Chapter 4

Foam mat drying of purple passion fruit and characterization of the powder

4.1 Introduction

Fruits or plant-based foods are known for its bioactive phytochemicals activities that may provide desirable health benefits to reduce the risk promoting effects of chronic diseases.[25] Short life in terms of perishability is the main problem challenging fruit and vegetable production. One of the major postharvest spoilages occur because of the fast degradation of quality resulting in large wastage.[10] Foam mat drying is relatively low cost drying technique than freeze and spray drying. The application of foam mat drying technique can be an effective way to increase the shelf-life and decreases the phytochemical loss also allows the dehydration of difficult- to-dry, heat-sensitive, high sugar content and viscous foods.[18,19] In foam mat drying, for the porous structure of the foamed materials, mass transfer is faster, hence shorter the drying time apparently results in higher quality of dried food product.[6] Various food items such as soy milk[3], star fruit[23], cowpea[14], guava juice[11], apple pulp[27], mango[28], banana [36], tomato pulp [21], bael[7], shrimp [2] has been used for foam mat drying.

In food macromolecules, carbohydrates (methyl cellulose, carboxy methyl cellulose etc.) and proteins (egg albumin, soy protein, whey protein etc.) dominate the foams and emulsions area. Modified carbohydrates i.e. cellulose derivatives usage were reported in artificial creams and propylene glycol alginate in salad dressings[33] and increasing the stability of whipped cream through enhanced viscosity that prevented drainage during the storage period.[34] Methyl cellulose is derived by etherification of alkaline cellulose with methyl chloride to form the cellulose ethers. Upon heating, formation of completely reversible gels is the reason for film formation in fried foods, foam stabilisation, and stabilisation of fruit pie filling during baking.[16] Also the surfactancy of methyl cellulose improves the whippability of cake batters where a portion of egg whites was replaced by the methyl cellulose.[19, 37] Some studies revealed that methyl cellulose as a foaming agent in papaya, yellow variety of passion fruit and gac fruit. [4, 5, 22] Karim and Wai [23] also stated that methyl cellulose was used as foaming agent to study the characteristics of foam prepared from starfruit *(Averrhoa carambola* L.) puree.

Samyor et al. (2017). Effect of foam mat drying on physicochemical and phytochemical properties of passion fruit powder. International Journal of Food Properties (Under Review)

There is scanty of research on foam mat drying of purple passion fruit and less detail report on the phytochemical properties of foam mat dried passion fruit powder. Therefore, in the present study foam mat drying of purple passion fruit has been carried out. Methyl cellulose was used as foam stabilizer. The process was modelled using response surface methodology (RSM) and predicted using artificial neural network (ANN). Quantification of vitamins and phenolic acids of passion fruit pulp and powder were investigated.

4.2 Materials and methods

4.2.1 Plant material

Purple passion fruit cultivar at ripen stage were purchased from the local market of West Kameng District, Arunachal Pradesh, in the month of July-September. Subtropical areas or at higher altitudes in the tropics are favourable to cultivate the purple colour species of passion fruit. The Fruits were washed and graded manually. Pulp was squeezed out and stored in -20˚C for future analysis.

4.2.2 Chemicals

Standard for phenolic acids *viz.*, ferulic , sinapic, syringic, hydroxybenzoic, *p*-coumeric, vanillic, caffeic, catechin and chlorogenic acid were purchased from Sigma-Aldrich Chemical Co. (St. Louis, Missouri, USA).Vitamin standards *viz.*, β-carotene, (±)-α-tocopherol and D-α-tocotrienol were also purchased from Sigma-Aldrich Chemical Co. (St. Louis, Missouri, USA).

4.2.3 Foam mat drying

Foam mat drying of passion fruit pulp was done in varying temperature, methyl cellulose concentration and whipping time. The methyl cellulose was used as foam stabilizer with varied range (1-3%). The passion fruit pulp and methyl cellulose mixture was whipped in a kitchen blender to incorporate air in the mixture. The foamed pulp concentrate was spread on a tray with 3mm of thickness and kept in dryer for drying at temperature 40-60˚C. Foamed samples was monitored every 30 min for its moisture loss by weighing the sample plates using an electric balance with an accuracy of ±0.01 g. When the final

moisture content reached 6.5% (d.b), drying was terminated.[28] After drying, the powder was vacuum packed and kept for further studies.[24]

4.2.4 Analysis

4.2.4.1 Vitamin C

Vitamin C was determined according to Sadasivam and Theymoli [29] (method described in section 3.6.3.1).

4.2.4.2 Total phenolic content

Determination of total phenolic content of passion fruit powder was carried out by Folin-Ciocalteu assay Slinkard and Singleton [30] (method described previously in section 3.2.4.2).

4.2.4.3 DPPH radical scavenging activity

DPPH radical scavenging activity of the fruit powder was measured according to the method of Brand-Williams et al.[9] (method described in chapter 3A, section 3.2.4.4).

4.2.4.4 Hygroscopicity

Hygroscopicity of foam mat powder was determined as described by Jaya and Das.[20] Briefly, 0.5 g sample was put in the pre-weighed petri dish and placed in a hermetically sealed glass desiccator, containing salt solution of Na Cl (75% RH) and stored at 20°C. At a specific time, interval weight gain was observed until, constant value was determined.

$$\text{Hygroscopicity}(\%) = \left(\frac{b+H}{a-H}\right)\times 100$$

Where H is the initial water content of the sample (0.5g), *b* (g) is the weight increase and *a* (g) is the initial sample weight.

4.2.5 Experimental design

The central composite design (CCD) followed by response surface methodology (RSM) was used to optimise experimental conditions of foam mat drying. The process was optimized in terms of whipping time (min), methyl cellulose (%) and temperature (°C). The ranges of experimental parameters were selected based on preliminary trials. Coded value of independent are shown in Table 4.1.

Table 4.1 Coded levels of independent variables for the central composite design (CCD)

Variables	**Coded value**	**Level**		
		-α	0	+α
Whipping time (min)	x_1	1	3	5
Methyl cellulose (%)	x_2	1	1.5	3
Temperature (˚C)	x_3	40	50	60

After data analysis, a second order polynomial equation was developed as follows:

$$y = \beta_0 + \sum_{i=1}^{n} \beta_i x_i + \sum_{i=1}^{n} \beta_{ii} x^2{}_{ii} + \sum_{i=1}^{n} \sum_{j=i+1}^{m} \beta_{ij} x_i x_J$$

The coefficient of the polynomial equation were β_0 (constant), β_i (linear effects), β_{ii} (quadratic effects) and β_{ij} (interaction effects). x_i and x_j are the coded levels of independent variables *i* and *j* in the equation given.

4.2.6 Artificial neural networks (ANN)

ANN is used to predict the relationship between input and output parameters. Three independent variables, i.e., whipping time (min), methyl cellulose (%) and temperature (˚C) were in the input layer and output layer was vitamin C (mg/100g), total phenolic content (mg GAE/100g) and hygroscopicity (%). Neural network was trained using a single hidden layer with 3-x-1 topology where x was the number of neurons in hidden layer. To determine the optimum number of neurons in hidden layer, x was varied from 1 to 20. The experimental data was used to train the neural network. Total 20 data points were distributed into three sets: training (14 points), validation (3 points) and testing (3 points). The best training performance of the neural network was based on minimization of root mean square error (RMSE) and highest regression coefficient (R^2).

4.2.7 Phytochemical analysis

4.2.7.1 Fourier transform infrared (FT-IR) analysis

Foam mat dried passion fruit powder (2mg) and 50 mg desiccated KBr powders were thoroughly mixed in a mortar and pestle before pressing into a thin pellet (method described in section 3.2.4.6).

4.2.7.2 Reverse Phase-High-performance liquid chromatography (RP-HPLC) analysis of phenolic acids

For phenolic acid analysis, 50g of sample and 0.5 g ascorbic acid were mixed together (method described previously in the (method described in section 3.2.4.7)

4.2.7.3 Reverse Phase-High-performance liquid chromatography (RP-HPLC) analysis of β-carotene, (±) α-tocopherol and D-α-tocotrienol

The β- carotene, (±)-α-tocopherol and D-α-tocotrienol were estimated by the method described by Aguilar-Garcia et al.[1] with slight modification. Passion fruit foam mat powder (50g) was used for extraction (method described in section 3.6.3.6.).

4.2.8 Statistical analysis

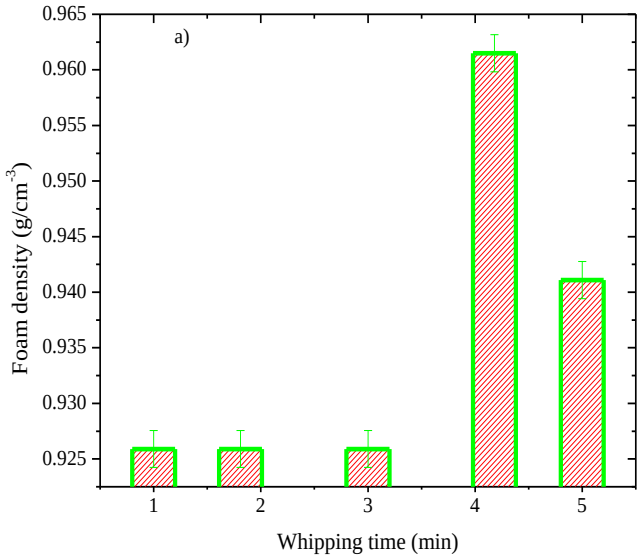
The experimental design was done by central composite design (CCD) followed by response surface methodology using design expert 7.0 software. Microsoft office excel 2007 was used for average and standard deviation calculation. The Origin 8.5 (Origin Lab Corporation, Northampton, USA) software was used for graphs.

4.3 Results and discussion

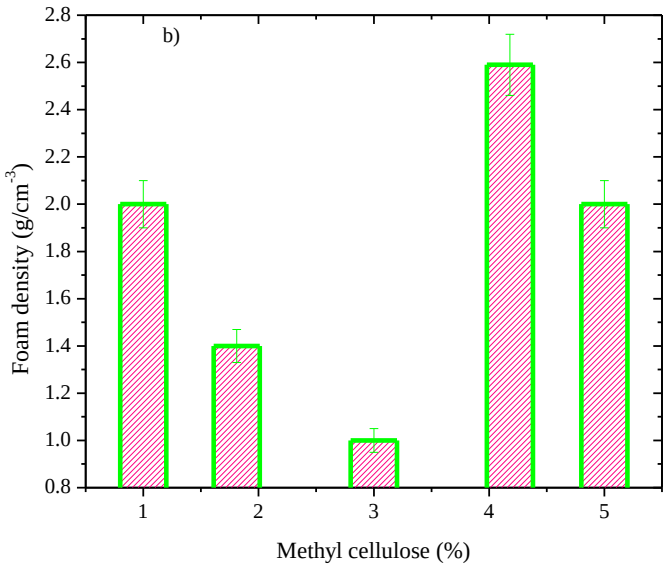
4.3.1 Preliminary trial

A preliminary trial was conducted to identify the effect of whipping time and methyl cellulose on foam density of passion fruit pulp. Density of foam was varied from 0.92-0.98 g/cm^3.The Fig.4.1 (a) and (b) illustrated the effect of whipping time and methyl cellulose on foam density (FD). From Fig.4.1a, it was observed that the FD of the mixture was constant and minimum, up to 3 min of whipping and the highest FD was observed 4 min whipping. Raharitsifa et al.[27] reported that foams density decrease with increase in

whipping time up to certain point and thereafter FD increase may be due to excessive whipping (overbeating) and leads to a collapse of foam. Air incorporated during whipping is inversely proportional to foam density.[14] During foam mat drying of bael Bag et al.[7] reported that the foam density of stabilized foams from bael was increased after 2 min of whipping. From Fig.4.1 (b), it was observed that for the increase of methyl cellulose concentration in fruit pulp, FD decreased proportionally up to a certain value and the lowest FD (0.9615 g/cm3) was observed at 3% methyl cellulose. Similar type of result was also observed by Bag et al.[7] during foam mat drying of bael fruit.



(a)



(b)

Fig. 4.1 Effect of (a) whipping time (WT min) and (b) methyl cellulose (MC%) on foam density of passion fruit pulp.

4.3.2 Model fitting

The CCD data was analysed using multiple regression analysis as shown in Table 4.2 and the correlation between the independent variables of foam mat drying *viz*., whipping time (1-5 min), methyl cellulose (1-3%) and temperature (40-60°C) and dependent variables such as vitamin C, TPC and hygroscopicity, were developed. After the analysis, a second order polynomial relationship was developed between dependent and independent variable. Significance test of regression model, individual model coefficients and lack of fit were carried out as shown in Table 4.2. Results showed that the models developed for responses were highly significant ($p \leq 0.05$). In order to evaluate the model adequacy, correlation of determination (R^2) of vitamin C (0.90), TPC (0.86) and hygroscopicity (0.80) were evaluated. Analysis of variance showed that R^2 of the models was higher than 85 % and lack of fit was insignificant which showed interaction among the responses and predicting implied model is adequately accurate.

Table 4.2 Analysis of variance (ANOVA) for the fitted quadratic polynomial model

Source	**Vitamin C**		**Total phenolic content**		**Hygroscopicity**	
	***F*-value**	***p*-value**	***F*-value**	***p*-value**	***F*-value**	***P*-value**
Model	5.79	0.0006	11.13	0.0004	3.29	0.0006
x_1 (Whipping time)	9.81	0.0106	5.04	0.0486	1.71	0.2198
x_2 (Methyl cellulose)	6.97	0.0247	7.77	0.0192	0.059	0.0138
x_3 (Temperature)	14.20	0.0037	66.33	< 0.0001	6.42	0.0297
x_1x_2	0.92	0.3595	1.37	0.2696	2.09	0.1792
x_1x_3	0.29	0.6010	1.21	0.2976	0.066	0.8029
x_2x_3	0.026	0.8754	0.11	0.7518	5.077E-003	0.9446
x_1^2	16.14	0.0025	9.87	0.0105	11.04	0.0077
x_2^2	1.75	0.2157	10.22	0.0095	2.80	0.1255
x_3^2	1.42	0.2608	0.11	0.7502	3.55	0.0891
Lack-of-fit	4.26	0.0689	0.54	0.7428	0.73	0.629
R^2	0.90		0.86		0.80	

4.3.2.1 Response surface analysis of vitamin C

Equation below showed the relationship between vitamin C and methyl cellulose concentration (%), whipping time (min) and temperature (˚C). The develop model was analysed in term regression of determination (R^2) and lack of fit. From Table 4.2, it was observed that the regression of determination (R^2) of vitamin C was significantly high (R^2=90) and lack of fit was insignificant which elucidated that model had efficacy to represent the relationship between vitamin C and methyl cellulose concentration (%), whipping time (min) and temperature (˚C).

Vitamin C (mg/100g)

$$= 33.92 - 1.44x_1 + 1.21 \times x_2 - 1.73 \times x_3 + 0.58 \times x_1x_2 - 0.32 \times x_1x_3 + 0.097 \times x_2x_3 - 1.80x^2_1 - 0.59 \times x_2^2 + 0.53 \times x_3^2$$

From Fig. 4.2a, it was observed that up to 2 % of methyl cellulose concentration resulted in increases in the vitamin C content and further increase in its concentration revealed a

decrease pattern of vitamin C in foam mat dried passion fruit powder (Fig.4.2a). The increase in vitamin C content may be due to the hydrocolloid activity of methyl cellulose on vitamin C during drying. For the presence of methyl cellulose in the aqueous medium, water activity of the medium decrease which might reduce the extent of the hydration reaction [15] and increase the stability of Vitamin C.

For Fig. 4.2a, it was also observed that for increase of whipping time up to 3 min the vitamin C content of the powder increased and later it decreased drastically (3 to 5 min). The increase in vitamin C content may be due to the release of vitamin C from cell during mixing. However, further increase in whipping time showed decrease in vitamin C and may be attributed to the structural break down and oxidative degradation. Temperature evinced significant effect on the vitamin C content of sample (Fig.4.2b). As the temperature increased from 40°C to 60°C, the vitamin C content of foam mat dried powder decreases and it can be ascribed to heat liability of vitamin C[13]. Increase in whipping time (1-3 min) revealed that vitamin C increases but further increases from 3 to 5 min, decreases the vitamin C content (Fig. 4.2.b).

4.3.2.2 Response surface analysis of total phenolic content

The quadratic equation below showed the relationship between total phenolic content and whipping time (min), methyl cellulose (%) and temperature (°C) in passion fruit powder. The correlation coefficient (R^2 0.86) and lack of fit (0.44) of developed model was elucidated that the develop model has efficacy to represent the relationship between and independent parameters.

Total phenolic content (mg GAE/100g)

$$= 242.18 + 9.51x_1 - 11.81 \times x_2 - 34.51 \times x_3 - 6.47 \times x_1x_2 + 6.08 \times x_1x_3 + 1.80 \times x_2x_3 - 12.96 \times x_1^2 - 13.18x_2^2 - 1.35 \times x_3^2$$

Fig.4.2(c), revealed the steady increase in the total phenolic content up to 2 % of methyl cellulose and thereafter showed decrease in the TPC over the time. The increase in TPC may be due to the stabilizing effect of methyl cellulose, based on electrostatic interactions between the phenolic compounds and the dissociated carboxylic groups of the colloids.[17] Further, increase in methyl cellulose beyond 2 %, there was a drastic decrease in TPC in passion fruit powder as shown in Fig 4.2c. The TPC of foam mat dried powder was increased with increase in whipping time up to 3 min and thereafter the trend showed a

decrease pattern (Fig 4.2c).The increase in TPC may be due to the release of TPC due to the cell lysis during whipping. However, further increase in whipping time showed decreased pattern of TPC, due to the structural break down and oxidative degradation of TPC. The foam mat drying temperature also affected the TPC in foam mat dried powder. The TPC of the foam mat dried powder decreased drastically with the increase of drying temperature from 40-60˚C (Fig 4.2d).The decrease in TPC for increase in temperature was obvious because of heat sensitive and prone to oxidation which cause structural distraction thereby decrease the TPC in powder.[32] As the whipping time increases, TPC also increase up to 3 min (Fig 4.2.d). Later, the TPC content slightly decreased with the increase in whipping time (3-5min).

4.3.2.3 Response surface analysis of hygroscopicity

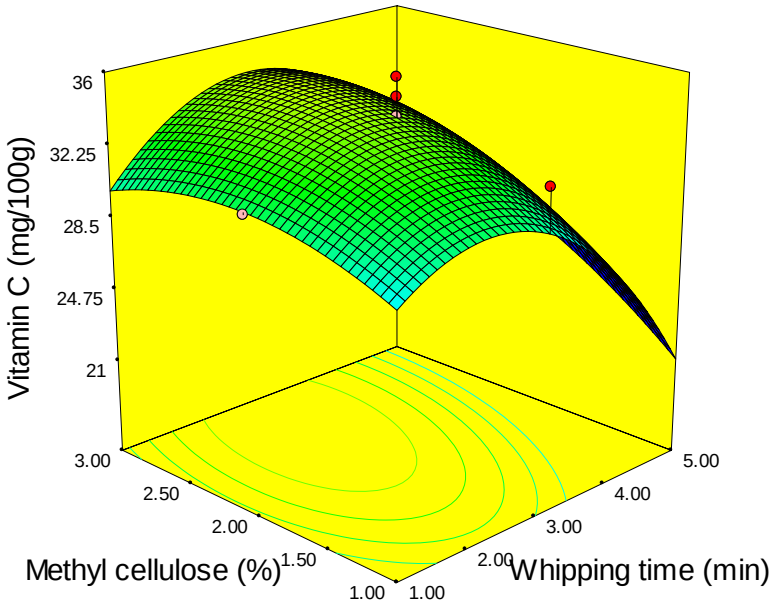
The mathematical relationship between whipping time (min), methyl cellulose (%) and temperature (˚C) with hygroscopicity (%) of foam mat powder were represented by equation below. The correlation coefficient (R^2) of the developed model was recorded as 0.80.

Hygroscopicity (%)

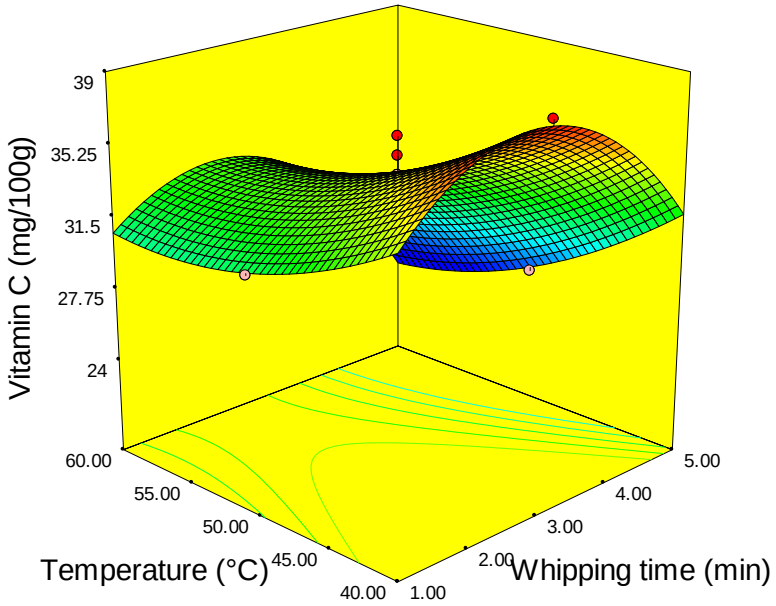
$$= 23.86 - 1.95 \times x_1 + 0.36 \times x_2 - 3.78 \times x_3 + 2.82 \times x_1 x_2 - 0.50 x_1 x_3 - 0.14 \times x_2 x_3 + 4.83 \times x_1^{\ 2} - 2.43 x_2^{\ 2} - 2.74 \times x_3^{\ 2}$$

The Fig. (4.2e-f) showed the 3D-graphical relationship between whipping time (min), methyl cellulose (%) and temperature (˚C) with hygroscopicity (%). From the Fig 4.2e, it was illustrated that with the increase of the concentration of methyl cellulose up to a certain level (2%) there was simultaneous increase in hygroscopicity (41.51%) and later decreased marginally. The increase in hygrocopicity of powder can be accredited to the increase in available hydroxyl groups in the amorphous regions of the substrate as well as the surface crystalline regions and therefore, it can easily absorb the moisture from the atmosphere. Later the decrease in hygroscopicity may be due to the presence of excessive amount of methyl cellulose which slowly decreases the affinity to adsorb water. Moreover, methyl cellulose is a material with low hygroscopicity, therefore higher amount methyl cellulose may decrease the hygroscopicity.[35] Fig 4.2e illustrated the effect of whipping time on hygroscopicity of powder. With increase of whipping time up to 3 min the hygroscopicity (22.33%) decreased drastically and after that a reverse trend was observed. Fig 4.2f,

illustrated that as the temperature increased (40-60°C), hygroscopicity also increased. Results revealed that higher drying temperature has the credibility to lower the moisture content and thereby increase the hygroscopicity. This is related to the water gradient between the product and the surrounding air and evinces moist powder

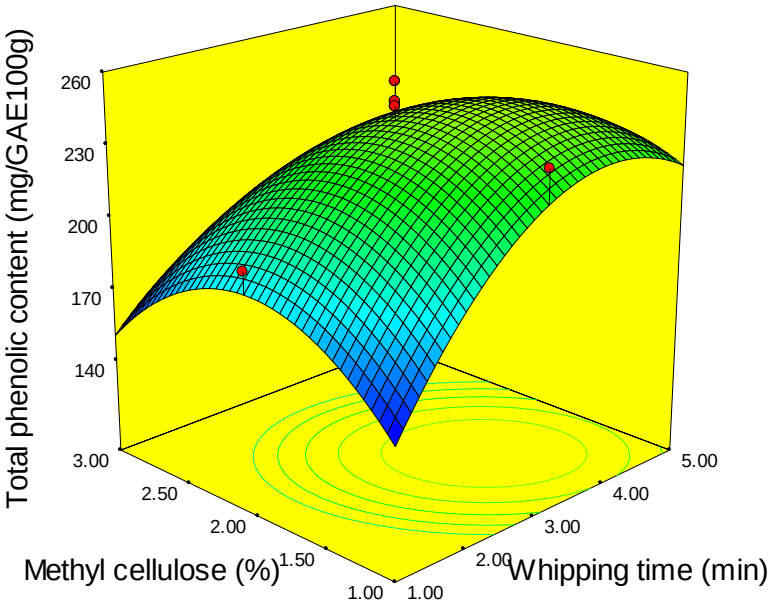

Vitamin C (mg/100g)
36
32.25
28.5
24.75
21
3.00
2.50
2.00
1.50
1.00
Methyl cellulose (%)
1.00
2.00
3.00
4.00
5.00
Whipping time (min)

(a)

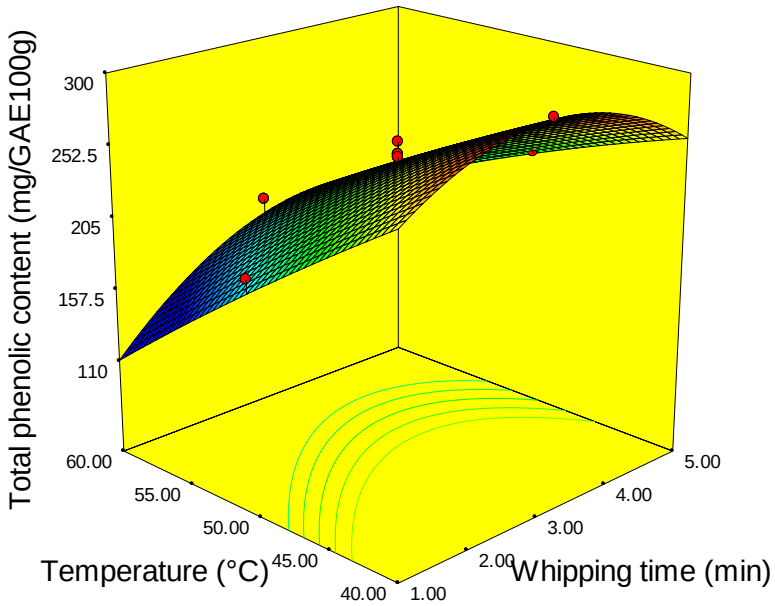

Vitamin C (mg/100g)
39
35.25
31.5
27.75
24
60.00
55.00
50.00
45.00
40.00
Temperature (°C)
1.00
2.00
3.00
4.00
5.00
Whipping time (min)

(b)

Contd.

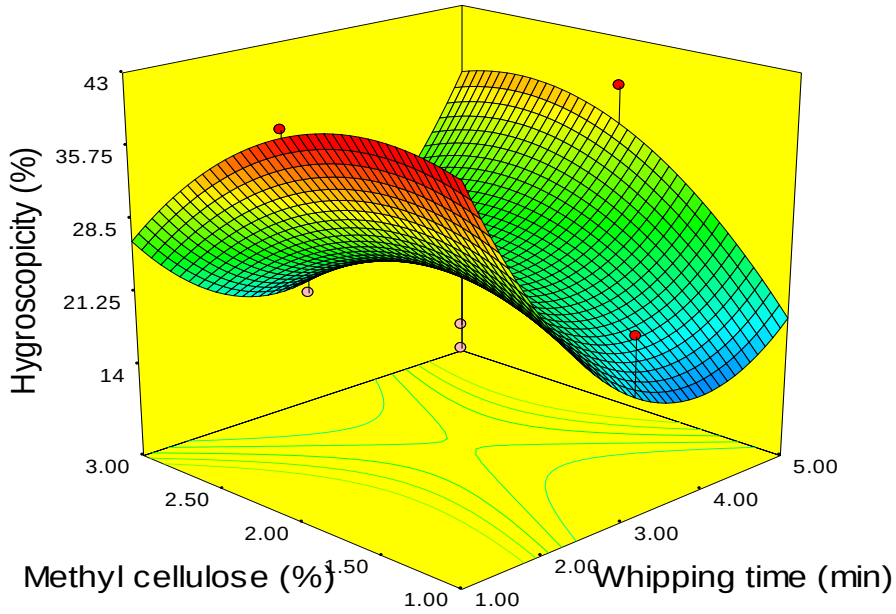

Total phenolic content (mg/GAE100g)
260
230
200
170
140
3.00
2.50
2.00
1.50
1.00
Methyl cellulose (%)
1.00
2.00
3.00
4.00
5.00
Whipping time (min)

(c)

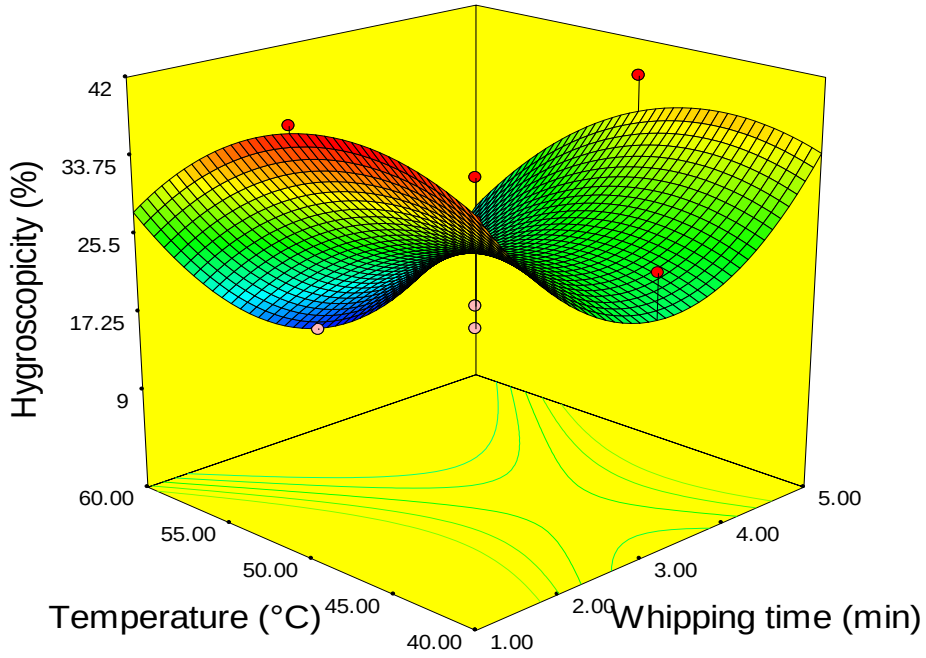

Total phenolic content (mg/GAE100g)
300
252.5
205
157.5
110
60.00
55.00
50.00
45.00
40.00
Temperature (°C)
1.00
2.00
3.00
4.00
5.00
Whipping time (min)

(d)

Contd.



(e)



(f)

Fig.4.2 Response surface 3D graph on;(a-b) effect of methyl cellulose, whipping time and temperature on vitamin c content, (c-d) effect of methyl cellulose, whipping time and temperature on total phenolic content, and (e-f) effect of methyl cellulose, whipping time and temperature on hygroscopicity of powder

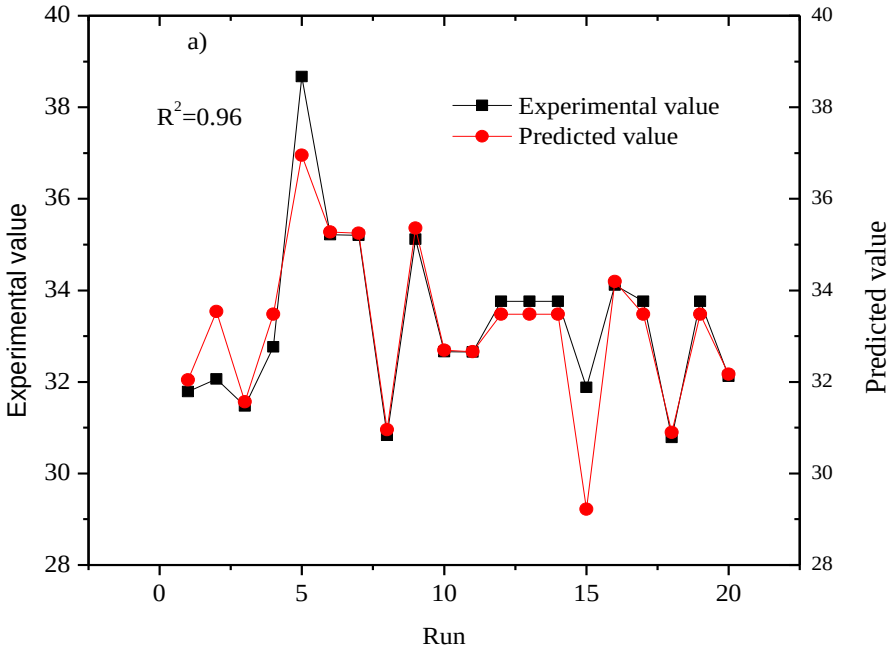
4.3.3 Optimization and validation of foam mat drying parameter

Since the foam mat concentrate is an intermediate product of foam mat drying process, therefore in the present study the effect of whipping time and methyl cellulose on foam density was not considered in the optimization process. However, initial trial was conducted to identify the effect of whipping time and methyl cellulose on foam density. In the optimization step, after response surface analysis the foam mat drying process was optimized on the basis of desirability. The optimum condition was selected on the basis of the highest TPC, vitamin C and lowest hygroscopysity. The optimum foam mat drying conditions were, whipping time 2.78 min, methyl cellulose 2.58 %, and temperature 44.05˚C. At the optimum condition the predicted value of response was vitamin C 34.67mg/100g, TPC 258.12 mg/100g and hygroscopicity 21.12%. After optimization, the process parameters were validated. During validation, the experiment was conducted in optimized condition and observed that experimental value of total phenolic content (255.87 mg GAE /100g), vitamin C (33.28mg/100g) and hygroscopicity (21.98 %) which was not differed significantly with the predicted data. The result has the evidence to support that the developed model can efficiently optimize the process.

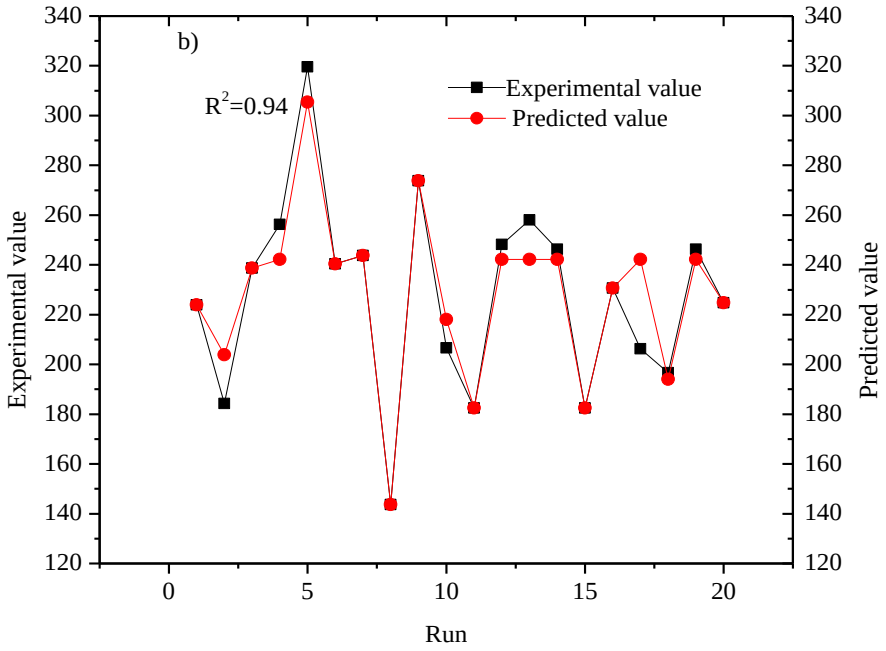
4.3.4 Artificial-neural-network modeling

Artificial neural networks (ANN), is basically computational models based on biological neural processes which predict models. ANN is a non-linear mathematical tool comprises of inter-connected adaptive processing elements ‘‘neurons” that are actually grouped in input, hidden and output layers, which eventually send messages to other.[18,8] The data generated from experimental design planned through CCD was used for ANN model. ANN model was developed using multi-layer perceptron with logistic sigmoidal function. The CCD data was categories as training (14), testing (3) and validation (3), to measure the performance of the develop ANN. Coefficient of determination (R^2) was used to determine the efficacy of developed ANN model. For TPC, the best ANN model was obtained with one hidden layer and ten hidden neurons with (R^2=0.96) for vitamin c, TPC (R^2=0.94) and hygroscopicity (R^2=0.89). A comparison between RSM and ANN model is presented in Fig 4.3. The co-efficient of determination (R^2) for vitamin C, total phenolic

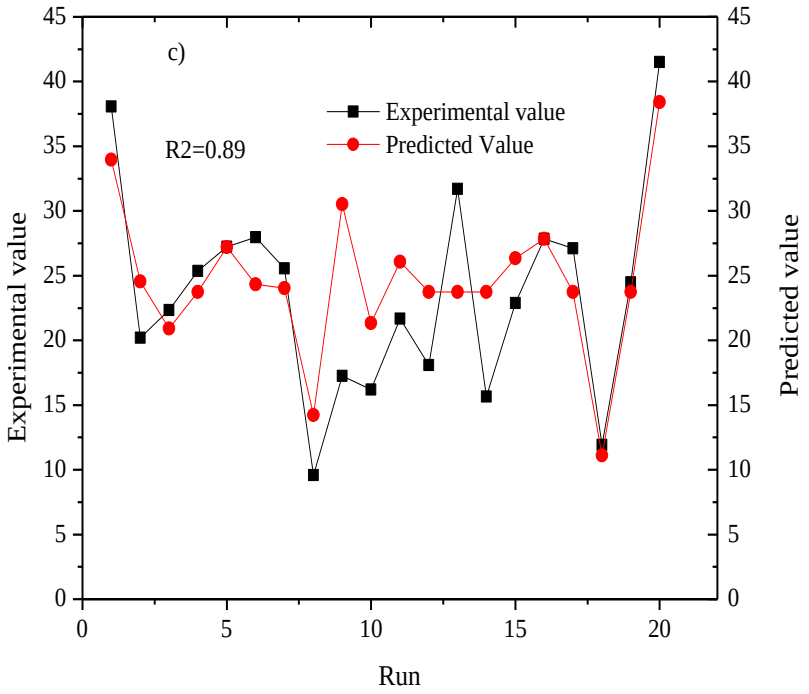
content and hygoscopicity values were higher than RSM which inferred that ANN has the higher ability to predict the experimental outcome than the RSM models.



(a)



(b) Contd.



(c)

Fig. 4.3 Comparison between experimental and predicted value obtained from RSM and ANN modelling (a) Vitamin C, (b) TPC and (c) Hygroscopicity

4.3.5 Physical and chemical compositions of powder

The physical and chemical properties of foam mat dried powder are shown in Table 4.3. The *L**, *a**, and *b** values of the foam mat dried powder differed significantly with respect to fruit pulp and the powder had more *L**, *a**, *b** values over the passion fruit pulp (Table 3.10). The DPPH scavenging activity and vitamin C content decreased in powder (60.53±0.21% and 35.19± 0.20 mg/100g) (Table 4.3) than the raw passion fruit pulp (70.53±0.03 %) and (60.53±0.21 mg/100g) (Table 3.10), whereas the TPC content of passion fruit powder (210.11±0.23mg GAE/100g) increased over raw fruit pulp (206.29 ±0.10 mg GAE/100g)(Table 4.3)

Table 4.3 Physical and chemical compositions of powder

Parameters	**Foam mat dried powder**
Moisture content (%)	6.52± 0.02
*L**	38.13 ±1.17
*a**	5.97 ±0.39
*b**	22.65 ± 0.39
Chroma(a*2+b*2)1/2	23.42± 0.02
Hue tan^{-1}(b*/a*)	75.21± 0.02
Vitamin C(mg/100g)	35.19± 0.20
Total phenolic content(mg GAE/100g)	210.11± 0.23
DPPH scavenging activity (%)	60.53±0.21

Values expressed as mean ± SD (n=3)

4.3.6 Phytochemical analysis

4.3.6.1 FT-IR analysis

FT-IR analysis of foam mat dried passion fruit powder was depicted (Fig.4.4) spectral band from 664 to 3226 cm^{-1}. A sharp peak showed in 3226 cm^{-1}. Band of C=O stretching was mainly due to the presence of carboxyl (-C=O) group of phenolic compounds. Some weak peaks were found in 644, 857.81 and 2297.48 cm^{-1} bands. A stretching characteristic

peak at approximately 3226 cm^{-1} and 2937 cm^{-1} were due to the O–H stretching band. The C=O carbonyl group characteristic peak was observed at 1650 cm^{-1}vibration.[31]

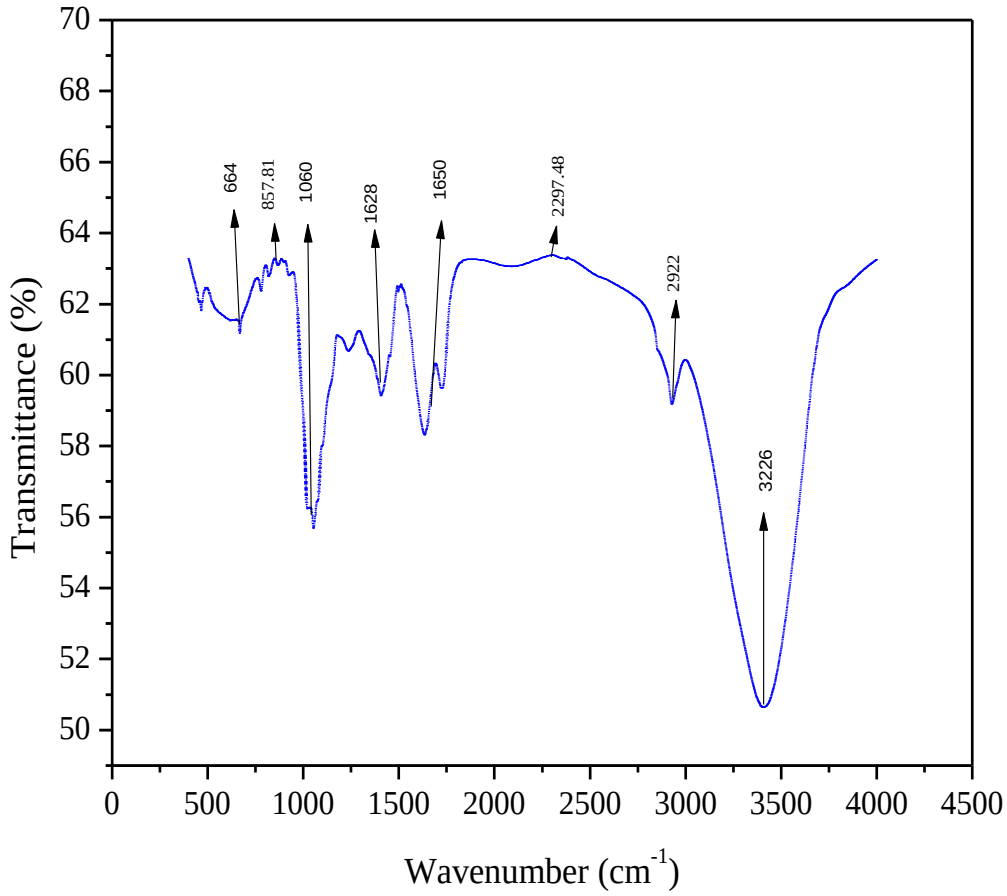


Fig. 4.4 FT-IR spectra of passion fruit powder

4.3.6.2 RP-HPLC

The vitamins and phenolic acids of foam mat powder were identified and quantified by RP-HPLC (Table 4.4). The β-carotene, (±)-α-tocopherol and D-α-tocotrienol were detected at the retention times of 3, 3.5 and 3.8 min, respectively. Cavalcante et al. (2011) stated that compounds like carotene and vitamin accumulation in passion fruit are contributed by various internal as well as external factors *viz.*, maturity stage, cultivation system etc. The vitamin content in the foam mat dried powder were illustrated in Table 4.4. Six phenolic acids were prominently observed even after foam mat drying of pulp. The foam mat dried powder was predominant with chlorogenic (790.33mg/100g), trans-ferulic acid (342mg/100g) and vanillic acid (893.87mg/100g).

Table 4.4 Quantification of vitamins and phenolic acids of passion fruit pulp and foam mat powder

Phytochemicals (mg/100g)	**Retention time (min)**	**Foam mat dried powder**
Vitamin		
1. β-carotene	3.00	13.26
2. (±)-α-tocopherol	3.50	15.20
3. D-α-tocotrienol	3.80	11.98
Phenolic Acid		
1. Caffeic acid	14.66	NA
2. (±) Catechin hydrate	13.00	NA
3. Chlorogenic acid	13.80	790.33
4. *p*- Coumeric acid	17.25	266.25
5. Transferulic acid	14.36	342.00
6. 4-Hydroxybenzoic acid	18.03	NA
7. Syringic acid	15.06	639.60
8. Sinapic acid	17.80	523.33
9. Vanillic acid	14.96	893.87

4.4 Conclusion

The foam mat drying of passion fruit pulp was successfully carried our using CCD followed by response surface methodology. The optimum process conditions of foam mat drying of passion fruit pulp were WT 2.58 min, MC 2.58 %, and temperature 44.05˚C. ANN model was successfully applied to predict the experimental outcome. In the RP-HPLC, three vitamins *viz.*, β-carotene, (±)-α-tocopherol and D-α-tocotrienol and five phenolic acids *viz.*, chlorogenic acid, trans-ferulic acid, syringic acid, sinapic acid and vanillic acid were detected and quantified. RP-HPLC of vitamins and phenolic compounds revealed that even after foam mat drying, compounds were present in the powder. The present chapter showed that foam mat dried powder from purple passion fruit can be used as an important ingredient in developing functional foods and has potential applicability in food industry. In addition, the foam mat drying is a low cost processing technique compared to spray and freeze drying and can easily be carried out in many in post harvested crops to study the various food properties.

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