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Research Article

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Development of Cereal Flakes from Papaya (*Carica papaya* L.) and it's Quality Evaluation During Storage

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ABSTRACT

In the present investigation, various treatment combinations were optimized for the preparation of papaya fruit flakes. For the standardization of papaya cereal flakes three different recipes were tried with various combinations of papaya pulp, maida flour (100 %), corn flour (100 %), maida flour and corn flour in combination (70:30) for the development of papaya cereal flakes. Papaya cereal flakes prepared by using different combinations of both flours were compared on the basis of sensory evaluation with standard recipe in which maida was used. Papaya cereal flakes (T_3) prepared using papaya pulp- 2.5 Kg, maida and corn flour in 70:30 ratio -(220.5 +94.5) g, sucrose- 150 g, glucose-150 g, pectin- 3.65 g, water- 250 ml, $CaCO_3$-3 g was rated best on the basis of sensory evaluation. Further the prepared product were packed in aluminium laminated pouches and stored for 6 months under ambient temperature conditions. The various quality characteristics such as moisture, total soluble solids, titratable acidity, ascorbic acid, total sugars, reducing sugars, ash, fibre and carotenoids, were analyzed at 0, 3 and 6 months interval. The stored papaya-cereal flakes had better quality in terms of color, flavor, texture, overall acceptability and also have better retention of all quality characteristics at ambient temperature conditions. Thus papaya-cereal flakes could be stored successfully without any significant changes in quality characteristics at ambient temperature conditions for 6 months in aluminium laminated pouches.

Keywords: *Papaya-cereal flakes, Nutritional value, Carotenoids, Storage quality evaluation*

INTRODUCTION

Papaya (*Carica papaya* L.) belongs to the family Caricaceae and is one of the most important fruit cultivated throughout the tropical and subtropical regions of the world (Saran et al., 2014). It is one of the economically important fruit crop of Australia, India, Srilanka, Philipines and South-East Asia including Thailand. It is 4th major fruit after Banana, Mango and Citrus grown in India. Due to its fast growth it yields more, but being perishable in nature possesses problem in marketing even to primary market.

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Papaya is common man's fruit with high nutritive value available in reasonable price makes it favorite fruit of obese people who are weight reducing regime (Pinnamaneni, 2017). Papaya fruit consists mostly of water, carbohydrates, low in calories and rich in natural vitamins and minerals particularly vitamin A and vitamin C. Papaya is a powerhouse of nutrients consumed throughout the world. It is a rich source of three powerful antioxidant vitamin C, carotene and vitamin E and also rich in various minerals (magnesium and potassium), B vitamin (pantothenic acid and folate) and fiber (Aravind et al., 2013). Ripe fruit is consumed as fresh and also used for processing. At unripe stage fruit is consumed as cooked vegetable. Papaya is laxative, stimulate digestion and the production of bile which may lead to healthy liver and pancrease (Aravind et al., 2013). Being a rich source of fiber, papaya consumption helps in lowering high cholesterol level. Papaya fruit has also been included in commercial preparation such as meat tenderizer, chew-gums and as stabilizer and to clarify the beer .Though some work on utilization of papaya for the preparation of value added products *viz*; beverages, fruit powder, instant products and intermediate moisture foods etc. (Attri et al., 2014; Attri et al., 2016 and Attri et al., 2018) has been reported in the literature, but very less work on development of papaya cereal flakes has far been reported. Today, the most popular area of processed food is ready to eat food sector where papaya-cereal flakes can niche market as it can meet nutritional demands. Breakfast cereals are commonly made with corn, rice and wheat. They include hot cereal products and ready to eat products such as wheat flakes etc. As cereals are rich sources of minerals, vitamins, carbohydrates, oils, proteins and fats. Breakfast cereals are important contributors to nutrients intake in the developed countries where fortification is permitted. Maize flour is used to make chapatis or flat breads which are eaten mainly in a few Northern states of India (Mehta & Dias, 1999). Xanthophylls (lutein and zeaxanthin) in maize have some pivotal and specific biological functions. Whereas, the presence of vitamins A, C, and K together with beta-carotene and selenium helps to improve the functioning of thyroid gland and immune system (Shah et al., 2016). Due to increasing attention being drawn towards the development of nutraceuticals, the phytochemical compounds derived from maize and their health properties have recently become the major focus of many studies. As cereal fortification has helped significantly in reducing many nutrient deficiencies in developed countries. So therefore, in the present study efforts were made to develop nutritious and palatable papaya cereal flakes and to analyze storage stability at ambient temperature. The papaya-cereal flakes can be used as a ready to eat snack food and can be easily reconstituted in hot milk to relish morning breakfast like any commercial cereal flakes.

MATERIALS AND METHODS

The study was conducted in the Department of Food Science and Technology, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan (HP), India.

Preparation of papaya cereal flakes

In this study the ripe papaya fruits were procured from local market. The randomly selected fruits were analyzed for various physico-chemical parameters. Initially, fruits were washed, peeled, seeds were removed and cut into slices and pulp was made. Two cereal flours (maida and corn flours) were taken for the study (Table 1) and sieving of flour was done. Papaya cereal flakes were prepared by using different combinations of both flours and the results were compared on the basis of sensory evaluation with standard recipe in which maida is generally used. For the preparation of flakes two combinations of cereal flours were made *viz.* (100 per cent maida flour and corn flour in 70:30 ratio) by following the slightly modified procedure as given by Rai and Chauhan (2008). Flakes were initially dehydrated in a dehydrator at 60 ±2 ^{o}C temperature followed by drying in OTG (Oven, toaster and griller) at 80 ^{o}C for half an

hour and then at 100 ^{o}C for another half an hour to achieve the characteristic crisp texture and were then packed in laminated pouches (Fig. 1).

Table 1: Standardization of treatments for the preparation of papaya cereal flakes

Treatments	Flour percentage	Papaya cereal flakes ingredients		
T_1	100 per cent maida flour	Papaya pulp- 2.5 Kg Maida- 315 g	Sucrose- 150 g Glucose-150 g Pectin- 3.65 g	Water- 250 ml $CaCO_3$-3 g
T_2	100 per cent corn flour	Papaya pulp- 2.5 Kg Corn flour- 315 g	Sucrose- 150 g Glucose-150 g Pectin- 3.65 g	Water- 250 ml $CaCO_3$-3 g
T_3	70 per cent maida + 30 per cent corn flour	Papaya pulp- 2.5 Kg Maida and corn flour- (220.5 +94.5) g	Sucrose- 150 g Glucose-150 g Pectin- 3.65 g	Water- 250 ml $CaCO_3$-3 g

Mature papaya fruit

↓

Washing

↓

Peeling, coring and cutting

↓

Pulp preparation in mixer grinder

↓

Papaya pulp

↓

Addition/mixing of corn flour or maida into papaya pulp

↓

Adjustment of pH about 4.0 by citric acid

↓

Addition of $CaCO_3$

↓

Thorough mixing and homozination for 10 minutes

↓

Passing through steam (steam pressure 3 psi)

↓

Dehydration in mechanical cabinet dehydrator at 60 ±2 ^{o}C

↓

For crispiness, drying at 80 ^{o}C in OTG for ½ h and at 100 ^{o}C for ½ h

↓

Packaging in aluminium laminated pouches (100 g) and storage at ambient conditions

Fig. 1: Flow diagram for the preparation of papaya cereal flakes

Physico-chemical and sensory analysis

Fresh papaya fruit as well as papaya cereal flakes were analyzed for various physico-chemical parameters as per standard procedures. Fruit length and width were recorded with vernier caliper while weight of the fruit was recorded by weighing the individual fruit in top pan balance. Papaya products of best treatment were analyzed for chemical as well as for sensory attributes *viz;* moisture, ash, TSS, acidity, fiber and sugars (reducing and total sugars), ascorbic acid, carotenoid and calcium content. The total soluble solids in the fruits were measured with the help of hand refractrometer. Moisture, ash, titratable acidity (% citric acid), ascorbic acid, carotenoid and rehydration ratio were determined by methods given by Ranganna (2009). Fiber content was determined by the method given by Gould (1978). Sensory quality parameters were determined by adopting a 9-point hedonic scale (1= dislike extremely and 9 = like extremely) (Ranganna, 2009).

Packaging and storage

The best treatment on the basis of sensory analysis was selected for further storage studies. The papaya flakes were packed in aluminum laminated pouches and stored for a period of six months at ambient temperature. Prepared papaya cereal flakes then evaluated at different intervals 0, 3 and 6 months of ambient storage for physico-chemical and sensory acceptability.

Statistical analysis

The data pertaining to physico-chemical characteristics obtained in this study were subjected to statistical analysis using CRD while those of sensory quality with RBD.

RESULTS AND DISCUSSION

Chemical characteristics of fresh papaya fruit

The chemical characteristics of fresh papaya fruit analyzed in this study were presented in Table 2. Fresh papaya fruit contained 86.94 ±0.14 per cent moisture, 9.50 ±0.25 ^{o}B TSS and 0.06 ±0.01 per cent acidity, whereas total sugars and reducing sugars were recorded as 5.74 ±0.62 and 2.50 ±0.47 per cent respectively. The β-carotene, ascorbic acid and fiber content of the fruit were found to be 4.10 ±0.30 mg/100 g, 43.75 ±0.36 mg/100 g and 1.20 ±0.18 per cent, respectively. Our results are in conformity with earlier reported results by Othman (2009) and Attri et al. (2016) with certain variations which could be due to season and varieties.

Table 2: Chemical characteristics of fresh papaya fruit

Parameters	Mean± S.D.
Moisture (%)	86.94 ±0.14
TSS (^{o}B)	9.50 ±0.25
Titratable acidity (%)	0.06 ±0.01
Ascorbic acid (mg/100gm)	43.75 ±0.36
Fiber (%)	1.20 ±0.18
Reducing sugars (%)	2.50 ±0.47
Total sugars (%)	5.74 ±0.62
Carotenoids (mg/100 g)	4.10 ±0.30
Ash (%)	4.20 ± 0.3

Sensory characteristics of papaya cereal flakes

The data is presented in Table 3 shows that treatment T_3 (papaya pulp with 70 per cent maida + 30 per cent corn flour) was liked by most of the judges and got highest overall acceptability score of 8.50 as comparison to other treatments. The selected treatment contain highest sensory score as 8.60 for colour, 8.50 for flavor, 8.76 for texture and 8.50 for overall acceptability.

Table 3: Effect of different treatment combinations on sensory characteristics of papaya cereal flakes

Parameters	T_1	T_2	T_3	$CD_{0.05}$
Colour	8.20	8.00	8.60	0.40
Flavor	8.50	7.00	8.50	0.21
Texture	7.50	7.00	8.76	0.32
Overall acceptability	7.80	6.50	8.50	0.82

Effect of storage on chemical characteristics of papaya cereal flakes

Papaya cereal flakes prepared by best selected treatment (T3) was evaluated for various physico-chemical parameters on initial day and during storage of 3 and 6 months intervals (Table 4). It has been observed during the storage study (Table 4) that with increase in storage period of papaya cereal flakes, there was increase in moisture content (from 2.50 to 2.80 %), TSS (from 59.80 to 61.9ºB), reducing sugars (from 24.30 to 26.1 %) and total sugars (from 37.76 to 39.00 %). However, decrease in titratable acid (0.96 to 0.91 %), ascorbic acid (from 37.8 to 27.5 mg/100 g) and β-carotene (from 2.00 to 1.87 g/100 g). The moisture content of papaya crereal flakes increased gradually during storage after six months which might be due to absorption of moisture from its surroundings as a result of hygroscopic nature of the dried product. Other reason in increased moisture content might be due to browning taken place during the storage. Our results were in agreement with those of Saddozai et al. (2017) in mango based cereal flakes in which they reported higher increase in moisture (2.21 to 6.41 at 25 ºC) during 180 days of storage due to packaging in high density polyethylene (HDPE) zipper bags. Slight increase in TSS content might be due to conversion of polysaccharides into soluble sugars during storage. The reason behind increase in reducing sugars during storage might be due to degradation of starch and other polysaccharides (such as pectin) that led to the formation of simple sugars. However non-significant variations were observed in acidity, total sugars and fibre of papaya cereal flakes during storage. Rai & Chauhan (2008) have also reported that acid content (as % anhydrous citric acid) in the papaya-cereal flakes did not change significantly throughout the storage period.

Table 4: Effect of ambient storage on the chemical composition of papaya cereal flakes

Parameters	Storage period			$CD_{0.05}$
	0 month	3 months	6 months	
Moisture (%)	2.50	2.67	2.80	0.20
TSS (°Brix)	59.80	61.20	61.90	0.09
Titratable acidity (%)	0.96	0.94	0.91	NS
Ascorbic Acid (mg/100 g)	37.80	30.10	27.50	1.51
Total sugars (%)	37.76	38.14	39.00	NS
Reducing sugars (%)	24.30	25.70	26.10	1.27
β-carotene (mg/100 g)	2.00	1.96	1.87	NS

Ascorbic acid content of papaya cereal flakes decreased as storage period increased regardless of packaging material used. Similarly, Rai & Chauhan (2008) reported the loss of ascorbic acid content might be due to its sensitivity to light and heat, or to its oxidation at high temperature during storage. Ahmed (2015) has also reported wheat, millet extract flour (Geeria) and sorghum flour were found to produce good quality mango cereal flakes and retained 90-98 per cent of ascorbic acid after six months of storage at room temperature (30 ºC). Saddozai et al. (2017) have also reported decreasing trend in carotenes in mango based cereal flakes during storage which might be due to carotenes are readily oxidized by various pro-oxidants. Its breakdown rate increases rapidly with increase in storage time and temperature and also affected by light exposure during storage. Similar decrease in *β*-carotene content during the storage have also been observed by Attri et al. (2018) in papaya powder. The slight decrease in ash and fibre content with increase in storage period was observed in papaya cereal flakes (Fig. 2).

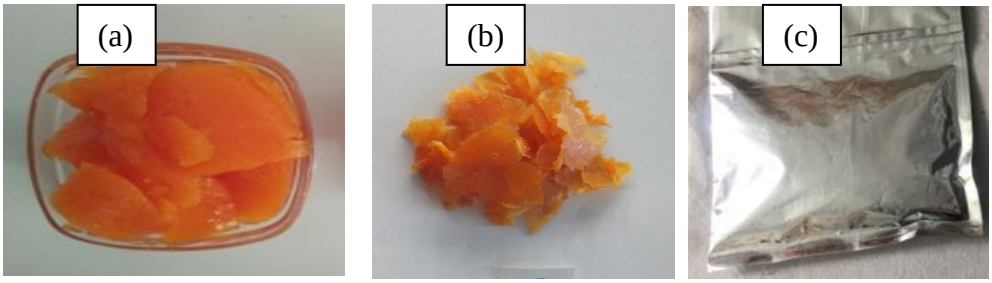

Fig. 2: Papaya-cereal flakes packed in aluminium laminated pouches (c), (a) papaya pulp (b) papaya-cereal flakes

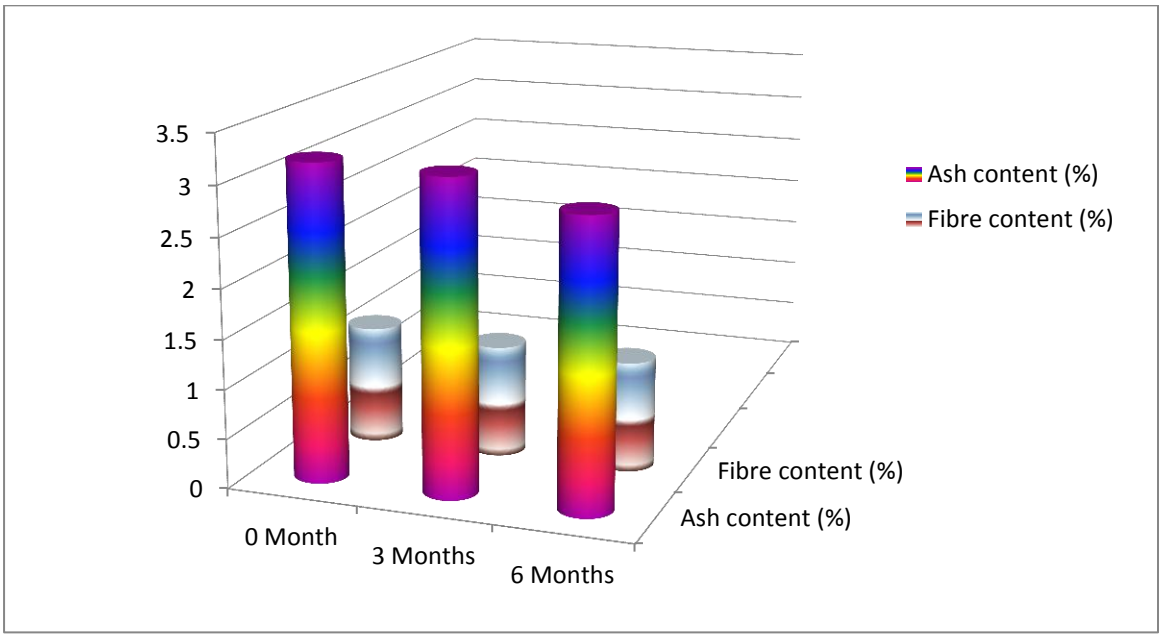

Fig. 2: Effect of storage on fibre and ash content of papaya cereal flakes

Effect of storage on sensory characteristics of papaya cereal flakes

The data in Table 5 indicates the sensory quality attributes of papaya cereal flakes measured on 9-point hedonic scale for colour, flavour, texture and overall acceptability. It was observed that with increase in storage period the quality attributes decreased slightly but they were all above the acceptable limit. The scores for colour, flavour, texture and overall acceptability on initial day was 8.60, 8.50, 8.76 and 8.50, respectively which decreased to 8.00, 7.76, 7.70 and 7.65, respectively after 6 months of storage. The decrease in colour scores might be due to non-enzymatic browning and degradation of *β*-carotene while the change in flavor and taste may be attributed to change in chemical composition of the flakes during storage. Similar decreasing trend in overall acceptability scores during the 180 days of storage have also been observed by Saddozai et al. (2017) in mango based cereal flakes.

Table 5: Effect of ambient storage on the sensory characteristics of papaya cereal flakes

Parameters	0 month	3 months	6 months	$CD_{0.05}$
Colour	8.60	8.26	8.00	0.39
Flavor	8.50	7.85	7.76	0.35
Texture	8.76	7.85	7.70	0.31
Overall acceptability	8.50	7.74	7.65	0.37

CONCLUSION

It was concluded that papaya cereal flakes developed using optimum combination of papaya pulp with maida flour and corn flour in 70:30 ratio was got highest sensory scores during sensory evaluation. The developed product was shelf stable for a period of six months at ambient temperature conditions. After 6 months of storage papaya cereal flakes contains ascorbic acid as 27.50 mg/100 g and β-carotene as 1.87 mg/100 g. So, good quality papaya cereal flakes could be developed without the use of sophisticated drying techniques (drum drying) with dehydrator and OTG oven as snack food for various age groups as presence of vitamins A, C, and K together with beta-carotene and selenium have various health benefits.

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