Research Article

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Development and characterization of foam mat dried palmyrah fruit pulp powder

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Abstract

The Palmyra fruit is a good source of vitamin C, carotenoids, minerals, and sugars and the fruit pulp is used to treat skin problems, nausea, vomiting and improves digestion by relieving constipation. Study was conducted to optimize the process parameters for the production of palmyrah fruit pulp powder using foam-mat drying. Palmyrah fruit pulp was foamed by incorporating egg albumin (EA) (0, 5, 10, 15 and 20 %, w/w) and methyl cellulose (MC) (0, 0.25, 0.5, 0.75 and 1 %, w/w) as foaming agents with different pulp concentrations (PC) (8, 10, 12, 14 and16 °Brix) and various whipping times (WT) (1, 2, 3, 4 and 5 min) using response surface methodology with CCRD design. From the results, the optimum conditions achieved after the numerical and graphical optimization for maximum foam expansion and stability were: EA (6.875 g/100 g pulp), MC (0.262 g/100 g pulp), PC (14° Brix), and WT (2 min). The drying time required for foamed palmyrah pulp was lower than non-foamed pulp. The quality attributes of palmyrah fruit pulp powder obtained from the pulp of 14°Brix added with 6.875 % egg albumin and methyl cellulose of 0.262% whipped for 2 min and dried with a foam thickness of 4 mm at a temperature of 60 °C was found to be optimum to produce the foam-mat dried powder.

Keywords: Palmyrah fruit, Additives, Whipping time, Foam density. Drainage volume, Foam mat drying.

Introduction

One of the most common native fruits in Asia is the palmyrah (*Borassus flabellifer* L.), which is particularly common in the southern Indian provinces. The pulp is mildly pleasant, with a yellowish red color, and is fibrous and mucilaginous. It firmly sticks to the hard fiber and black endocarp, making it difficult to pulp. Because palmyrah pulp contains high levels of nutrients that are vital to human health, such as proteins, carbohydrates, carotenoids, and fibers, it has a high nutritional value (Sanakralingam *et al.* 2004). According to scientific research, its pulp and seed are used to create a variety of culinary goods that are thought to be a good source of vitamin A and fiber, including food bars, fruit drinks, snack foods, and baked goods (Kurian *et al.* 2017). Additionally, pastries, jellies, and ice cream can be made using this fruit (Jansz *et al*. 2002). Currently, rural populations use artisanal methods to use palmyrah pulp. Because of the nature of its fatty acids, it also offers industrial potential for use in cosmetics and pharmaceuticals. An estimated 2 million tonnes of pulp are only breaking down in the soil (Sankaralingam *et al.* 1999).

An old-fashioned method that is frequently used to extend the shelf life of fruits and their products is drying. However, because they contain low

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molecular weight components like fructose, glucose, sucrose, citric acid, etc., drying sugar-rich foods like fruit pulp and juices can be challenging. These materials also have low glass transition temperatures (Tg), and at temperatures slightly above Tg, they have high molecular mobility because of their low molecular weight. Fruit powders are typically prepared by adding food-grade anti-caking agents, such as tricalcium phosphate, and components with high Tg, like maltodextrin, to address this issue (Jaya and Das 2009). However, high-sugar materials can be quickly dried in the air to produce fast powders when they are transformed into stable foams. (Rajkumar *et al.,* 2007; Thuwapanichayanan *et al.,* 2008). Fruit pulp intended for the foam-mat-drying process was treated with methyl cellulose (MC) and egg albumin (EA) in turn to promote foam formation (Falade *et al.* 2003). The Kandasamy group (2014) There have been previous reports on the foaming conditions of a variety of tropical fruits, including pineapple, passion fruit, guava, banana, papaya, mango, star fruits, and apples (Jayaraman *et al.* 1974). On the other hand, there are no records of palmyrah fruit pulp being dried on foam mats. Thus, a study was carried out to determine how whipping duration, pulp concentration, and foaming additives affected the foam density, drainage volume, and drying of foamed pulp made from palmyrah fruit pulp. In order to maximize foam stability (minimum drainage volume) and maximize foam expansion (minimum foam density), as well as to optimize the drying parameters (temperature and thickness), the foaming process was also carried out.

Materials and Methods

Materials

For the studies, fresh fallen palmyrah fruits were obtained from the palmyrah field at the Horticultural Research Station, Pandirimamidi (17.25 North Latitude, 81.45 East Longitude). After the fruits were cleaned and sorted, the damaged ones were thrown out. After two minutes of immersion in hot water (between 50 and 60 °C), the fruits were carefully peeled. Using a grater, the palmyrah pulp (Fig. 1) was manually removed. To extract the pulp, distilled water (1:0.25 w/w) was added to help remove the seeds. The pulp was then strained using a stainless steel sieve with 20 mesh. The extracted pulp was put into a glass bottle that had been sealed and sterilized. For 15 minutes, the bottled pulp was heated to boiling water to suppress enzyme and microbiological activity. Following that, it was chilled and kept at ambient temperature (Fig. 1). Total soluble solids (TSS) were measured using a hand refractometer (ERMA, Tokyo, Japan) and the determined amount of distilled water was mixed to provide the necessary pulp concentration during the foaming trial.

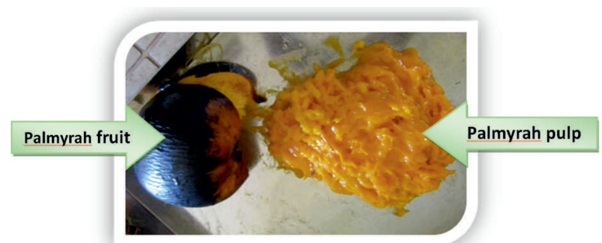


Fig.1. Fruit pulp of palmyrah

Foaming Device

The electric-operated hand blender is part of the laboratory-scale foaming apparatus. The substance in the jar was stirred using a stainless steel whipping blade (1.6 mm thick) with three cutting edges

Foaming Experiments

To ascertain the impact of pulp content, whipping time, and foaming additives on foam density (FD) and foam drainage volume (DV), the central composite rotatable design (CCRD) was employed. A 200 mL palmyrah pulp of the proper concentration was mixed with the necessary amount of methyl cellulose (MC) and egg albumin (EA). The foaming apparatus (3,000 rpm) was used to fully mix the mixture for the necessary amount of time at a regulated room temperature (22–25°C), as indicated in Table 1. Foam density and drainage volume were measured on the foamed pulp samples.

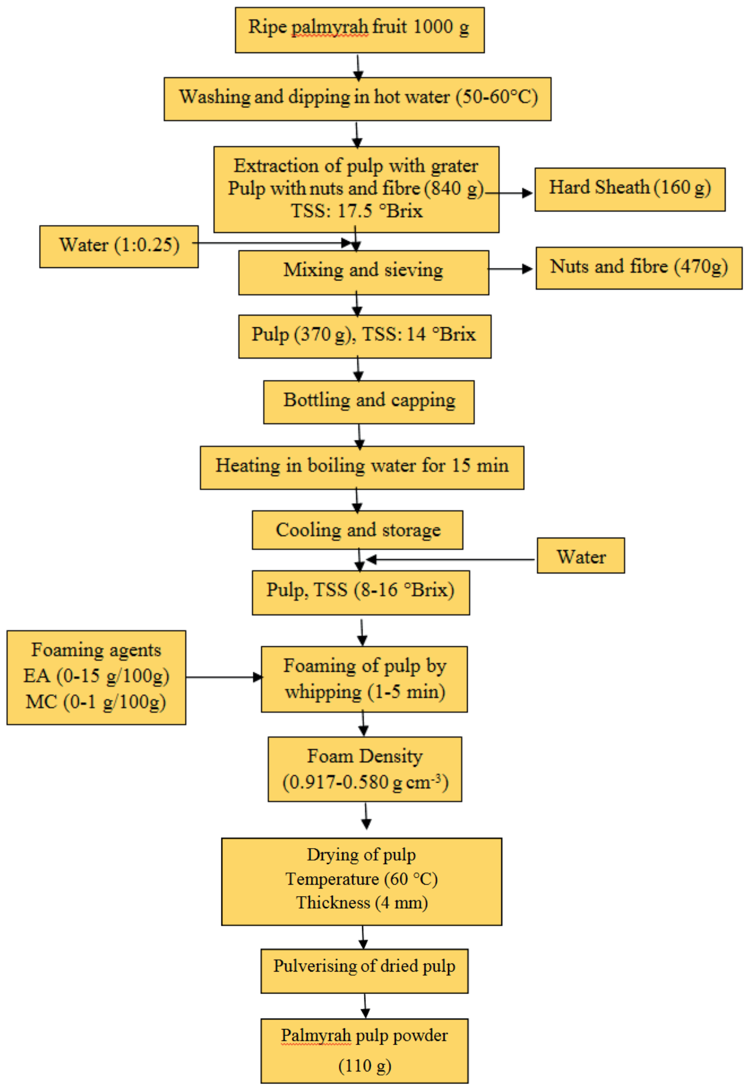


Fig. 2. Flow diagram depicting preparation of palmyrah pulp powder

Determination of Foam Density

To find the density of the palmyrah pulp foam, the mixture was weighed into a 50 milliliter measuring cylinder. As noted by Karim and Wai (1999), the foam was inserted into the cylinder without damaging the foam structure or creating air gaps. For every preparation batch, the foam density was measured three times, and the average results were published.

Determination of Foam Drainage Volume

In order to estimate foam stability, foam drainage was evaluated using the methods outlined by Sauter and Montoure (1972) and Narender and Pal (2009). Using this procedure, a 25 ml graduated cylinder was placed on top of an 80 mm filter filled with foam. The measuring cylinder held the liquid juice that had been collected after draining had separated it from the froth. The drainage volume was determined by measuring the volume of liquid that accumulated in the cylinder after an hour. For every preparation batch, the experiments were run three times, and the average results were published.

Experimental Design and Statistical Analysis

On the basis of early trials, the experimental parameter ranges were chosen. Egg albumin (0–15 g/100 g of pulp), methyl cellulose (0–1 g/100 g of pulp), pulp concentration (8–16 °Brix), and whipping duration (1–5 min) were the independent variables taken into consideration. The central composite rotatable design (CCRD)-shaped experimental design was optimized through the application of the response surface methodology (Mithun and Kaleemullah, 2019). In order to comprehend the interactions of EA, MC, PC, and WT on the quality of foam in 30 runs—16 factorial, 8 axial, and 6 at center point—a four-variable (five levels of each variable) CCRD and a response surface methodology (RSM) were employed (Montgomery, 2001).

The response functions 'y' (dependent variables) were foam density and drainage volume The following second-order polynomial model was fitted to the dependent variables with the experimental data.

$$y = \beta_o + \sum_{i}^{4} \beta_i X_i + \sum_{i}^{4} \beta_{ii} X_{ii}^{\ 2} + \sum_{i}^{3} \sum_{j=i+1}^{4} \beta_{ij} X_i X_j \tag{1}$$

To fit the models shown in equation 1 and determine the statistical significance of the model terms, regression analysis and analysis of variance (ANOVA) were performed. The models' suitability was assessed through the application of model analysis, coefficient of determination (R2) analysis, and lack-of-fit test (Lee *et al.* 2000; Mangaraj and Singh 2009; Tripathi and Mishra 2009). Using a 5% significance level, the F value was calculated to determine the statistical significance of each term in the polynomial. With the use of the commercial statistical program Design-Expert (2021) version 13.0., response surfaces and contour plots were produced.

Optimization of Foaming

Using Design-Expert software, numerical and graphical optimization was done for the independent variables to produce foam with the lowest possible foam density (FD, or maximum foam expansion) and minimal drainage volume (DV, or maximum foam stability). Using a traditional graphical method, the minimal FD and minimum DV were determined. Systems were graphically represented using predictive models. The best combinations of EA, MC, PC, and WT were found using contour plots of the response variables and superimposing surface methods to produce palmyrah fruit pulp foam.

Drying

The drying was done using a batch type tray drier (Make: Yorco, India) with a heating unit, blower, drying chamber, air outlet apertures, and thermostat. To maintain the appropriate temperature inside the chamber, the drier was run a few times. On food-grade non-sticky plates, the homogenous foamed and non-foamed palamyrah fruit pulp was equally spread apart at a foam thickness of 4 mm (Fig 2). A thermometer was used to measure the temperature within the drying chamber. The fruit pulps of palmyrah, both foamed and non-foamed, were dried at 60 °C. To measure the weight loss of the samples, the trays were removed from the drying chamber every hour. Using a computerized electronic scale with a minimum count of 0.01 mg, the samples were weighed. The drying studies came to an end when the sample weights showed consistent values. Calculations were performed using the average data from the triple experiments. Chakraverty (1997) provided instructions for calculating the rate of drying and the moisture content on a dry basis (% d.b).

Quality analysis

After the trays cooled down to room temperature, the dried palmyrah fruit pulp froth was scrapped, and the product was promptly packed in 300 gauge high density polythene bags to stop moisture from diffusing in. The product was ground to a fineness of 250 µm. The samples underwent quality analysis after being kept under ambient conditions. After reconstituting the powder to its original moisture content using conventional protocols, the powder samples were analyzed for several biochemical properties, such as pH, acidity, ascorbic acid, and β-carotene, in order to discern the relative changes in nutrients (Ranganna, 2000). With three replications, the biochemical composition of the dried powder from foam mats was reconstituted, and the results were statistically analyzed using a completely randomized block design method in the Statistical Package for the Social Sciences (SPSS 13.0).

Results and Discussion

The observations for foam density and drainage volume with different combinations of the independent variables are presented in Table 1. The models for drainage volume and foam density are very significant ($p < 0.001$), according to analysis of variance (Table 2). In the cases of foam density and drainage volume, the lack-of-fit was negligible, suggesting that these models are accurate enough to anticipate those reactions. The answers' coefficient of determination (R2) values were 0.919 and 0.936, respectively, showing that the RSM models were sufficient and that a significant amount of variability was explained by the data.

Table 1. Effect of process variables on palmyrah pulp foam density and drainage volume

No.	EA (%)	MC (%)	PC (°Brix)	WT (min)	FD (g cm-3)	DV (mL)
	(x_1)	(x_2)	(x_3)	(x_4)		
1	15(+1)	0.75(+1)	14(+1)	4(+1)	0.726	0
2	15(+1)	0.75(+1)	14(+1)	2(-1)	0.701	1
3	15(+1)	0.75(+1)	10(-1)	4(+1)	0.689	1
4	15(+1)	0.75(+1)	10(-1)	2(-1)	0.672	1
5	15(+1)	0.25(-1)	14(+1)	4(+1)	0.657	1
6	15(+1)	0.25(-1)	14(+1)	2(-1)	0.642	1
7	15(+1)	0.25(-1)	10(-1)	4(+1)	0.631	2
8	15(+1)	0.25(-1)	10(-1)	2(-1)	0.618	2
9	5(-1)	0.75(+1)	14(+1)	4(+1)	0.902	1
10	5(-1)	0.75(+1)	14(+1)	2(-1)	0.78	1
11	5(-1)	0.75(+1)	10(-1)	4(+1)	0.74	1
12	5(-1)	0.75(+1)	10(-1)	2(-1)	0.721	1
13	5(-1)	0.25(-1)	14(+1)	4(+1)	0.742	2
14	5(-1)	0.25(-1)	14(+1)	2(-1)	0.721	2
15	5(-1)	0.25(-1)	10(-1)	4(+1)	0.716	2
16	5(-1)	0.25(-1)	10(-1)	2(-1)	0.689	2
17	20(+2)	0.5(0)	12(0)	3(0)	0.672	1
18	0(-2)	0.5(0)	12(0)	3(0)	0.864	1
19	10(0)	1.0(+2)	12(0)	3(0)	0.761	1
20	10(0)	0.0(-2)	12(0)	3(0)	0.59	3
21	10(0)	0.5(0)	16(+2)	3(0)	0.801	1
22	10(0)	0.5(0)	8(-2)	3(0)	0.635	2
23	10(0)	0.5(0)	12(0)	5(+2)	0.66	1
24	10(0)	0.5(0)	12(0)	1(-2)	0.65	1
25	10(0)	0.5(0)	12(0)	3(0)	0.621	1
26	10(0)	0.5(0)	12(0)	3(0)	0.634	1
27	10(0)	0.5(0)	12(0)	3(0)	0.631	1
28	10(0)	0.5(0)	12(0)	3(0)	0.654	1
29	10(0)	0.5(0)	12(0)	3(0)	0.631	1
30	10(0)	0.5(0)	12(0)	3(0)	0.684	1.5

EA-Egg Albumin (%), MC-Methyl Cellulose (%), PC-Pulp Concentration (°Brix), WT-Whipping Time (min), FD-Foam Density (g cm-3), DV-Drainage Volume (mL)

Data in the parenthesis is the coded value of process variables

Effect of Foaming Process Variables on Foam Density and Drainage Volume

Foam Density (FD): At various treatments, the foam density of the palmyrah fruit pulp foam ranged from 0.618 to 0.902 g cm^{-3}. (Table 1). ANOVA revealed that while whipping duration was significant at the 5% level, foam density was highly significant at the 0.1% level on linear terms of egg albumin, methyl cellulose, and pulp concentration (Table 2). The egg albumin and methyl cellulose quadratic terms have a substantial impact at the 0.1% and 5% levels, respectively, but there was no significant interaction term. The impact of process variables on the foam density of palmyrah fruit pulp can be seen in the following equation, which eliminates nonsignificant elements and uses coded values for independent variables.

$$FD = 0.642 - 0.044A + 0.035B + 0.030C + 0.011D + 0.032A^2 + 0.009B^2 \quad (2)$$

A-Egg Albumin (%), B-Methyl cellulose (%), C-Pulp Concentration (°Brix), D-Whipping time (min)

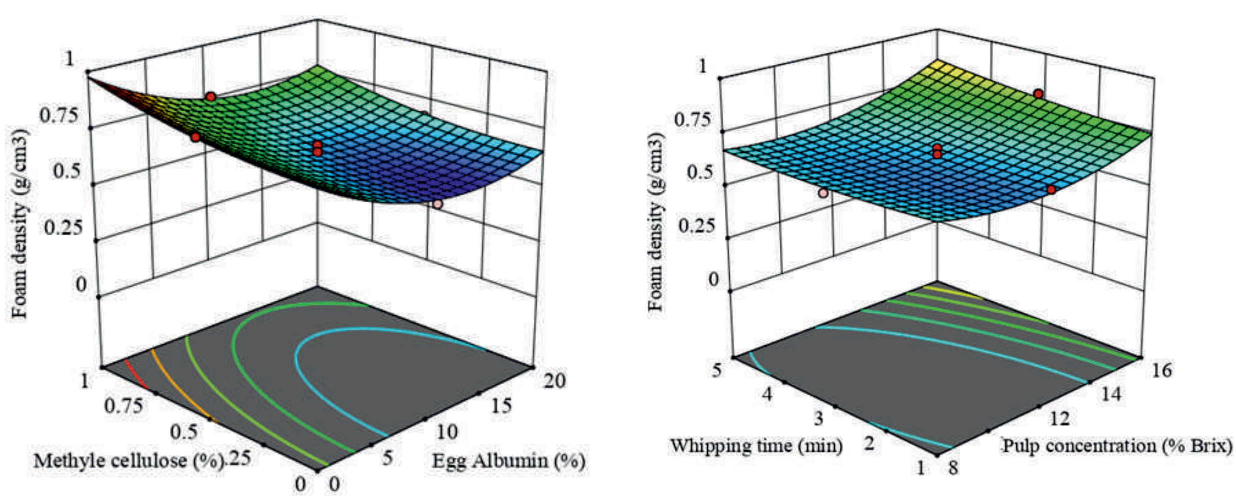
Table 2. Regression coefficients and ANOVA of the second-order polynomial model for the response variables (in coded units)

Variables	DF	Estimated variables		F values	
		FD	DV	FD	DV
Model	14	0.6425	1.08	15.78***	12.25***
A	1	-0.0441	-0.125	71.70***	7.11*
B	1	0.0357	-0.4583	46.96***	95.53***
C	1	0.0303	-0.2083	33.79***	19.74***
D	1	0.0116	-0.0417	4.98*	0.7895
AB	1	-0.0022	0.0625	0.1175	1.18
AC	1	-0.0102	-0.1875	2.55	10.66**
AD	1	-0.0074	-0.0625	1.36	1.18
BC	1	0.0112	0.0625	3.07	1.18
BD	1	0.0067	-0.0625	1.1	1.18
CD	1	0.0067	-0.0625	1.1	1.18
A^2	1	0.0322	-0.0312	43.69***	0.5075
B^2	1	0.0091	0.2188	3.48*	24.87***
C^2	1	0.0197	0.0938	16.37	4.57*
D^2	1	0.004	-0.0312	0.6629	0.5075
Lack of fit	10			1.34	1.4
R^2		0.9364			
Adjusted R^2		0.8771			

***p<0.001; **p<0.01; *p<0.05
FD-Foam Density, DV-Drainage Volume

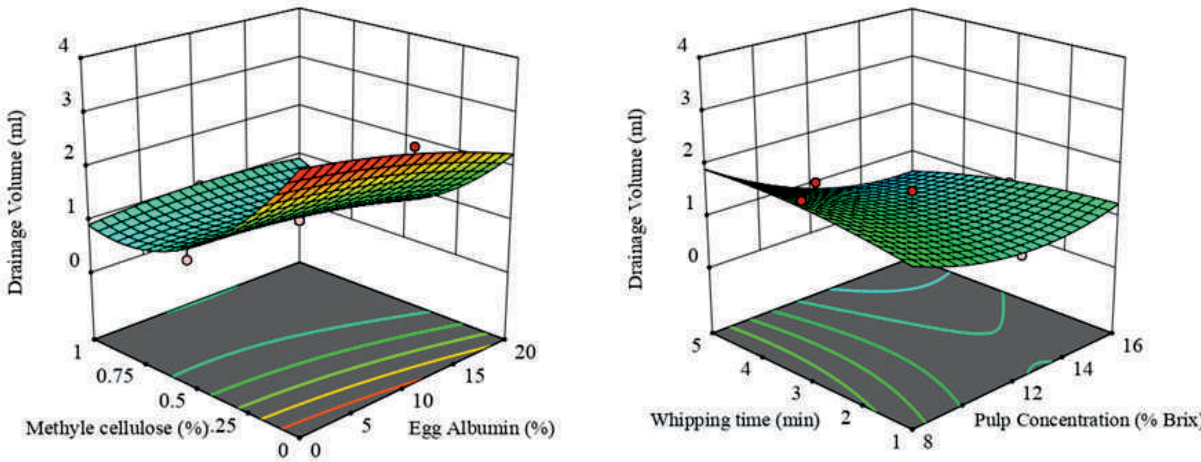
The palmyrah fruit pulp foam density rose as the first-order terms of methyl cellulose, pulp concentration, and whipping time increased, according to the positive coefficients of these variables; in contrast, the foam density decreased as the variable of egg albumin increased, according to the negative coefficients of this variable. The quadratic terms indicated that foam density increased as a result of these factors being increased excessively. Ninety-three. 6% of the product's entire variability in foam density was explained by the regression model. In the 3D plot and contour plots (Figs. 3 a, b), the fluctuation of foam density with egg albumin, methyl cellulose, pulp content, and whipping time are graphically displayed. The foam density dramatically dropped ($p<0.001$) as the amount of egg albumin in the pulp rose. Reduced foam density suggests that more air was held in the foam, which increased the amount of foam expansion. Egg albumin lowers surface tension and interfacial tension to a level low enough to generate an interfacial layer that is thicker than necessary, as evidenced by the decreased foam density. It appears that the air bubbles were unstable at lower egg albumin concentrations due to the inability to produce the necessary thickness needed for the interfacial coating. Karim and Wai (1999) cited a similar report with starfruit puree. With a rise in egg albumin concentration, the foam density fell until it reached a minimum value at around 6.83%. The density of the foam was lowest at this concentration. Nevertheless, the foam density rose when the egg albumin concentration was raised above this threshold. The foam density greatly rose along with the methyl cellulose content. The mixture's viscosity increased when the concentrations of methyl cellulose and egg albumin were raised above 6.83%, potentially surpassing the limiting viscosity at which the greatest amount of air could be integrated. As a result, there was either less foam expansion or more foam density. Comparable findings about the foam density of pureed star fruit were documented (Karim and Wai 1999) and bael fruit pulp (Bag *et al.* 2009). The concentration of palmyrah pulp along with the foaming agent mixture affected the whippability of pulp.

The impact of pulp concentration on the foam densities of foams stabilized with methyl cellulose and egg albumin is depicted in Figure 3a. Foam density dropped as pulp's total soluble solids concentration dropped from 14% to 11% Brix. When the pulp content dropped below this point, the foam density rose once more. Patel (1996) stated that when the sample's soluble solid content is low, extra foaming agents and stabilizers must be applied.



(a) (b)

Fig. 3. Contour plots and response surface showing the effect of a) egg albumin and methyl cellulose concentrations on foam density b) pulp concentration and whipping time on foam density



(a) (b)

Fig. 4. Contour plots and response surface showing the effect a) egg albumin and methyl cellulose concentrations on drainage volume, and b) pulp concentration, and whipping time on drainage volume

As the whipping duration was prolonged, the foam density for foams stabilized with methyl cellulose and egg albumin decreased (Fig. 3b). However, after two minutes of whipping, a little increase in foam density was observed in the methyl cellulose and egg albumin stabilized foams, following the initial reduction. Raharitsifa *et al.* (2006) also noted that foam density rose after a minimum amount of whipping time, most likely as a result of overbeating or excessive whipping, which can cause the foam to collapse. According to Falade *et al.* (2003), mechanical deformation, thinning of the liquid film between the foam bubbles, and excessive aeration can all cause the bubble wall structure to rupture. The foams made from egg albumin and methyl cellulose stabilized palmyrah fruit pulp showed the lowest foam density after two minutes of whipping, and there was no discernible drop in foam density after that. Comparable findings in bael pulp dried on a foam pad (Bag *et al.* 2009).

Drainage Volume (DV)

The foam's drainage value ranged from 0 to 3 mL (Table 1) depending on the pulp concentration, whipping time, methyl cellulose, egg albumin, and other process variables. According to an ANOVA, the concentration of pulp and egg albumin were significant at the 5% level, while the drainage volume was very significant at the 0.1% level on linear terms of methyl cellulose (Table 2). While the quadratic terms of methyl cellulose, egg albumin, and pulp concentration are significantly influencing the drainage volume, there is no significant interaction term present. The following equation illustrates how process variables affect the drainage volume of palmyrah fruit pulp by excluding the regression's nonsignificant terms and using the independent variables' coded values.

Drainage volume (DV) = 1.08-0.125A-0.458B -0.208C-01875AC+0.218B2+0.093C2(3)

A-Egg Albumin (%), B-Methyl cellulose(%), C-Pulp Concentration (oBrix), D-Whipping time (min)

The first-order terms' negative coefficients for pulp content, methyl cellulose, and egg albumin showed that drainage volume drops as these variables rise. Whipping time has no discernible impact on drainage volume. Ninety-one percent of the overall variation in the foam's drainage volume was explained by the regression model. In the 3-D surface plot and contour plot (Fig. 4 a, b), the drainage volume fluctuations of the palmyrah pulp foam with various combinations of the process parameters are graphically displayed. At all egg albumin levels, an increase in the concentration of methyl cellulose resulted in a decrease in the drainage volume (Fig 4 a). At constant pulp concentration and whipping time, the methyl cellulose concentration had a greater impact on drainage volume than the egg albumin concentration.

Foams with higher methyl cellulose concentrations showed less drainage than those with lower methyl cellulose concentrations. Egg albumin and methyl cellulose stabilized foam's drainage volume was decreased by palmyrah fruit pulp's higher total solids. On the other hand, as pulp concentration increased, foam drainage volume increased as well and then dropped beyond a certain point (10.5° Brix), as illustrated in Fig. 4b. According to Falade *et al.* (2003), increasing the cowpea paste foam's total solid content improved the foam's stability. Surface tension, interface permeability, foam size distribution, and thickness of the interface all affect the drainage volume of foam (Falade *et al.* 2003). Several solutions were found for the ideal covering criterion using the desirability function approach, with a desirability value of 0.782 for foaming. In this case, the solution with the greatest pulp concentration values, lowest egg albumin, methyl cellulose, and whipping duration values was chosen to produce the least amount of foam and drainage volume. Egg albumin (6.87%), methyl cellulose (0.262%), pulp concentration (14° Brix), and whipping time (2 min) were the ideal foaming conditions for optimal palmyrah fruit pulp foam expansion and stability. Under these ideal circumstances, foaming tests were carried out on palmyrah fruit pulp. The predicted values for foam density and drainage volume were 0.689 g cm−3 and 1.732 mL, respectively where as experimental values are 0.5 g cm-3 and 2 mL. Similar results were obtained for bael pulp foaming (Bag et al. 2009).

Drying of foamed palmyrah fruit pulp

For drying trials, the optimal foamed pulp and non-foamed palmyrah fruit pulp were taken. The drying process for both pulps was conducted in a batch type tray dryer at a temperature of 60°C with foam thicknesses of 4 mm. The impact of foaming on pulp's drying properties at 60 degrees Celsius. For 4 mm thick foam, it took 150 minutes to dry foamed pulp from 588.6 to 3.5% (d.b) moisture content, but it took 210 minutes to dry non-foamed pulp to reach 7.3% (d.b) moisture content. Similar findings were made when producing papaya powder and drying foamed papaya pulp (Kandsamy *et al.* 2014).

Table 3 lists the biochemical outcomes of the foamed palmyrah pulp that was dried at 60 °C. When comparing foamed pulp powder to non-foamed pulp powder, it was discovered that there was a considerable decrease in ascorbic acid powder (130 to 124 mg/100 g). This might be the result of the ascorbic acid's oxidation due to the damaging effects of the extended heat treatment (Levi *et al.* 1983). Additionally, it was discovered that the amount of β-carotene foamed powder was significantly lower than that of non-foamed powder. Significant biochemical components included the pH and acidity of the foamed powder, respectively. Similar biochemical changes were reported by Srivastava (1998) for mango, Aruna et al. (1998) for papaya, Kandasamy *et al.* (2014) for papaya. Based on the biochemical analysis, it was found that the palmyrah fruit powder treated with methyl cellulose (0.262%) and egg albumin (6.875%) dried at 60°C and foam thickness of 4 mm retained significantly higher amount of nutritional qualities (Table 3).

Table 3. Biochemical properties of foam mat dried palmyrah fruit pulp powder

Parameter		Foamed	Non foamed
Drying time, min		150	210
pH		5.34	5.34
Acidity (%)		0.49	0.49
Ascorbic acid (mg/100g)		130	124
β-carotene (mg/100g)		26.8	26.8
Colour values	L	64.75	72.25
	a	11.96	9.13
	b	35.62	9.37
ΔE	0.09	1.02	
Yield (kg/m_2)		0.096	0.112

Conclusions

In order to maximize foam stability and maximize the expansion of palmyrah fruit pulp, the primary process of foaming was optimized with the lowest possible foam density and drainage value. With pulp concentration of 14°Brix, foaming time of 2 minutes, minimum foam density (FD) and drainage volume (DV) of 0.689 g cm−3 and 1.732 mL, respectively, with a desirability value for foaming of 0.782, the optimal levels of egg albumin and methyl cellulose were found to be 6.875% and 0.262%, respectively. It was determined that 4 mm thick foamed palmyrah fruit powder at 60°C retained a much higher amount of nutritious qualities than the other treatments for drying, based on the nutritional qualities. Based on the overall study, it was concluded that the palmyrah pulp of 14°Brix added with 6.875 egg albumin, whipped for 2 min and dried with a foam thickness of 4 mm at a temperature of 60 °C was found to be optimum to produce the foam-mat dried palmyrah powder.

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