

Research Article

Studies on Development of Protein Fortified Banana-Cactus Pear Mixed Fruit Bar

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Abstract

Fruit bar is a concentrated fruit product with good nutritive value. Fruit bar principally made from fruit pulp retain most of the nutrients, minerals and flavor constituents thus forming a good nutritional supplement besides being a confectionery product. Food enrichment and fortification are the most cost effective and sustainable strategy to address the problem of micronutrient malnutrition. The study was conducted to standardize the protocol for preparation of cactus pear-banana fruit bar and to enhance the nutritional value by fortifying with whey protein concentrate. For preparation of fruit bars, cactus pear and banana pulp were blended in different proportions to standardize parameters like pulp combination, pectin & whey protein concentrate and then mixture was dried in mechanical dehydrator at $65 \pm 5^\circ\text{C}$ for 8-10 h. Best formulation was selected on the basis of sensory evaluation and texture profile analysis. The best formulation was 60:40 of banana to cactus pear pulp ratio, 0.6 % citric acid, 1.0 % pectin, 5.0% WPC and 15% sugar which was dried at temperature of 65°C in tray dryer. Thus the study revealed that the developed fruit bar was found to be rich in protein and it can be used as a supplement to malnutrition.

Keywords: Banana, Cactus pear, Fruit Bar, Whey Protein Concentrate (WPC), Pectin, Sensory attributes, Texture Profile Analysis

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Introduction

Fruit bar is classified as a confectionary product with longer shelf life. Fruit bars are considered to be hygienic as they are produced mechanically. Fruit bar is a nutritious product, has a chewy texture which is similar to dried raisins. It is a good source of dietary fibre and natural sugar [1]. Manufacturing of fruit bar exists in food industries since many years. This is one of the preservation technologies to preserve the fruits. Fruit bars principally made from fruit pulp retain most of the nutrients, minerals and flavour constituents thus forming a good nutritional supplement besides being a much sought after confectionery product. Fruit bars offer tremendous advantage owing to simplicity and lower inherent cost in production with better consumer appeal [2].

Fruits are generally consumed by all age groups. But they are available only during specific seasons. There are many ways of preserving fruits and making fruit bars is one of them. Fruits are rich source of vitamins and minerals as they carry good nutrition value. Pulpy Fruits like Banana, Mango, Guava and Apple are well suited for development of fruit bar [3].

In recent years, consumers have become more health conscious in their food choices but have less time to prepare healthful meals. As a result the market demand for “minimally processed” or “lightly processed” foods has rapidly increased [4]. This investigation was carried out with an objective to process the banana and cactus pear fruits, to enhance the nutritional value by fortifying with whey protein concentrate and to study the organoleptic evaluation of the developed fortified banana-cactus pear mixed fruit bar.

Banana

Banana (*Musa paradisiaca*) is a good source of minerals such as potassium and calcium. Banana is highly rated for its easy digestibility and therapeutic values. It provides more than a quarter of the food calories, vitamins, calcium and potassium [5]. Banana has a low fat content and is rich in potassium, magnesium and phosphorous. Banana is recommended by nutritionists and highly appreciated by consumers because of its flavor and sweetness.

Cactus Pear

Prickly pear (*Opuntia ficus indica*) fruit has long been known in traditional medicine for treating a number of pathologies such as ulcer, dyspnea, and glaucoma, as well as liver conditions, wounds and fatigue [6, 7]. The cactus pear fruit may be considered as functional food. This feature has been attributed to its bioactive compounds such as vitamin C and E, polyphenols, carotenoids, flavonoids (e.g., kaempferol, quercetin, and isorhamnetin), taurine and pigments [8, 9]. Cactus pears have a variety of colors, with the red and purple fruits being particularly attractive. These colored fruits contain betalains, which are the same pigment present in the red beet and used widely in the food industry [10].

Whey Protein

Whey proteins are essential ingredients in nutrition bars and they are emerging as key ingredients in energy gels and pastes. The mild flavor of whey protein ingredients makes them compatible with a wide variety of flavours and guarantees the high consumer acceptability. The use of whey proteins in sports and snack products delivers the nutrients shown to positively affect body compositions. Whey proteins have functional properties like high solubility, water binding, gelation or thickening, foaming, emulsification, flavor and colour generation [11]. Whey products have become recently quite popular and are heavily promoted as an ideal protein source for sports person. Whey Protein Concentrate is a pure, natural high quality protein complex derived from milk. Hence the fruit bar is fortified with Whey Protein Concentrate (WPC). WPC consists of individual protein components including lactoferrin, beta-lactalbumin, alpha-lactalbumin, glycomacropeptide, and immunoglobulin offering a number of health benefits [12]. This has led to the protein enrichment of mixed fruit bar. Whey proteins are functional foods exhibiting excellent solubility, low viscosity, diversified functional and superior nutritional qualities, their application in fruit products is much limited. The present study explored the possibility of inclusion of whey proteins into banana-cactus pear blended fruit bar to modify the nutrition composition in a natural way.

Experimental

Materials

Mature, ripe banana and cactus pear were procured from the local market for the preparation of fruit bar. Crystalline cane sugar, pectin (High methoxyl type) and citric acid (Make: SDFCL, Mumbai) were procured from the authorized stockiest and distributor of Anand. Whey protein concentrate (WPC) was procured from the AMUL Dairy, Anand.

Development of Fruit Bar

Sound, fully ripened fruits of banana and cactus pear were selected for the preparation of fruit bar. The fruits are then washed thoroughly with clean water and peeled to remove the outer skin. Pulp was extracted from the peeled fruits with the help of pulper. The blend of pulp was boiled and to this, pectin (0-2.0%), sugar (15%), Citric acid (0.6%), Whey Protein Concentrate (0-10%) were added as per the formulations (**Table 1**). Fruit bar was prepared as per the process depicted in **Figure 1**.

Table 1 Formulations for preparation of banana-cactus pear mixed fruit bar

Treatment	Banana Pulp (%)	Cactus pear pulp (%)	Citric Acid (%)	Pectin (%)	Sugar (%)
T1	100	0	0.6	1	15
T2	80	20	0.6	1	15
T3	60	40	0.6	1	15
T4	40	60	0.6	1	15
T5	20	80	0.6	1	15
T6	0	100	0.6	1	15

This mixture was heated to form a homogeneous mix till 50 °Brix and spread on greased stainless steel tray and dried into dryer at $65 \pm 5^\circ\text{C}$ for 10-12 hours in tray dryer. The cooled fruit bar were cut into rectangular pieces and wrapped in food grade polythene (fresh wrap). Fruit bars were evaluated for sensory quality using hedonic scale with the parameters on the basis of colour, texture, taste, flavor and overall acceptability (OAA) and protein content.

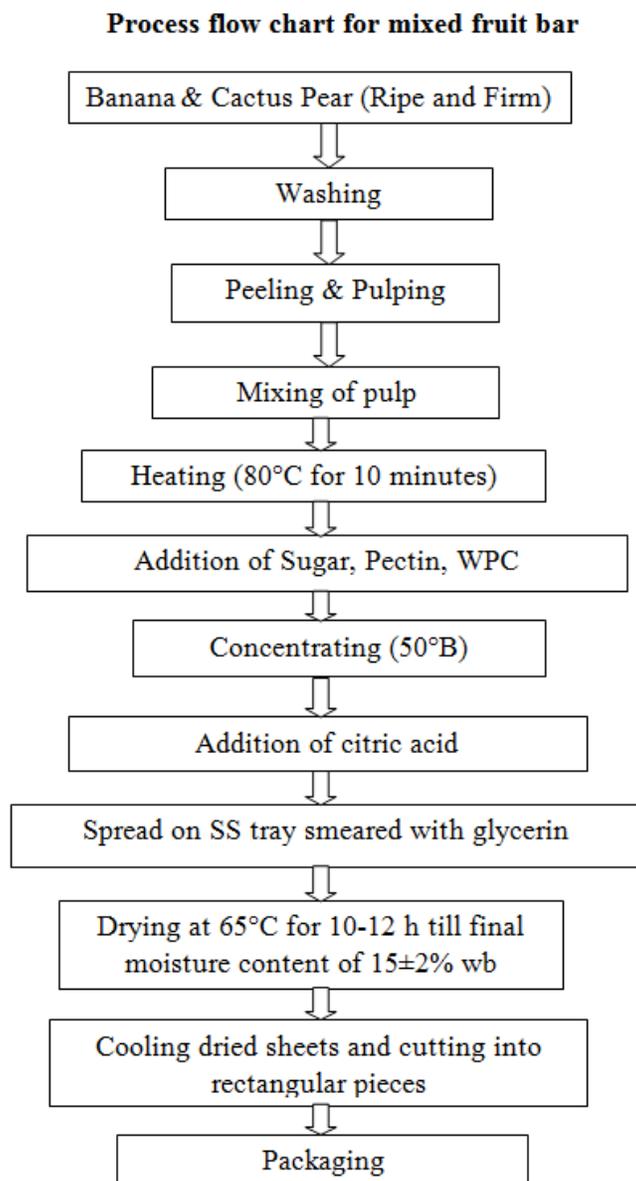


Figure 1 Process flow chart for preparation of fortified banana-cactus pear mixed fruit bar

Physico-chemical analysis of fresh pulps and dried fruit bar

Moisture content was estimated using gravimetric method [13]. The pH values of the samples were determined using a digital pH meter (Elico LI 610 – pH meter). Acidity was calculated by titrating against 0.1 N NaOH [13]. Ash content was determined according to the procedure described by [13]. The total soluble solids of the samples were determined using digital refractometers (Atago, Japan).

For the sensory evaluation of mixed fruit bar, the samples were evaluated using a 9 point hedonic rating test. The score-card suggested by [13] was used for judging the product. Three samples of each experimental mixed fruit bar were subjected to uniaxial compression to 30% of the initial sample height, using a Food Texture Analyzer of Lloyd Instruments LRX Plus material testing machine for texture profiling.

Optimization of parameters for preparation of mixed fruit bar

Optimization of Banana-Cactus pear pulp combination

Fruit bars were prepared by using different blends of banana and cactus pear pulp to evaluate the effects of different blends on quality of mixed fruit bar based on organoleptic evaluation, physico-chemical characteristics and texture analysis.

Optimization of Pectin Content

The amount of pectin which is required for proper setting of fruit bar and to obtain uniform texture was optimized by adding pectin at different concentrations ranging from 0 to 2%. The amount of pectin was standardised using organoleptic evaluation.

Optimization of Whey Protein Concentrate

To fortify the optimized mixed fruit bar, whey protein concentrate was added in different proportions (0-10%) and optimization was carried out by using organoleptic analysis. Fortification of mixed fruit bar with whey protein may increase its nutritional as well as market value. Whey proteins provide excellent nutritional values in nutrition foods formulated for kids, adults and old aged people as growth tonic for body health maintenance. Whey protein fortified fruit products are high protein and carbohydrates content, low in fat and salt content hence suitable for all age groups.

Results and Discussions

Physico-chemical characteristics of banana and cactus pear pulps

Banana and cactus pear fruits were analyzed for various physico-chemical characteristics as illustrated in **Table 2**.

Moisture content of the fresh banana pulp obtained was found to be 73.26% which was slightly higher than the reported values for banana pulp i.e. 69 to 72% [13]. Reported values are in good agreement with the findings reported by [14]. Total soluble solids (TSS) of the banana pulp were found to be 17.4°B, the value was similar to the reported values for banana pulp i.e. 17.42-23.42°B by [14, 15, 16]. Acidity of the fresh banana pulp was found to be 0.34% whereas the higher value of acidity of banana pulp as 0.35% was reported by [14]. Prasad (2009) and Ekanayake and Bandara (2002) reported values of the acidity of banana pulp as 0.1 and 0.26-0.4% CA; respectively [16, 17]. Ash content of the fresh banana pulp obtained was found to be 1.2% which was similar to the reported values for banana pulp i.e. 1.1% [17].

Table 2 Physico-chemical characteristics of banana and cactus pear fruit pulps

Parameters	Cactus Pear Pulp	Banana Pulp
Moisture Content, %	86.10±0.23	73.26±0.48
pH	5.3±0.14	4.9±0.78
Acidity, % C.A.	0.26±0.08	0.34±0.08
Total Soluble Solids, °Bx	12.18±0.45	17.4±0.32
Ash, %	0.86±0.12	1.2±0.21
All the values are mean "±" SD of five samples		

Moisture content of the fresh cactus pear pulp obtained was found to be 86.1% which was found quite similar to the reported values for cactus pear pulp i.e. 85.98% [18]. Total soluble solids (TSS) of the cactus pear pulp were found to be 12.18°B, the value was similar to the reported values for cactus pear pulp i.e. 12-17°B by [19]. Acidity and pH of fresh cactus pear pulp was found to be 0.26% and 5.3; respectively. Moßhammer *et al.*, 2006 reported the higher pH and lower acidity values of cactus pear pulp as between 5.6-6.5 and 0.05-0.18; respectively [19].

Optimization of incorporation levels of pectin in fruit bar

The results reported in **Table 3** illustrates that, addition of pectin to the fruit bar at various incorporation levels (0 - 2.0%) significantly affected the organoleptic properties of fruit bar.

Organoleptically it was found that addition of pectin improved the texture of the product. However, increasing the pectin beyond a certain level was found to affect the texture of dried bar and impair the flavor of the product by masking the original flavor. The high pectin content provides for more cross-linking of the polymer, and thereby increases the rigidity of the gel. The hardness of the jelly increased significantly with increase in quantities of pectin [20]. This might be because of the more gelling effect of pectin. If the pectin content is higher, firm and tough product is formed [21] and thus results in more hardness of dried bar. It can be concluded that the optimum level of incorporation of pectin at 1% is required to achieve the highest overall acceptability.

Table 3 Optimization of pectin content for preparation of mixed fruit bar by organoleptic evaluation

Parameters	Pectin, %				
	0	0.5	1.0	1.5	2.0
Colour-Appearance	6.4	6.5	7.8	7.4	7.0
Body-Texture	6.2	6.4	8.0	6.8	6.6
Flavour	6.5	6.2	7.8	7.1	7.0
Chewability	5.4	6.0	8.1	7.2	6.4
Over All Acceptability	6.1	6.2	7.9	7.1	6.7

Optimization of Banana-Cactus Pear Mixed Fruit Bar

Effect of different blends of banana and cactus pear pulp on physicochemical characteristics of mixed fruit bar

Physico-chemical characteristics of mixed fruit bar have been represented in **Table 4**. Moisture content of all six samples of fruit bar ranged 12.6 to 29.2%. It was found that the moisture content in prepared fruit bar samples increased with decreased in banana to cactus pear pulp ratio. This might be due to the higher moisture content in cactus pear pulp. It was observed that the banana to cactus pear pulp ratio was decreased, total soluble solids of fruit bar also decreased. This is may be due to the decreased amount of banana pulp as it contains more amounts of total soluble solids than cactus pear pulp.

Table 4 Effect of different blends of banana and cactus pear fruit pulp on Physico-chemical analysis of dried mixed fruit bar

Parameters	Score/ Value based on mean value of different parameter of treatment					
Treatments	T1	T2	T3	T4	T5	T6
Banana: Cactus Pear Pulp	100:0	80:20	60:40	40:60	20:80	0:100
Physico-chemical Analysis						
Moisture, %	12.6	15.4	15.8	16.4	22.0	29.2
Total Solids, %	87.4	84.6	84.2	83.6	78.0	70.8
Total Soluble Solids, °Bx	86.3	83.8	82.5	78.8	74.8	62.3

Effect of different blends of banana and cactus pear pulp on organoleptic attributes of mixed fruit bar

The sensory scores in terms of colour-appearance, body-texture, flavor and OAA of mixed fruit bar were ranged from 5-7.8, 4-8.8, 6-8.4 and 5-8.3 (**Figure 2**). The highest scores for colour appearance (8.23), Body-Texture (8.8), Flavour (8.4) and OAA (8.3) were found in T3. This might be due to the better sugar-acid blend of the product. It was observed that addition of up to 40% of cactus pear pulp for preparation of mixed fruit bar gives better sensory attributes to dried fruit bar. The lowest scores for colour appearance (5.0), Body-Texture (4.0), Flavour (6.0) and OAA (5.0) were found in T6 which was prepared from 100% of cactus pear pulp. This might be due to the higher percentage of moisture in cactus pear pulp which imparts stickiness to the final product.

Effect of different blends of banana and cactus pear pulp on texture of mixed fruit bar

The texture in terms of hardness (kgf) and chewiness (kgf.mm) of mixed fruit bar were ranged from 0.18-4.26 and 0.3-10.66 (**Figure 3**). It was difficult to draw any inference for hardness and chewiness of dried mixed fruit bar as there was large variation in treatment mean. So the most acceptable hardness and chewiness was decided on the basis of the most acceptable dried mixed fruit bar on the basis of overall acceptability and body and texture, and on the basis of that, mixed fruit bar prepared form T3 had the most acceptable hardness and chewiness with 3.38 kgf and 3.62.kgf.mm.

The best sample was found to have OAA 8.3, hardness 3.38 kgf, chewiness 3.62.kgf.mm at 60:40 of banana-cactus pear pulp ratio, 0.6% citric acid and 1.0% pectin. This formulation was used for optimizing the level of whey protein concentrate for preparation of fortified mixed fruit bar.

Optimization of level of Whey Protein Concentrate

The treatment means of sensory scores of the dried fruit bar for various sensory attributes are presented in **Table 5**. It was found that the sensory scores improved with the increase in WPC from 0 to 5 % and further increase in WPC from 5 to 10% caused a decrease in sensory scores.

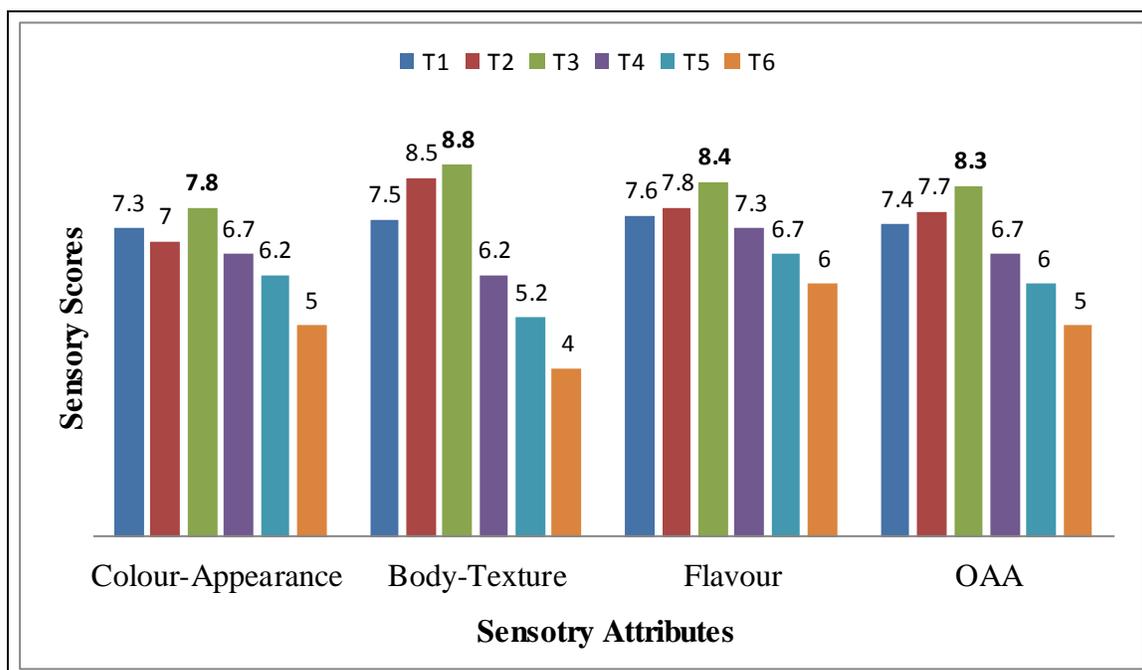


Figure 2 Treatment mean of sensory attributes of dried mixed fruit bar

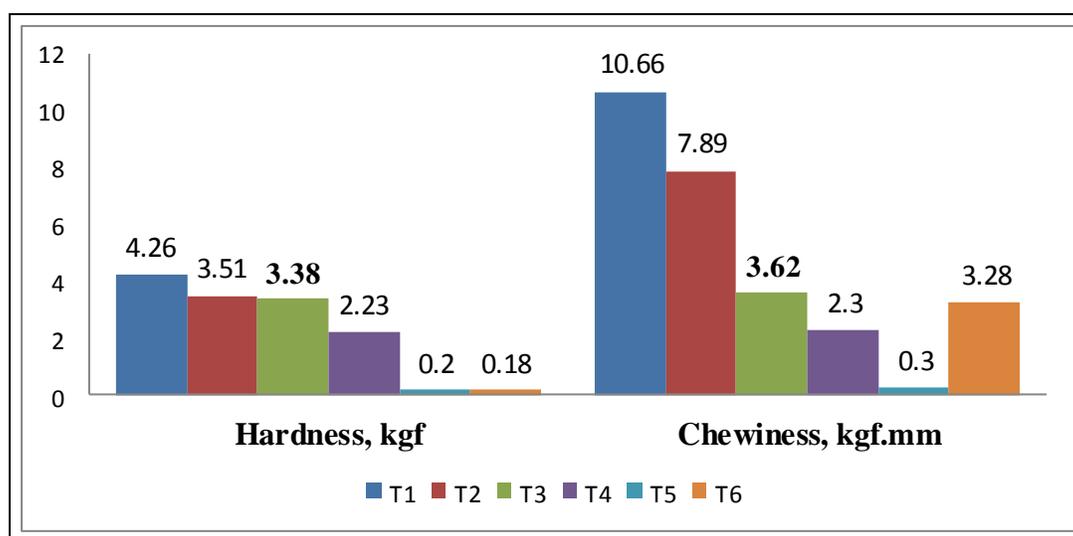


Figure 3 Treatment mean of Hardness and Chewiness of dried mixed fruit bar

Table 5 Optimization of WPC of mixed fruit bar by organoleptic evaluation.

Parameters	Whey Protein Concentrate, %				
	0	2.5	5.0	7.5	10.0
Colour-Appearance	7.5	8.0	8.7	8.5	6.6
Body-Texture	7.2	8.3	8.4	7.8	6.4
Flavour	7.6	7.6	8.0	7.9	6.1
OAA	6.9	7.5	7.8	7.5	5.8

The incorporation of WPC for the preparation of banana-cactus pear fortified bar, resulted into product rich in protein content and good organoleptic characteristics. Similar results were obtained in the other studies conducted on incorporation with the soy protein and coconut powder fortified mango bar [22] and soy protein isolate and whey protein concentrate in guava pulp for the preparation of different product to combat against malnutrition problem.

It was concluded that the good quality of banana-cactus pear fortified mixed fruit bar can be prepared with optimized recipe as 60:40 of banana to cactus pear pulp ratio, 0.6 % citric acid, and 1.0 % pectin, 5.0% WPC which was dried at temperature of 65°C in tray dryer.

Conclusion

Conclusively, it emerged that banana-cactus pear mixed fruit bar fortified with WPC can successfully prepared using banana pulp, cactus pear pulp, sugar, citric acid and pectin in a specific percentage and the mixture is dried in a mechanical dehydrator at $65 \pm 5^\circ\text{C}$ for 8-10 h and thus the formulation was optimized. According to the organoleptic qualities, fortified bar was excellent followed by nutritional quality particularly protein, fat, crude fibre and calorie content increased with increasing WPC (0-5%) in fruit bar. Supplementing the value added banana-cactus pear fruit bar to preschool children and adolescents will be a promising effort to reduce malnutrition.

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