- chemical Characteristics of Protein Enriched Mango Bar

Parameters	Mango Pulp	Mango Bar Control	Soy protein isolate	Whey Protein Conc.	Pea protein conc.
Moisture %	81.0	14.0	14.0	14.0	14.0
pH	2.5	3.35	3.40	3.18	3.37
Titratable acidity (%)	0.4	0.8	0.72	0.56	0.64
Brix / TSS (°B)	15	78	84	80	72
Reducing sugars (%)	8.4	56.4	39.1	25.4	30
Total sugars (%)	9.1	70.1	71.3	44.3	38.1
Protein (%)	0.6	0.8	4.6	3.8	5.2

Of the three protein fortified fruit bars the pea protein used bar has high amount of protein. Other physico chemical parameters showed some variations in the values for there types of bars.

The Physico chemical characteristics of Calcium fortified mango bar are given in table 7

Table 7: Physico chemical Characteristics of Calcium Fortified Mango Bars

Parameters	Mango Pulp	Mango Bar control	Mango bar fortified with			
			Calcium Phosphate	Calcium Carbonate	Calcium Citrate	Calcium fumarate
Moisture (%)	81.0	14.0	12.0	12.2	12.9	13.1
PH	2.5	3.3	4.6	3.3	3.7	3.2
Titratable acidity (%)	0.4	0.8	0.4	0.6	1.1	0.8
Brix / TSS (°B)	15	78	76	80	76	80
Reducing sugars (%)	8.4	56.4	21.9	33	23.5	26.5
Total sugars (%)	9.0	70.1	38.0	46	47.3	48
Calcium (mg%)	45	100	458	462	364	589

The Physico chemical Characteristics of Vitamin- C Fortified Mango Bar are shown in table 8.

Table 8 : Physico chemical Characteristics of Vitamin- C Fortified Mango Bar

Parameters	Mango pulp	Mango bar control	Mango bar with Vitamin C
Moisture (%)	81.0	14.0	14.0
PH	2.5	3.3	3.3
Titrateable acidity (%)	0.4	0.8	0.5
Brix / TSS (°B)	15	78	78
Vitamin- C (mg %)	16	7	236

Physico chemical Characteristics of Guava + Carrot fruit bar:

The Physico chemical Characteristics of guava + carrot fruit bar are shown in table 9

Table 9: Physico chemical Characteristics of Guava + Carrot fruit Bar

Parameters	Fruit bar with different levels of carrot puree		
	10%	15%	20%
Moisture (%)	12.0	12.8	12.5
PH	4.0	4.7	5.2
Brix / TSS (°B)	72.8	72.9	72.9
Reducing sugars	26.7	25.5	26.3
Total sugars (%)	29.6	28.2	28.7
SO ₂ (ppm)	344	470	380
Beta carotene (µg/100g)	1622	2559	3058
Ascorbic acid (mg/100g)	12.4	8.9	8.2

Organoleptic Evaluation of Fruit Bars:

After the developing nutrient fortified mango bars the organoleptic characteristics were evaluated with the help of a trained panel of judges (8-10 no) using a four point scale. Organoleptic scores for Protein Fortified, Calcium Fortified, Vitamin-C Fortified Mango Bar as well as Guava +Carrot (10% / 15% / 20% carrot puree) Fruit Bar are indicated in table 10A, 10B, 10C, 10D.

Table 10 A--Organoleptic Qualities of Protein Fortified Fruit Bars

Parameters	Mango bar Control	Soy protein isolate	Whey protein concentrate	Pea protein concentrate
Set & Appearance	4	3.6	4.0	4.0
Colour & Appeal	4	3.6	3.8	3.4
Texture	4	3.4	3.8	3.6
Taste & flavour	4	3.6	3.0	3.0
Overall acceptability	4	3.6	3.8	2.8

Table 10 B: Organoleptic Qualities of Calcium Fortified Mango Bar

Attributes	Mango Bar Control	Mango bar fortified with			
		Calcium Phosphate	Calcium Carbonate	Calcium Citrate	Calcium Fumarate
Set & Appearance	4.0	3.0	3.0	3.0	3.5
Colour & Appeal	4.0	3.0	3.0	3.0	3.0
Texture	4.0	3.0	3.0	4.0	4.0
Taste & flavour	4.0	1.5	1.5	3.8	4.0
Overall acceptability	4.0	2.0	2.0	3.5	3.6

Table 10 C: Organoleptic Qualities of Vitamin-C Fortified Mango Bar

Attributes	Mango bar	
	Control	Vitamin C fortified
Set & Appearance	4	4
Colour & appeal	4	4
Texture	4	4
Taste & flavour	4	4
Overall acceptability	4	4

Table 10 D: Organoleptic Qualities of Guava +Carrot Fruit Bar

Attributes	Mango bar Basic	Fruit bar with different levels of carrot puree		
		10%	15%	20%
Set & Appearance	4	3.4	2.5	2.0
Colour & appeal	4	3.6	2.5	2.1
Texture	4	3.6	2.5	2.3
Taste & flavour	4	3.8	3.0	3.0
Overall acceptability	4	3.6	2.5	2.6

DEVELOPMENT OF ENRICHED MANGO BAR & ITS CHARACTERISTICS

Figure 1: Protein Fortified Mango bars



Figure2: Calcium Fortified Mango bars



Figure3: Vitamin-C Fortified Mango bar



Discussion:

The protein sources enriched in the study have some special features & biological functions. Quality of Soy protein isolate is comparable to milk, meat & egg protein. It contributes to general health & wellness. It is also having low glycemic property. Whey protein is a nutraceutical, has been known for its positive health benefits- immunity enhancement, cholesterol reduction, reducing blood pressure, inhibition of dental plaques, & tooth decay. It is a good food supplement for making fruit & energy bars.

Of the three protein sources soy protein enriched mango bar contained 5.2% protein. But texturally the quality was poor. The protein content was low in whey protein used bar. But the texture of whey protein used bar was very good.

Mango bar fortified with Calcium fumarate had maximum (589mg%) calcium content followed by calcium carbonate (462mg%) and calcium phosphate (458mg%). Least was seen in citrate (364mg%) added mango bar.

The vitamin C fortified mango bar has retained maximum Vitamin content (206mg %).

Guava bar has maximum beta carotene when carrot is used at 20% level (3058 μ g) , followed by other two levels. The vitamin C content was very high in 10% enriched bar (12,4mg%) since guava is a rich source of vitamin C.

As per Food Standards & FDA (USA) Fruit bars should not have odd flavours or off flavours but must possess flavour typical of its kind. Fruit bars should have typical colour of the fruit. Fruit bar texture shall be soft, not dry or hard without any foreign materials. All the fruit bars prepared in the study were having natural flavours & colors.

The sensory qualities of the study whey protein concentrate and soy protein isolate enriched mango bars were superior compared to pea protein added mango bar.

Of all the four types of calcium fortified mango bars, calcium fumarate enriched bars are highly acceptable. Calcium fumarate has high solubility quality & rapidly dissolves in fruit preparations & improves texture in fruit & vegetable products. Its bio availability has been reported good. Therefore FDA has approved Ca fumarate as a dietary supplement, More over, the Ca fumarate enriched products have better fruit flavour than those with other calcium salts and calcium citrate enriched mango bars are found good in terms of acceptability. The Vitamin C enriched mango bar is much the same as control in all sensory qualities.

Set & appearance, colour, texture, taste and overall acceptability of the guava fruit bar containing 10% carrot puree is found excellent compared to the other two levels. The beta carotene content is very high in the bar containing 20% carrot puree. Ascorbic acid content is maximum in 10% carrot puree enriched bar. Over all the 10% level carrot puree enriched guava bar is found acceptable compared to either 15% or 20% carrot enriched samples.

Conclusion:

Protein enriched fruit bars were leathery & only whey protein enriched bar was well accepted. Calcium fumarate enriched fruit bar was highly accepted. Almost all the vitamin C was retained in the Vitamin C enriched mango bar. As regards the organoleptic qualities, of all the mango fruit bars processed, vitamin C fortified bar was excellent followed by whey protein and calcium fumarate enriched fruit bars in several respects. It is interesting to note that the guava + carrot puree enriched fruit bar was very good in taste, appearance &

textural qualities. The betacarotene content was maximum in 20% carrot used fruit bar but 10% level is adequate to maintain textural qualities.

The nutrient fortified mango bars have good potential both in domestic & export markets and there is great scope to earn foreign exchange. This type of value addition by way of nutrient fortification / enrichment do certainly help in income generation of the entrepreneurs at large & promote good nutrition.

Acknowledgement

We express our grateful thanks to Department of Science and Technology, Government of India, for sanctioning this project and constantly encouraging us in promotion of this new technology.

