Preparation of Papaya Powder under Foam-Mat Drying Technique using Egg Albumin as Foaming Agent

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Article History

Manuscript No. 286
Received in 23rd February, 2012
Received in revised form 5th August, 2012
Accepted in final form 6th September, 2012

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Keywords

Papaya, egg albumin, foam, drying, moisture

Abstract

Foam-mat drying of papaya pulp using egg albumin as foaming agent was investigated. The egg albumin was incorporated into papaya pulp at 5, 10, 15 and 20% (w/w) and whipped for 5, 10, 15 and 20 min in room temperature. Foam expansion, foam stability and foam density were determined. The maximum stable foam formation was 125.62% at 15% egg albumin and whipping time of 15 min. The foam expansion was significantly influenced by levels of the egg albumin at ($p\leq0.01$). Foam density was measured and expressed in g cm^{-3}. The resulting foams were dried at air temperatures of 60, 65 and 70°C with foam thickness of 2, 4, 6 and 8 mm under air flow rate of 2.25 cu.m min^{-1}. Lower drying temperature and higher foam thickness resulted in longer drying time. Biochemical and sensory properties of fresh papaya fruit and reconstituted juice from foam-mat dried papaya powder were determined. Biochemical analysis results showed a significant ($p\leq0.05$) reduction in ascorbic acid, β-carotene and total sugars in the foamed papaya dried product at higher drying temperatures (65 and 70°C) and higher foam thickness (4, 6 and 8 mm) due to destruction at higher drying temperature and longer drying time. There was no significant change in other biochemical constituents such as TSS, pH and acidity. The sensory attributes of reconstituted papaya powder juice showed a significant ($p\leq0.01$) reduction in colour, flavor, taste and overall acceptability at higher temperature (65°C and 70°C) and significantly less as compared to fresh papaya juice. The papaya powder obtained from the foam thickness of 2 mm and dried at 60°C was found to be optimum to produce the foam-mat dried papaya powder.

1. Introduction

Foam-mat drying is a process by which a liquid concentrate along with a suitable foaming agent is used to whip to form stable foam and subjected to dehydration in the form of a thin mat of foam at relatively low temperature (Morgan et al., 1961). Rate of drying in this process is comparatively very high because of an enormous increase in the liquid-gas interface thus heat transfer is imparted by large volume of gas present in the foamed mass (Martin et al., 1992). Drying occurs in multiple constant rate periods due to periodic bursting of successive layers of foam bubbles, thus exposing new surfaces for heat and mass transfer as the drying progresses (Chandak and Chivate, 1972). This method is suitable for any heat sensitive, sticky and viscous materials which cannot be dried by spray drying (Hart et al., 1963 and Berry et al., 1965). The foam-mat dried products has better reconstitution properties because of its honeycomb structure and is superior to drum and spray dried products (Morgan et al., 1961 and Chandak and Chivate, 1974). Foaming of liquid and semisolid materials has long been recognized as one of the efficient methods to shorten drying time. In the recent years, foam mat drying technology has revamped and renewed attention for its added ability to process hard-to-dry materials to produce products of desired properties, retaining its volatiles that otherwise would be lost during the drying of non foamed materials (Kudra and Ratti, 2006).

Papaya (*Carica papaya* L.) is one of the important fruits of tropical and subtropical regions in the world. The fruit is rich in β-carotene, vitamin-A and C, iron, calcium, protein, carbohydrates, phosphorous and good source of energy (Gopalan et al., 1972). Papaya can be made into jam, jelly, nectar, dried into slabs, canned in the form of slice, etc. Papaya in the form of powder also used for preparation of nectar, ice cream flavour, ready to eat fruited cereals, etc. Over the last two decades global production of papaya reached almost 10.5 million tones. India is the leading producer of papaya and its share in the world production about 37% (National Horticultural Board, 2009). Most fruits including papaya have high moisture content and are highly perishable, can not be preserved for longer period of time results massive losses. The total postharvest losses of papaya worked out to 25.49% (Gajanana et al., 2010). The climacteric nature, high tendency to deteriorate in ambient storage conditions and inadequate preservation techniques are some of the reasons for losses associated with the commodities. When the moisture is removed, they can be preserved over a longer period of time with minimal deterioration. Among the several methods of preservation, air drying is one of the common methods for preservation of foodstuffs, offering dehydrated products that have extended shelf life. However, the quality of conventionally dried products is often lower compared to the original material, particularly the color, rehydration ratio, texture, and other characteristics (Ratti, 2001). This could be due to the long exposure of food to heat during drying. Thus, the dehydration time needs to be minimized to avoid loss of nutritional and sensory qualities.

Over the years, the foam-mat drying have been applied to many fruits including coffee extract (Chandak and Chivate, 1974), mango, banana, guava, apple (Jayaraman et al., 1974), mango (Baldry et al., 1976), egg melonge (Rao et al., 1987), soymilk (Akintoye and Oguntunde, 1991), pine apple (Hassan and Ahmed, 1998), star fruit (Karim and Wai, 1999a), cowpea (Falade et al., 2003), bananas (Sankat and Castaigne, 2004), mango pulp (Rajkumar et al., 2007a), banana (Thuwapanichayanan et al., 2008), mango (Alakali et al., 2009), plantain and cooking banana (Falade and Okocha, 2010), mango (Kadam et al., 2010), tomato (Kadam and Balasubramanian, 2011) and bael fruit pulp (Bag et al., 2011). Since there is no report showing its application to papaya, the investigation has been carried out with the specific objectives (a) to optimize the concentration of papaya pulp and foaming agent (b) to study the drying characteristics of foamed papaya concentrate (c) to analyses the nutritional qualities of foam mat dried papaya powder**.**

2. Materials and Methods

2.1. Sample preparation

Selection of fruits and foaming agent, peeling, pulping, pretreatment, incorporation of foaming agent, whipping, spreading the foam in the form of thin mat, drying, scraping, grinding, sieving, packing and sealing are some of the major processing steps involved in the foam-mat drying of papaya fruit. Papaya fruits used in this study were procured from the local orchard. The fruits were washed in running water and kept at atmospheric condition till the desired peel colour is attained. Fully ripened fruits were peeled manually using a stainless steel knife and the flesh portions were pulped using a mixer grinder (Sumeet, India). Biochemical analyses of fresh papaya pulp such as acidity, pH, total soluble solids (TSS), total sugars, ascorbic acid and β-carotene contents were carried out to evaluate their relative loss during foam mat drying as per the method described by Ranganna (2000). The TSS was checked with hand refractometer (ERMA, Tokyo, Japan). The fruit pulp was placed in sterilized glass bottle and the bottled pulp was heated in boiling water for 20 min and cooled to room temperature and was treated with potassium metabisulphite at 0.05% (w/w) to inhibit microbial and enzymatic activity (Jayaraman et al., 1974 and Bag et al., 2011). Fresh eggs were procured from local market to extract fresh egg albumin. The albumin was separated from the yolk using a yolk separator. The egg albumin was homogenized and used as foaming agent cum stabilizer at the concentrations of 5, 10, 15 and 20% (w/w).

2.2. Preparation papaya pulp foam

The laboratory scale foaming device (Figure 1) consisting of 153 mm diameter and 280 mm height cylindrical stainless steel container with graduated scale at inside was connected to a nozzle at bottom. A rubber tube of one end was connected to the nozzle and other end with an air compressor. A regulating valve was installed for monitoring compressed airflow rate.

The whipping mechanism of 17 mm diameter shaft was fixed with 8 stainless steel propeller blades having height and diameter of 150 and 100 mm respectively and was used to agitate the material in the foaming container. The shaft of the mechanism was fitted to the shaft of electric motor having 0.25 horse power mounted on the top lid. The speed of the rotation of the propeller was 1440 rpm. About 300 g of papaya pulp was taken in the foaming container along with selected levels of egg albumin (5, 10, 15 and 20%, w/w). The whipper was allowed to rotate and air was introduced to the chamber slowly at the rate 0.03 cu.m min^{-1}. The foaming device was operated at 1440 rpm at room temperature

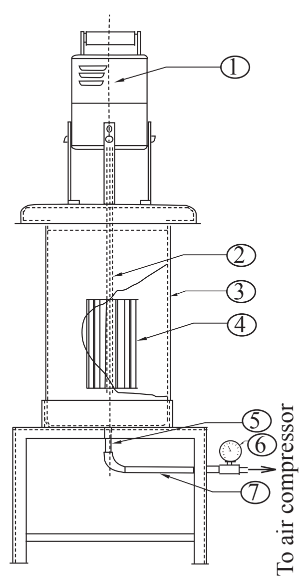

Figure 1: Foam developing unit

until maximum foam formation. Compressed airflow at the rate 0.03 cu.m min^{-1} was maintained. The foamed slurry was directly discharged from the foaming device by removing top lid along with electric motor. During the foaming study, all the experiments were replicated thrice and the mean values were recorded. The influence of whipping time and concentration of egg albumin on foam expansion was statistically analyzed ($p \leq 0.01$) by factorial completely randomized design (Cochran and Cox, 1957).

2.3. Determination of foaming properties

The foaming process was optimized in terms of maximum foam expansion with minimum density, stability of foam in longer time and density of foam. Based on these foaming properties,

$$FE = \frac{V_1 - V_0}{V_0} \times 100 \text{ ----------(1)}$$

the optimum levels were identified. The foam expansion, foam stability and foam density were determined as described by Akiokato et al. (1983) and Rajkumar et al. (2007b):

Where EF is the foam expansion, %, V_0 is the initial volume of papaya pulp, cm^3 and V_1 is the final volume of foamed papaya pulp, cm^3. Foam stability with minimum drainage volume of papaya foam was determined by filling of 100 mL of the foamed pulp in a transparent graduated cylinder and kept at room temperature for 3 h. The amount of liquid juice which separated

$$\text{Foam stability} = \Delta_0 \ \frac{\Delta t}{\Delta V} \text{ ----------(2)}$$

from the foam as a result of drainage and the reduction in foam volume were measured as an index for the foam stability for every 30 min by using the following relationship:

Where Δ_0 is the volume of foam at zero time and ΔV is the

$$\text{Foam density (g cm}^{-3}) = \frac{m}{V_1} \text{ ----------(3)}$$

change in foam volume during the time interval Δt. The density of the foamed papaya pulp was determined by dividing the mass of fresh pulp by the final volume of foam.

2.4. Drying of foamed and non-foamed papaya pulp

A batch type cabinet drier (Kilburn, India) having heating unit, blower, drying chamber, air outlet openings and thermostat was used for drying studies. The drying chamber measuring 100×100×100 cm^3 was constructed of 3 mm thick mild steel sheets. The drying chamber can accommodate 24 stainless steel trays size of (90 × 40 × 2.5 cm^3). The drying temperature inside the chamber was regulated using thermostat with an accuracy of ±1°C. In order to stabilize the temperature inside the drying chamber, the drier was operated for a period of 30 min at required temperature before placing the trays in the dryer. During preliminary drying tests, it was found that the foamed and non-foamed dried papaya product firmly stuck to the stainless steel tray, and scraping off them became serious problem. To prevent sticking and to facilitate easy removal of the dried foamed and non-foamed papaya product after drying, the trays were lined with a non-stick food-grade Teflon sheet.

The homogeneous foamed papaya pulps were evenly spread on the stainless steel trays at thickness of 2, 4, 6 and 8 mm. The foam thickness was determined by dividing the known volume (mass/density) of foam by the drying area. Similarly non-foamed papaya pulp thickness was also arrived. The trays were then placed on the tray stand in position for drying. The temperature inside the drying chamber was measured by using thermometer. The foamed and non-foamed papaya pulps were dried at different temperatures viz., 60, 65 and 70°C with an air flow rate of 2.25 m^3 min^{-1}. The drying temperatures were selected as research reports presented in the previous literatures for fruits. The trays were taken out of the drying chamber at every 30 min interval for determination of weight loss. Moisture content was recorded using a digital electronic balance having

$$MC,\%(db) = \frac{W_m}{W_d} \times 100 \text{ ----------(4)}$$

least count of 0.01 mg (Citizen Instruments, Pune, India) on initial and final weight basis. The drying was ceased when the weight of the samples recorded constant values. The moisture content was calculated as described by Chakraverty (1997).

Where MC is the moisture content on dry basis, %, W_m is the weight of moisture in the sample, g and W_d is the weight of dry matter of the sample, g.

2.5. Quality evaluation

The dried foam was scraped and the flakes were milled and sieved to obtain a fineness of 250 micron. The powder was packed immediately in polyethylene (150µm) bags and sealed to prevent caking. The samples were stored at room temperature for periodical evaluations. To distinguish the relative changes in nutrients, papaya powder samples were analyzed for different biochemical properties viz., TSS, pH, acidity, ascorbic acid, total sugars and β-carotene after reconstituting the powder to its original moisture content. The biochemical contents of the reconstituted foam mat dried papaya powder with three replications were statistically analyzed as factorial completely randomized design and compared with fresh papaya pulps to optimize the drying and foaming parameters. The results obtained were analyzed statistically by completely randomized block design using AGRES statistical package ($p \leq 0.05$).

3. Results and Discussion

Various biochemical contents of fresh non-foamed papaya pulps were determined as total soluble solids (13°Brix), pH

(5.2), acidity (1.4%), ascorbic acid (145 mg 100 g^{-1}), total sugar (36.8 g $100g^{-1}$) and beta-carotene (4.056 mg 100 g^{-1}). The results obtained on biochemical properties are in comparison with the results reported by Pandey (1997), Aruna et al., (1998).

3.1. Effect of concentration egg albumin and duration of whipping on foam expansion

The effect of duration of whipping on foam expansion in papaya pulp at different concentration of egg albumin is shown in Table 1. From the table, it is seen that the foam volume was increased significantly as the concentration of egg albumin in the pulp increased. Higher foam expansion indicates that more air was trapped in the foam and egg albumin reduces the surface tension and interfacial tension to a level sufficiently low to form the interfacial film that exceeds the critical thickness.

Apparently, at lower concentration of egg albumin, the air bubbles were not stable because the critical thickness required for interfacial film could not be formed (Karim and Wai, 1999b). As the concentration of egg albumin increased, the foam expansion increased until maximum value. The maximum foam was obtained at egg albumin concentration of around 15% (w/w). At this concentration, the foam expansion was as high as 125.62%. However, increasing the egg albumin concentration beyond this level did not produce appreciable changes in the foam expansion. Similar observations were reported on the foam expansion of mango (Rajkumar et al., 2007b), star fruit (Karim and Wai, 1999a) and bael fruit pulp (Bag et al., 2011). The duration of whipping also influenced the foam expansion. It is observed from the Table 1 that the foam expansion increased with increase in whipping time. The egg albumin stabilized foams exhibited maximum upto 15 min of whipping and thereafter a considerable decrease in foam expansion was noticed. Raharitsifa et al. (2006) also reported that expansion of foams increased with whipping time up to a maximum and decreased thereafter probably because excessive whipping (overbeating) could cause foam to collapse. The egg albumin stabilized foams exhibited maximum at 15 min of whipping thereafter no appreciable increase in foam expansion occurred.

Table 1: Effects of levels of egg albumin and duration of whipping on foam expansion

Level of egg albumin (%)	Expansion of foam (%) whipping after				
	5 min	10 min	15 min	20 min	
5.0	14.45	24.53	38.23	40.37	**
10.0	28.73	48.07	76.85	80.18	**
15.0	58.74	82.39	125.62	131.72	**
20.0	63.12	88.61	130.78	137.65	**

Each observation is the mean three replicates; **significantly different at (p≤0.01)

Table 2: Foaming properties of papaya pulp

Level of egg albumin (%)	Weight of fresh pulp (g)	Volume of fresh pulp (cm^3)	Density of fresh pulp (g cm^{-3})	Foam volume (cm^3)	Foam expansion (%)	Foam density (g cm^{-3})
5.0	300	286.0	1.048	414	38.23	0.724
10.0	300	287.6	1.043	528	76.85	0.568
15.0	300	286.8	1.046	675	125.62	0.444
20.0	300	286.4	1.047	705	130.78	0.426

Similar trend was reported by Sankat and Castaigne (2004) for bananas and Bag et al. (2011) for bael fruit pulp. Table 2 describes the foaming characteristics of the papaya pulp.

The density of fresh papaya pulp varied between 1.043 and 1.048 g cm^{-3}, whereas after whipping for 15 min, it decreased to between 0.724 and 0.426 g cm^{-3}. The foam density was decreased as the concentration of egg albumin was increased. Hart et al. (1963) stated that for foam mat drying, the low density foams are stabled for longer time thereby reduced drying time and the optimum range of density of foamed material should be between 0.2 and 0.6 g cm^{-3}.

3.2. Effect of concentration of egg albumin on foam stability

Foam stability reflects the water holding capacity of the foam and one way to determine the rate at which the liquid drains from it (Kampf et al., 2003). The liquid in foams is distributed between thin films and plateau borders. Because of the radius of curvature of a plateau border, the pressure inside is less than that in thin films by capillary pressure. This difference, known as plateau border suction, leads to drainage of liquid from thin films to the neighboring plateau border. Finally, all liquid in the plateau border of foams are subject to drain of the liquid from between the bubbles caused by the action of gravity (Narsimhan, 1991). The stable foam structure is desirable for rapid drying and ease of removing the dried material from the tray. If foams break or drain excessively, drying time is increased, reducing product quality. The stability or drainage volume of foam is influenced by the thickness of the interface, foam size distribution, interface permeability, and surface tension. The concentration of foaming agent is one of the major factors in foam stability. Figure 2 shows the effect of egg albumin concentration on foam stability.

From the figure, it is seen that the foam with higher concentration of egg albumin exhibited more stability as compared to lower concentration of egg albumin. However, decrease in pulp concentration caused decrease in stability of foam and increase in drainage volume. Increase in egg albumin concentration caused stability of foam or decrease of drainage volume. The

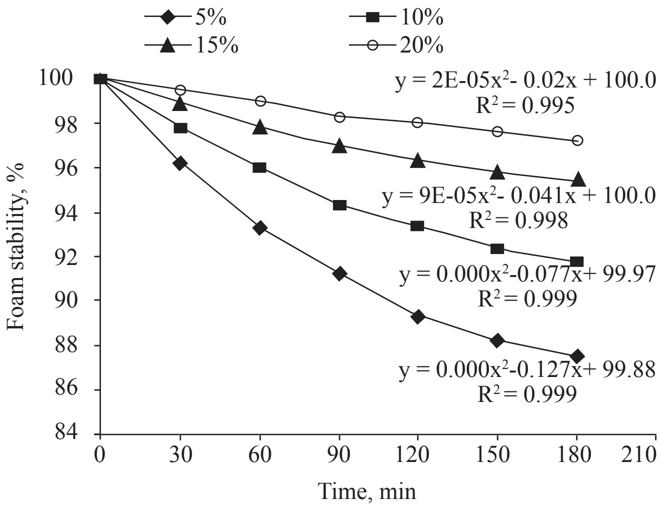

Figure 2: Effect of concentration of egg albumin on foam stability Each value is the mean three replicates

foam stability value was 95.4% and 97.2% at the concentration of 15% and 20% egg albumin respectively at 180th min and it was less in lower concentration of egg albumin (5 and 10%). Similar result was reported by Pernell et al. (2002) for egg white and Falade et al. (2003) for cowpea.

3.3. Effect of foam thickness on drying characteristics papaya pulp

Foam mat drying of foamed papaya pulp was carried out by foam obtained at optimized level of 15% egg albumin with four foam thicknesses viz., 2, 4, 6 and 8 mm and three drying temperatures of 60, 65 and 70°C in a batch type cabinet tray dryer. Similar drying trends were occurred at all the temperatures studied. The drying study showed that the foamed papaya pulp dried at 60°C was found to be the best and hence this drying kinetics are discussed in comparison with non-foamed papaya pulp dried at 60°C. The effect of foam thickness on the moisture content of foamed papaya pulp drying at 60°C is shown in Figure 3. From the figure, it is observed that the time taken for drying of foamed papaya pulp from 843.57 to 4.5±0.3% moisture content on dry basis was 2, 3, 4 and 5 h for 2, 4, 6 and 8 mm thick foam.

The effect of thickness on the moisture content of non-foamed papaya pulp drying at 60°C is shown in Figure 4. The time taken for drying of non-foamed papaya pulp was 4, 5.5, 7 and 9 h for 2, 4, 6 and 8 mm thick respectively to reach the moisture content 8.7±0.3% on dry basis. From the drying curves, it is noted that the reduction in the moisture content at any point of drying increased with decrease in foam thickness. This may be due to the fact that moisture migration is higher in smaller foam thickness than greater foam thickness. The reduction in the moisture content of foamed papaya pulp at any point of time during drying was higher when compared to the non-foamed papaya pulp at all thickness studied. This is due to enormous increase of liquid-gas interface in the foamed mass. The rate

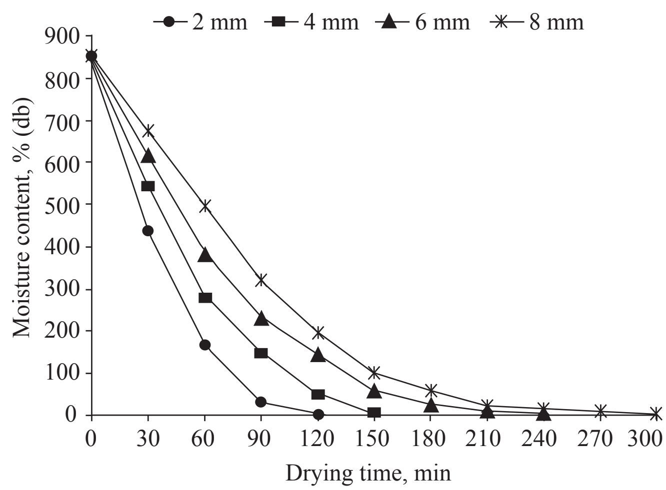

Figure 3: Effect of foam thickness on drying characteristics of foamed papaya pulp at 60°C

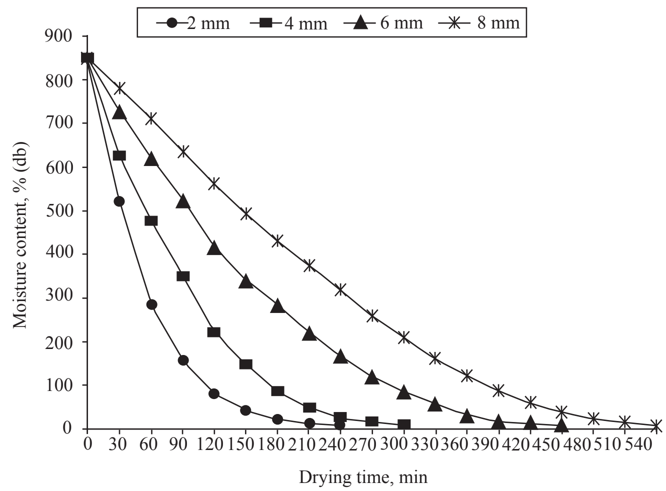

Figure 4: Effect of pulp thickness on drying characteristics of non-foamed papaya pulp at 60°C

of removal of moisture in the foamed papaya pulp was higher than in non-foamed papaya pulp because the water present in the foams is in the form of thin films making water easily vaporizable. These drying results were confirmed with the drying results reported by Akintoye and Oguntunde (1991) for soymilk foam, Rajkumar et al. (2007b) for mango pulp and Thuwapanichayanan et al. (2008) for banana.

3.4. Effect of drying temperature on quality of foam-mat dried papaya powder

The nutritional qualities of dried product play an important role in selecting the drying parameters and were compared with fresh papaya pulp and non-foamed dried papaya powder. The biochemical results of the foamed papaya pulp dried at 60, 65 and 70°C are shown in Table 3. The biochemical results of the foamed papaya pulp dried at 60, 65 and 70°C are shown in Table 3 The biochemical changes were comparatively higher in 4, 6 and 8 mm thick foam dried at 65 and 70°C as

Table 3: Biochemical composition of foam-mat dried papaya powder

Drying temp.	Foam thickness (mm)	Biochemical composition					
		TSS (°Brix)	pH	Acidity (%)	Ascorbic acid (mg 100 g^{-1})	β-carotene (mg 100 g^{-1})	Total sugars (g 100 g^{-1})
60°C	2	12.65	4.90	1.47	140.42	4.00	36.78
	4	12.65	4.92	1.47	139.21	3.85	36.76
	6	12.60	5.05	1.46	137.76	3.73	36.50
	8	12.65	5.13	1.46	137.06	3.60	36.35
65°C	2	12.70	5.31	1.46	138.52	3.86	35.80
	4	12.60	4.90	1.46	137.67	3.80	35.80
	6	12.60	4.93	1.45	130.62	3.60	35.50
	8	12.65	4.90	1.46	128.73	3.45	35.45
70°C	2	12.75	4.94	1.46	125.52	3.70	35.35
	4	12.70	4.90	1.45	118.68	3.65	35.30
	6	12.65	5.12	1.47	118.34	3.36	35.32
	8	12.65	5.28	1.46	111.92	3.30	35.46
	CD ($p\leq0.05$)	0.19	0.19	0.09	1.74	0.09	1.26
		NS	NS	NS	**	**	**

Each observation is the mean three replicates; NS = Not-significant; **significantly difference at $p\leq0.05$

compared to 2 mm thick foam dried at 60°C. It was found that there was a significant reduction in ascorbic acid (140.42 to 111.92 mg 100 g^{-1}). This may be due to the destructive effect of the prolonged thermal treatment, which caused oxidation of the ascorbic acid (Levi et al. 1983). It was also found that there was a significant reduction in β-carotene (4 to 3.3 mg 100g^{-1}). Total sugars (36.78 to 35.32 g 100 g^{-1}) also changed significantly. Other biochemical contents such as TSS (12.6 to 12.75 °Brix), pH (5 to 4.9) and acidity (1.47 to 1.45%) were not significant. The slight increase in acidity level may be due to the influence of acidity content of the egg albumin. Similar biochemical changes were reported by Srivastava (1998) for mango, Aruna et al. (1998) for papaya, Hassan and Ahmed (1998) for pineapple, Mishra et al. (2002) for apple, Rajkumar et al. (2007b) for mango, Thuwapanichayanan et al. (2008) for bananas, Falade and Okocha (2010) for banana.

Based on the biochemical analysis, it was found that the papaya powder obtained from foam thickness of 2 mm and dried at 60°C retained significantly higher amount of nutritional qualities than other treatments such 4, 6 and 8 mm foam thickness and dried at 65 and 70°C. The biochemical results of the non-foamed papaya powder are presented in Table 4. From the table, is clearly seen that the biochemical compositions in the foamed dried papaya powder were retained significantly higher as compared in the non-foamed dried papaya powder at all drying temperature and pulp thickness studied. This might be due to a higher drying rate with lower drying time in foamed pulp whereas lower drying rate with higher drying time in non-foamed pulp. A similar observation was made by Mishra et al. (2002) for mango and Rajkumar et al. (2007b) for mango pulp. Overall, it was found that using 15% egg albumin, drying temperature of 60°C and a foam thickness of 2 mm retained significantly ($p\leq0.05$) higher amounts nutritional qualities when compared to other treatments.

3.5. Sensory evaluation of foam-mat dried papaya powder

The juice was prepared from the papaya powder obtained from 2 mm thick foam and was compared with fresh papaya fruit juice. The effect of drying temperature on sensory attributes of reconstituted papaya powder for different characteristics such as colour, flavour, taste and overall acceptability were used to test the significance of different treatments and are given in Table 5.

From the table, it is clearly seen that the sample dried at 60°C recorded higher ratings on colour, flavour, taste and overall acceptability as compared to the samples dried at 65 and 70°C. The various treatments adopted had not significantly effect on flavour, taste and overall acceptability but significant effect on the colour. However, the fresh sample also received the higher rating in all the attributes. However, the flavor and taste of the reconstituted sample at 65 and 70°C received a lower rating. This could be due to the loss of volatiles during the drying process. Similar trend was reported by Hassan and Ahmed (1998) for foam-mat dried pineapple powder juice and Falade and Okocha (2010) for foam-mat dried reconstituted banana paste.

Table 4: Biochemical composition of non-foam dried papaya powder

Drying temp.	Pulp thickness (mm)	Biochemical compositions					
		TSS (°Brix)	pH	Acidity %	Ascorbic acid (g 100 g^{-1})	β-Carotene (g 100 g^{-1})	Total sugar (g 100 g^{-1})
60°C	2	11.57	4.83	0.74	117.86	3.84	36.68
	4	11.55	4.81	0.76	116.56	3.42	36.67
	6	11.63	4.82	0.75	109.44	3.10	35.90
	8	11.64	4.85	0.72	105.32	3.05	35.75
65°C	2	11.72	4.82	0.73	113.87	3.45	35.80
	4	11.55	4.84	0.76	111.65	3.18	35.76
	6	11.78	4.88	0.75	100.75	3.00	35.14
	8	11.68	4.93	0.79	96.34	3.07	35.00
70°C	2	11.61	4.86	0.75	95.13	3.25	36.06
	4	11.60	4.92	0.77	93.40	2.91	35.74
	6	11.64	4.89	0.71	83.84	2.87	34.32
	8	11.63	4.87	0.76	80.57	2.85	34.47
	CD (p≤0.05)	0.15	0.08	0.06	1.90	0.12	1.60
		NS	NS	NS	**	**	**

Each observation is the mean of three replicates; NS= Not-significant; **Significantly difference at p≤0.05

Table 5: Effect of drying temperature on sensory attributes of reconstituted papaya powder

Characteristics	Fresh sample	60°C	65°C	70°C	CD (p=0.01)	
Colour	6.50	6.21	5.84	5.70	1.27	**
Flavour	6.93	6.58	6.26	6.00	1.46	NS
Taste	7.30	6.73	6.20	6.00	1.44	NS
Overall acceptability	6.86	6.43	6.07	5.90	1.35	NS

Each observation is the mean of ten replicates; NS = not significant; ** significantly difference at (p≤0.01)

4. Conclusion

The optimum level of egg albumin was found to be 15% and whipping time was 15 min. The stability of foam (95.4%) also was found to be long at higher concentration of egg albumin (15%) as compared to lower concentration of egg albumin. It was concluded that the time taken for drying of foamed papaya pulp was 2, 3, 4 and 5 h for 2, 4, 6 and 8 mm foam thickness with moisture content of 4.5±0.3% on dry basis. The biochemical composition concern, it was concluded that 2 mm thick foamed papaya powder at 60°C retained significantly higher amount of nutritional qualities as compared to 4, 6 and 8 mm thick foamed papaya powder dried at 65 and 70°C. From the overall study, it was concluded that the maximum foam volume expansion with minimum foam density was formed at 15% egg albumin and whipping time of 15 min. The stable foam was dried at foam thickness of 2 mm at temperature of 60°C was optimum condition for preparation of papaya powder.

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