DEVELOPMENT OF PROTEIN ENRICHED FUNCTIONAL FRUIT BAR

ABSTRACT

Food Enrichment and fortification are the most cost effective and sustainable strategies to address micronutrient malnutrition. The present study was conducted to standardize the protocol for preparation of sapota-papaya fruit bar and to enhance the nutritional value by fortifying with whey protein concentrate. Sapota, Papaya and a mixture of Sapota:Papaya pulp in 1:1 ratio were blended with sodium alginate, citric acid and whey protein concentrate and the mixture was dried in a mechanical tray drier at 60± 2ºC for 14 h. The bars were graded on the basis of sensory evaluation.(The protein content of the fruit bars ranged from 2.1% to 2.5% due to addition of whey protein concentrate). The quality of fruit bars were subjected to chemical analysis, texture profile analysis and microbial analysis. The protein content of the fruit bars ranged from 2.1% to 2.5% due to addition of whey protein concentrate. The products developed from this study aims to enhance the bioavailability of fibre and protein in human diet.

Key words: Food Enrichment, Fortification, Fruit bars, Malnutrition, Fruit leather

INTRODUCTION

India is the second largest producer of fruits, as well as vegetables, (FAO,UN). India's horticulture production is estimated to have risen annually by 1.37 per cent to 351.92 million tonne in 2022-23 due to better productivity. (https://economictimes.indiatimes.com/news/economy/agriculture/horticulture)

The major fruit growing states in India are Maharashtra, Tamil Nadu, Karnataka, Andhra Pradesh, Bihar, Uttar Pradesh, Madhya Pradesh and Gujarat (MIDH, 2013-14). Fruits, known to be excellent source of energy, minerals, vitamins , bioactive compounds and fibres play a unique role in meeting the nutritional needs of our population. The importance of fruits in our diet therefore increases manifold. The post harvest losses of fresh fruits is estimated to be 20- 30 %.One of the best ways of utilizing and preserving fresh fruits is processing them into various products such as fruit juices, concentrates, canned fruits, jam, jellies, leather etc.

Sapota is from the Sapotaceae family with a diverse and significant range of 700 species and 35 to 40 poorly defined genera (Peiris ,2007).The largest producers of sapota in the world are India, Mexico, Guatemala, and Venezuela (Athmaselvi *et al*., 2014; Saxena, 2014; Hiwale, 2015). The fruit is a good source of digestible sugar (15-20%) protein, fat, fibre and minerals .

India is also the largest producer of papaya, contributing 42% of world production from 30% of the global area under papaya cultivation as per an FAO report for 2012 (IIFPT, 2020). This nutritious fruit, ranks first among 13–17 fresh fruits for vitamin C content per 100 g edible portion. It is an excellent source of provitamin A (carotenoids), which is important for eye sight, helping to prevent early blindness in children. Papaya has more carotene compared to apple, guava and plantain, which helps to prevent damage by free radicals as reported by Hewajulige and Dhekney (2016).

Fruit leather is a dried fruit treat, chewy and flavourful. Fruit leather, bar or slab is the term used for the products prepared by dehydration of fruit pulp with or without acid and sugar. When water is removed from fruit pulp by drying, sugars, acids, fibre and many vitamins and minerals become concentrated in the remaining solid part of the fruit bar/leather. This makes dried fruits, high in sugar and other nutrients (Ayotte,1980).Whey proteins are widely used as food ingredient due to their nutritional properties and functional properties (Morr *et al.*, 1993).This protein has a biological value (BV) that exceeds that of egg protein (by 15 percent) and other high protein foods (meat, soy and casein). It is one of the good sources of protein, which can be fortified in fruit pulp. Smithers, (2008) reported that whey protein is a rich source of essential amino acids when compared to other typical food proteins and is rich in branched chain amino acids (leucine, isoleucine, and valine ›20%, w/w). These amino acids are believed to be metabolic regulators in protein and glucose homoeostasis and lipid metabolism and may play a role in weight control (Smilowitz, *et al*., 2005; Zemel, 2004). Fortification of fruit bar with whey protein from baelfruit has been tried by different researchers. (Parimita and Arora, 2015)

Thus the present investigation was under taken to develop fruit bars with different combinations of papaya, sapota and fortified and fortify then with whey protein concentrate.

MATERIALS AND METHODS

Materials

In this study fruit bars were prepared using papaya,sapota , WPC_{80} sugar,sodium alginate and citric acid.

Formulation of the fruit bars

Three different fruit bars, Papaya bar (Sample A), Sapota bar(Sample B and 1:1 ratio of Sapota -Papaya (Sample C), were formulated as given below.

Table 1 : Ingredient composition of the fruit bars

Samples	Papaya(%)	Sapota(%)	Whey protein concentrate(%)	Citric acid(%)	Brix°	Sodium alginate(%)
A	100	---	2	0.5	25-30	0.5
B	---	100	2	0.5	25-30	0.5
C	50	50	2	0.5	25-30	0.5

Methodology

The fruits were subjected to pretreatments such as washing, weighing, peeling, cutting and grinding. For enrichment of protein, 2% whey protein concentrate (WPC_{80}) was added to the fruit pulps mixed thoroughly and heated. Cane sugar was added to fruit pulp to adjust TSS to 25 º Brix. Pulp acidity was adjusted to 0.5 per cent using citric acid. Sodium alginate at 0.5% was added to the pulp. The prepared pulp was spread in the form of thin layer up to 1cm on greased aluminum trays and placed in tray dryer at 60℃ 14 hours.

The dried sheets were cooled and cut in rectangular pieces of 8 × 4 × 0.5 cm. The cut pieces were wrapped in a butter paper, packed and stored in an air tight container.

Chemical Anaysis

The Nutritional parameters like Moisture, Fat, Protein, Fiber and Ash of the three fruit bars were analyzed as per the methods described in AOAC (1990).

Textural analysis,

Textural analyzer (Stable micro system, TA-XTplus) was used for textural analysis, of the fruit bars

Picture 1 : Textural Analyser (TA-XTplus)

Sensory analysis: Protein enriched functional fruit bars were organoleptically evaluated by semi-trained panelists of the institute .The Fruit bars were judged for various sensory attributes using 9 point hedonic scale. The parameters included were appearance, colour, texture, sweetness, flavour, mouthfeel and overall acceptability. The average of the scores awarded by the panelists were recorded as mean value for sensory score.

Microbial Analysis; Total viable count, Coliform count, Yeast and mould counts of processed samples were determined by the method described by American Public Health Association(APHA), 1984.

RESULTS AND DISCUSSION

Fig 1 Papaya bar

Fig 2 Sapota bar

Fig 3. Sapota - Papayabar

Protein enriched functional fruit bars were analyzed for protein, fat, fibre, ash and moisture content, according to methods described in AOAC (1990) and their results have been summarized below.

Table 2 : Nutritional profile of the Fruit bars

S.No	ATTRIBUTES	PAPAYA BAR	SAPOTA BAR	SAPOTA:PAPAYABAR(1:1)
1.	Protein (%)	2.5	2.1	2.3
2.	Fat (%)	1.6	3.5	3.3
3.	Fibre (%)	8.6	6.6	9.6
4.	Ash (%)	1.3	1.8	1.5
5.	Moisture content (%)	22	20	21

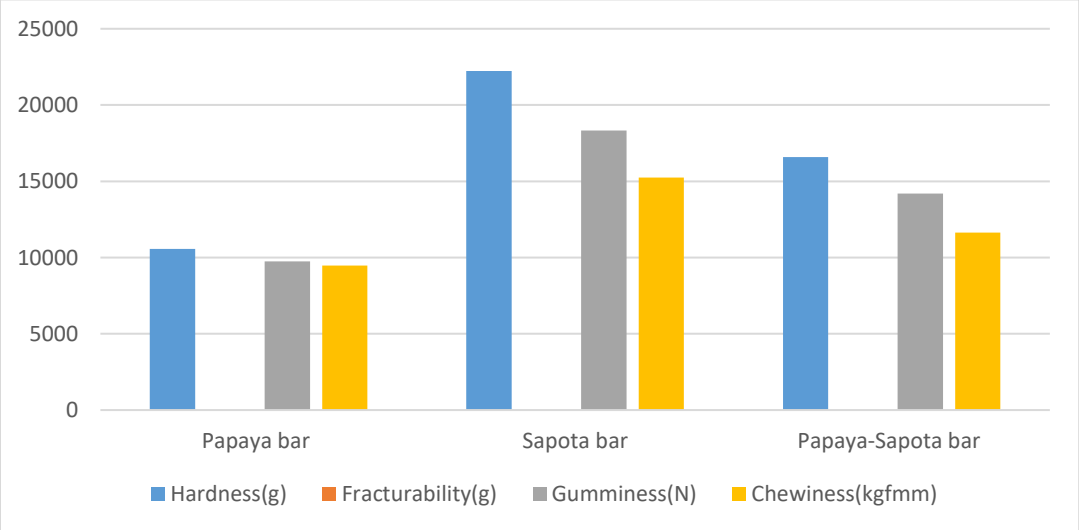
Similar result of moisture content in mango leather was reported by Paul Sreedam (2011) and papaya-tomato fruit bar by Ahmad *et.al.,(*2005). Fat, ash and moisture content of sapota bar was similar to Sapodilla fruit bar as reported by Rabeta *et. al.(*2016).

Textural analysis:

Table 3 : The textural characteristics of the protein enriched functional fruit bars are presented in the table below.

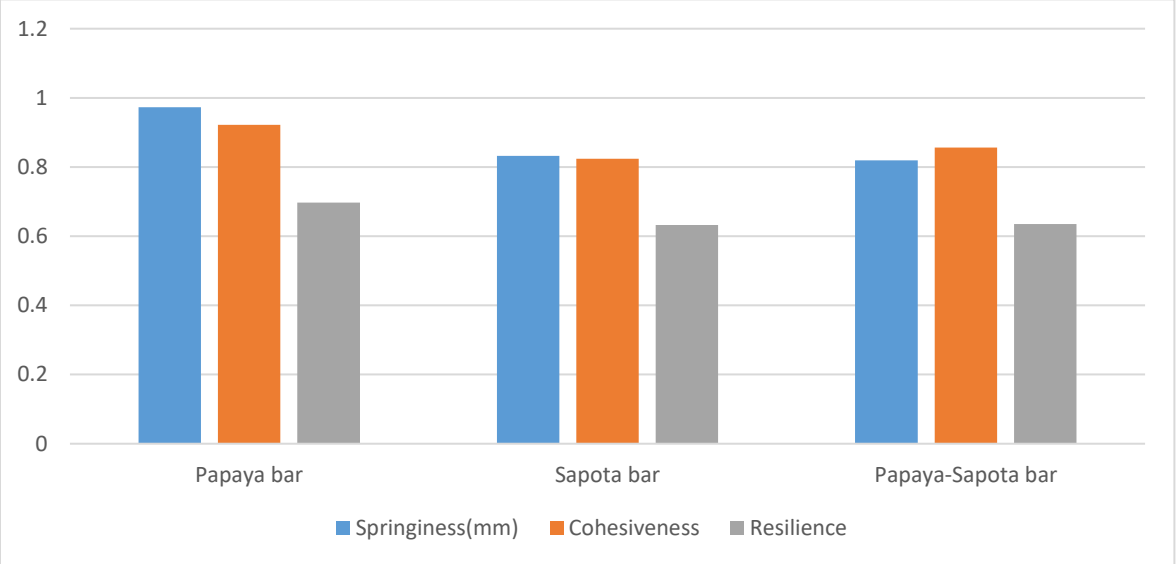
Characteristics	Papaya bar	Sapota bar	Sapota -Papaya bar
Hardness (g)	10560.493	22242.064	16580.894
Fracturability (g)	0	0	0
Adhesiveness(g.sec)	-30.002	-4.820	-142.453
Springiness (mm)	0.973	0.832	0.819
Cohesiveness	0.922	0.824	0.856
Gumminess	9737.798	18325.208	14196.113
Chewiness (kgfmm)	9472.660	15240.767	11630.973
Resilience	0.697	0.632	0.635

Graph 1 Textural profile analysis (hardness, fracturability, gumminess, chewiness) of different types of fruit bar



Graph 2 : Textural characteristics (adhesiveness) of different fruit bars

Graph 3 : Textural characteristics (springiness, cohesiveness, resilience) of different fruit bars

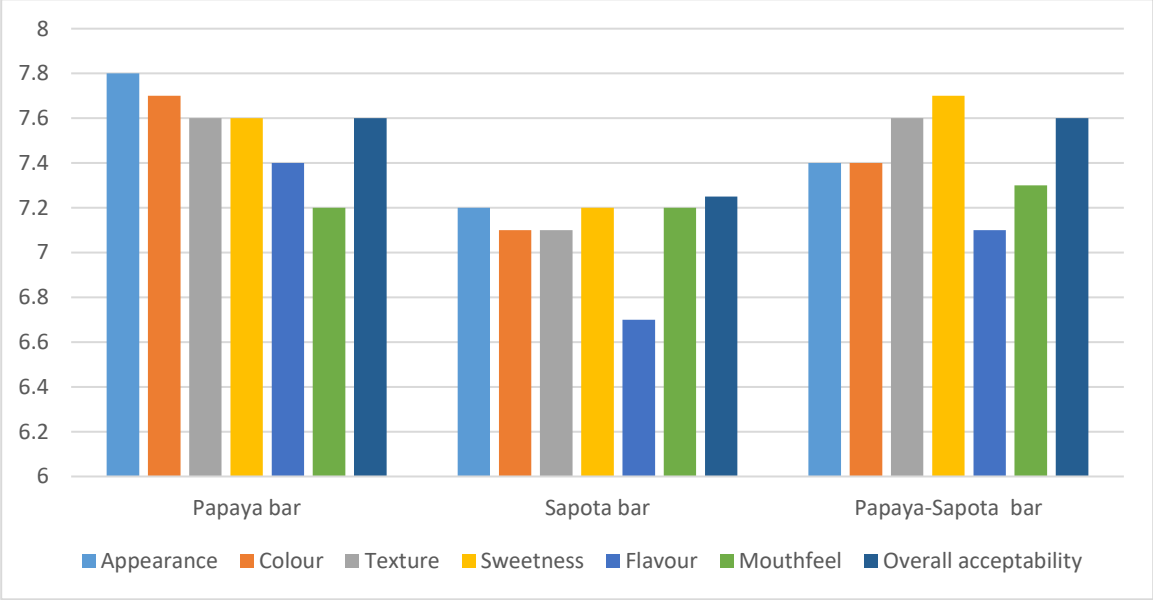


The gumminess and chewiness was increased due to the addition of sodium alginate as a gelling agent. The fruit bars were given 0 value for fracturability, indicating semi-solid jelly type product. Similar report of adhesiveness and chewiness with slight variations in sapodilla fruit bar was reported by Rabeta *et.al.(*2016).

Hardness was also increased due to proper drying of the fruit bars. The hardness was maximum for sapota bar compared to others. Similarly, the hardness was maximum in date bars as reported by Muhammad *et al.*(2012). Adhesiveness was maximum in papaya-sapota bar, as it was sticky compared to papaya bar. Springiness and Cohesiveness were maximum in papaya bar than sapota and sapota-papaya bar. Gumminess was minimum in papaya bar while other two bars had slight variations.

Sensory Analysis: The prepared protein enriched functional fruit bars (papaya bar, sapota bar and sapota -papaya bar) were evaluated by panelist for sensory characteristics using 9 point hedonic scale. The sensory characteristics evaluated were appearance, colour, texture, sweetness, flavour, mouthfeel and overall acceptability.

Graph 4 : The average mean of score of the sensory characteristics are presented



Sensory characteristic of different types of fruit bars

The sensory evaluation of fruit bars were similar to that of papaya-tomato fruit bar by incorporating hydrocolloids as reported by Ahmad *et. al.,* (2005). These parameters were also in tandem to the sensorial quality of fig mango bar reported by Pawase *et. al., (*2017), sensory characteristics of dehydrated guava by Mohammad Ayub *et. al.,(*2005) and development of fruit bar using apple-banana pulp supplemented with Omega-3 fatty acid by Parimita and Arora (2015).

From the results of this trial ,the fruit bar containing sapota and papaya in the ratio 1:1 had an appreciable overall acceptability for sensory qualities as evaluated by semi-trained panelist.

Microbial Analysis: Total count is an index of quality of intermediate moisture food, and a high count indicates contamination of the product during handling and processing. The viable count for papaya ,sapota and mixed bar were 55×10^9,50×10^9 and 60×10^9 respectively.

Coliform and yeast and mold were not detected in the fruit bars. Similar results for yeast &mould count and coliform count on apple-banana fruit bar was reported by Parimita and Arora (2015).

References

Ahmad, S., A. K. Vashney and P. K. Srivasta, (2005). Quality attributes of fruit bar made from papaya and tomato by incorporating hydrocolloids. International Journal of Food Properties, 8(1), 89–99.

American Public Health Association. 1984. Compendium of Methods for the Microbiological Examination of Foods, 2nd ed. APHA, Washington, DC

AOAC, (1990). Association of Official Analytical Chemists. Official Methods of Analysis of the Association of Official Analytical Chemists. 15th ed. Arlington VA.

Athmaselvi,K., Pandian Jenney, C. Pavithra and Ishita Roy, 2014. Physical and biochemical properties of selected tropical fruit. Int. Agrophys., 28, 383-388
doi: 10.2478/intag-2014-0028.

Ayotte,E., 1980. Fruit Leather, Publication no. P-228, University of Alaska Cooperative Extension Service, Fairbanks, Alaska, USA

Hewajulige, I.G.N. and S.A. Dhekney, 2016, Papayas. The Encyclopedia of Food and Health, pp209-212,

Hiwale, S. 2015. Sustainable horticulture in semiarid dry lands. Springer

INDIAN INSTITUTE OF FOOD PROCESSING TECHNOLOGY Ministry of Food Processing Industries, Govt. of India Thanjavur 2020, Project report papaya tutti frutti manufacturing unit.

Morr, C. and E. Ha, 1993. Whey protein concentrates and isolates: processing and functional properties. Critical Reviews in Food Science & Nutrition, 33(6), 431-476.

Mohammad Ayub,Alam Zeb,Javid Ullah and M Muzaffar, 2005. Effect of non-nutritive sweeteners, chemical preservatives and antioxidants on microbial and sensory characteristics of dehydrated guava. J.Sc. & Tech. Univ. Peshawar, 2005, 29 (1).

Muhammad Nadeem, Salim-ur Rehman,Faqir Muhammad AnjumMian and Anjum Murtaza, 2012. Development, Characterization, and Optimization of Protein Level in Date Bars Using Response Surface Methodology.The Scientific World Journal (3):518702 DOI:10.1100/2012/518702

Parimita, E. and E. P. Arora, 2015. Studies on development of whey protein fortified fruit bar from bael (Aegle marmelos). International Journal of Engineering Studies and Technical Approach, 1(3), 1-8.

Paul Sreedam Chandra (2011). Comparative study of mango leather. Msc. (Published thesis). Bangladesh Agricultural University.

Pawase PA, D.R. More and P.N. Satwadhar, 2017. Effect of addition of pectin on textural and sensorial quality characteristics of fig mango bar. Journal of Pharmacognosy and Phytochemistry Vol. 6, Issue 5

Peiris, K. 2007. Sapodilla Manilkara zapota L. p.183–224. In: D.K.N.G. Pushpakumara, H.P.M. Gunasena, and V.P. Singh (eds), Underutilized fruit trees in Sri Lanka. van Royen Publisher: World Agroforestry Centre, South Asia Office, New Delhi, India.

Rabeta Mohd Salleh,Tee Lee Ying and Leila Mousavi, 2016. Development of Fruit Bar using Sapodilla (Manilkara zapota L.). Journal of Food Processing and Preservation, 41(2)

Saxena, M. 2014. Handbook on horticulture statistics. Government of India Ministry of Agriculture Department of Agriculture and Cooperation: New Delhi

Smilowitz, J. T., C. J. Dillard, and J. B. German, 2005. Milk beyond essential nutrients: The metabolic food. Australian Journal of Dairy Technology, 60, 77–83.

Smithers, G. W, 2008. Whey and whey proteins from ‘gutter-to-gold’. International Dairy Journal, 18 (7), 695-704.

Zemel, M. B. 2004. Role of calcium and dairy products in energy partitioning and weight management. American Journal of Clinical Nutrition, 79(Suppl.), 907S–Ref 4:

DOI:10.1111/jfpp.12806

https://economictimes.indiatimes.com/news/economy/agriculture/horticulture-output-rises-to-351-92-million-tonne-in-2022-23)

https://midh .gov.in statewise horticulture status