The Pharma Innovation Journal 2017; 6(9): 386-392

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating 2017: 5.03
TPI 2017; 6(9): 386-392

www.thepharmajournal.com
Received: 20-07-2017
Accepted: 21-08-2017

Dr. Paras Porwal
Assistant Professor, Amity Institute of Biotechnology, Amity University Uttar Pradesh, Lucknow Campus Lucknow, Uttar Pradesh, India

Dr. Rajendra Kumar Pandey
Professor & Head, Department of Animal Husbandry & Dairying Institute of Agricultural Sciences Banaras Hindu University Varanasi, Uttar Pradesh, India

Dr. Kaushal Kishor
Department of Warner College of dairy Technology University of Sam Higginbottom University of Agriculture, Technology & Sciences Allahabad, Uttar Pradesh, India

Correspondence
Dr. Kaushal Kishor
Department of Warner College of dairy Technology University of Sam Higginbottom University of Agriculture, Technology & Sciences Allahabad, Uttar Pradesh, India

Optimization of process parameters for the production of spray dried bael (*Aegle marmelos* Correa) powder

Dr. Paras Porwal, Dr. Rajendra Kumar Pandey, Dr. Kaushal Kishor

Abstract
The response surface methodology (RSM) was used to investigate the effect of process variables i.e. inlet air temperature (160 to 185ºC), maltodextrin (MD) level (1.5 to 2.5%) and tricalcium phosphate (TCP) concentration (0.5 to 1.5%) upon moisture, solubility, dispersibility and ascorbic acid value of powder were observed. Central composite rotatable design (CCRD) analysis revealed that independent variables significantly affected all the responses. The inlet air temperature showed maximum influence on moisture and ascorbic acid content, while the maltodextrin concentration has different effect on solubility and dispersibility. With lower level of maltodextrin concentration the solubility of bael powder increases and with increase in maltodextrin concentration the dispersibility increases. The bael powder was developed using the derived optimum processing conditions to check the validity of the quadratic model. The experimental values were found to be in close agreement to the predicted values and were within the acceptable limits indicating the suitability of the model in predicting quality attributes of bael powder. The optimum spray-drying conditions for drying bael slurry were inlet air temperature, maltodextrin and tricalcium phosphate concentration of 165 °C, 2.48% and 1.5% respectively.

Keywords: optimization, process parameters, production, *Aegle marmelos* Correa

Introduction

Drying is an economical method of preserving foods since ancient times in many countries. Hundreds of variants are recently used in the drying of particulate solids, pastes, continuous sheets, slurries or solutions; hence it provides the most diversity among food process engineering unit operations. The quality of a food powder is based on a variety of properties depending on the specific application. In general, the final moisture content, solubility, dispersibility and ascorbic acid are of primary importance (J. Vander-lijn 1976) [19]. Food powders are instantly present in our daily routine life. They are easy to preserve, transport, store, weight and process (Goula and Adamopoulos, 2008) [4].

Bael (*Aegle marmelos* Correa.) belongs to family Rutaceae is an important medicinal plant which possesses various medicinal properties having origin from Eastern Ghats and Central India. It is grown throughout India as well as in Sri Lanka, Pakistan, Bangladesh, Burma, Thailand, and most of the Southeast Asian countries. It is native to India. (Singh and Roy, 1984; Morton, 1987) [32, 25]. Bael fruit is highly nutritive with the richest source of riboflavin. It is richer than most of the reputed fruits like apple, guava and mango as the calorific value of bael, apple, guava and mango are 88, 64, 59 and 36 calories respectively per 100g. (Singh and Chaurasiya, 2014) [6].

Bael is primarily consumed fresh. Bael fruit comes under the underutilized fruits, because, it's neither grown commercially on large scale nor traded widely. It is cultivated, traded and consumed locally (Singh, 2007). Currently, world trade in the processed bael is not as much as other common fruits. However, being a seasonal fruit and having high nutritional and medicinal value, the demand of the processed bael products in future is likely to have steady and significant increase.

Spray drying is used to produce a wide range of products including heat sensitive materials (Crowe, 1971; Gardner, 1971) [9, 1]. The versatility of drier designs provides opportunities to produce the powders that uniformly meet industrial specifications (Huntington, 2004; Sharma *et al*. 2000) [12, 29]. The production capacity can be expanded to over 25 t of product per hour (Masters, 1997) [23]. The process is continuous and easily automated which reduce labor costs (Gardner, 1971; Sharma *et al*. 2000) [1, 29]. There are less sticking and corrosion problems in spray drying if the material does not contact the equipment walls until it is dry (Gupta, 1978) [5]. It is a powerful tool for delivering cost effective, high quality products (Masters, 1979).

Material and methods

Concentration of fruit Juice The feedstock is concentrated before introducing into the spray dryer. The concentrated juice has increased in solid contents thereby reducing the amount of liquids and that must be evaporated in the spray dryer. The feedstock in conventional large scale spray dryer normally concentrates to 50%-60% (w/w) before introducing to spray dryer. However, the small scale laboratory spray dryer will have more diluted feedstock because it will be clogged easily if the feed have high viscosity (Chegini and Ghobadian, 2007; Murugesan and Orsat, 2011) [13, 28].

Carrier agent Food grade ingredients such as Maltodextrin (drying aid) and Tricalcium phosphate (anti-caking agent) were used to avoid stickiness problem for preparing fruit powders (Jaya and Das 2004) [21].

Raw materials Fresh bael (*Aegle marmelos*) fruits were purchased from local market, Sundarpur Varanasi. Fully ripen bael fruits were washed, graded and their hard rind was broken manually.

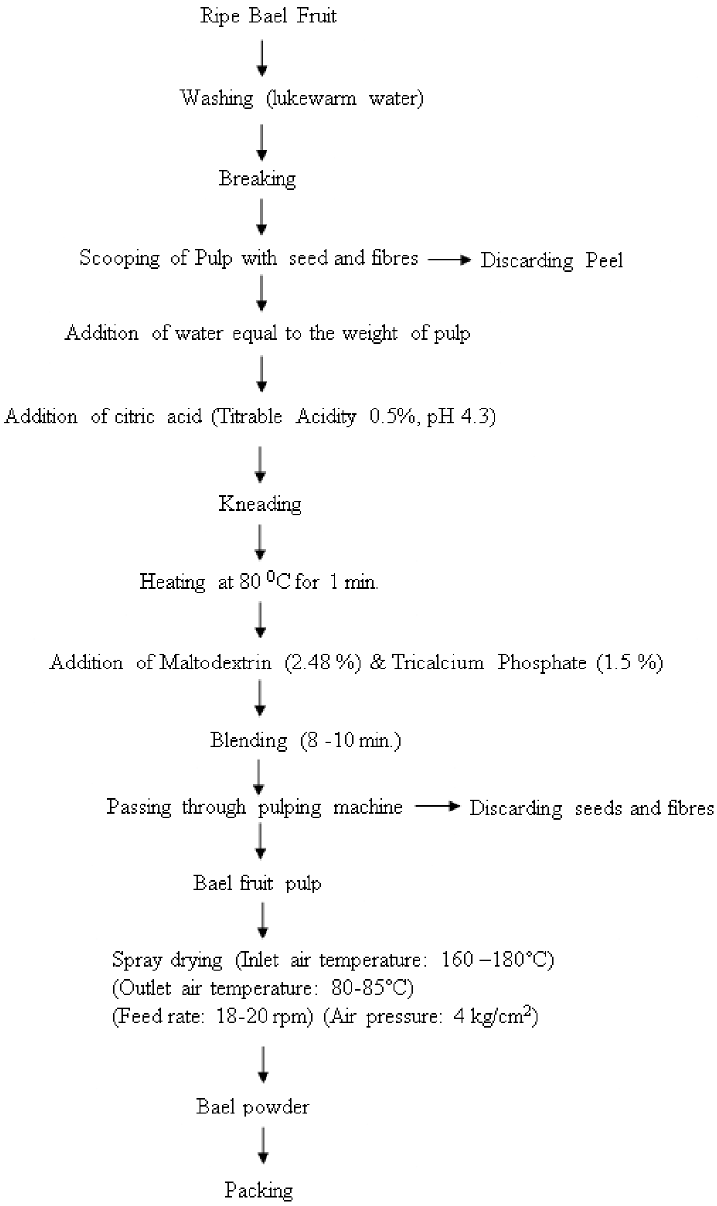
Sample preparation Before being dehydrated, the juice was diluted in distilled water until reaching a total soluble solid content of 12°Brix. Once the juice total solids were standardized, the following substance was added: maltodextrin of 2.48% and tricalcium phosphate 1.5%.

Experimental site. The experiment was conducted at the Centre of Food Science and Technology of the Banaras Hindu University, Varanasi, India

Optimization of the spray-drying process for the development of bael powder

A total of 20 runs were conducted. Inlet air temperature varied from160 °C to 185 °C, maltodextrin (1.5 to 2.5%) and tricalcium phosphate concentration level (0.5 to 1.5%). Factors such as moisture content (%), solubility (%), dispersibility (%), and ascorbic acid (mg/100 g) difference value were used as quality attributes of bael powder.

Body of Product



Result and discussion

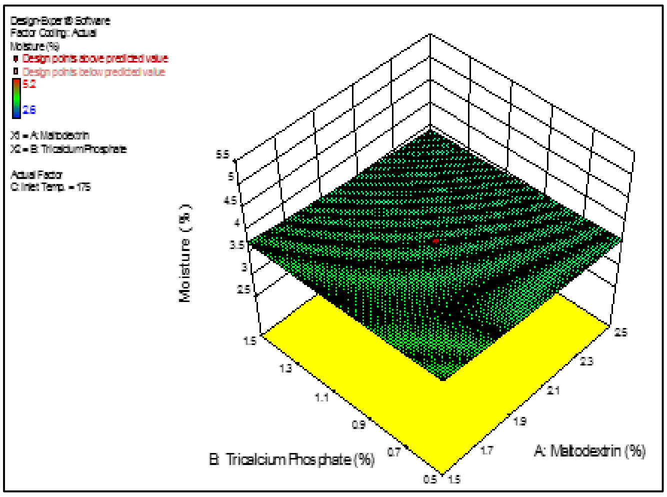
Four response surface models were obtained for the moisture content, solubility, dispersibility, and ascorbic acid content value. Table 4 shows the ANOVA data for response variables and their significance at 90% confidence level along with correlation coefficients. A high correlation coefficient explained the goodness of fit of the experimental data in the response surface models of moisture content, solubility, dispersibility and ascorbic acid content value. The different graphs of four responses were developed as a function of the three independent variables (levels of inlet air temperature, maltodextrin concentration and tricalcium phosphate) according to their significance to the response. The graphs for moisture content, solubility, dispersibility and ascorbic acid content value as a function of levels of inlet air temperature, maltodextrin and tricalcium phosphate concentration are shown in Fig. 2(a-c) to 5(a-c). The optimum area was obtained by superimposing graphical method from which the optimum formulation was obtained (Madamba, 1997) [26].

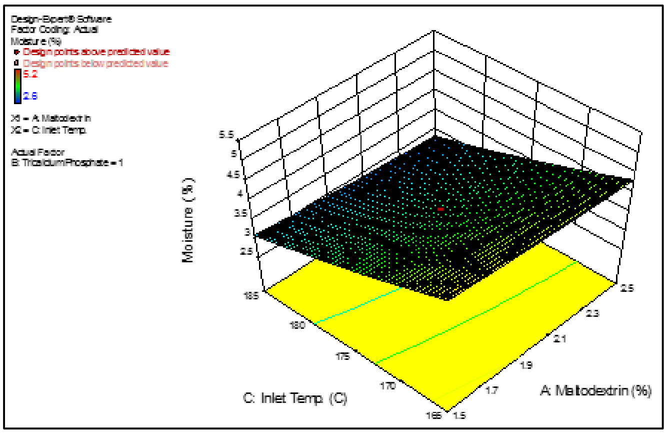
Moisture Content

Moisture content, the quadratic equation obtained by the response surface analysis of the data showing the effect of maltodextrin (A), Tricalcium Phosphate (B) and inlet air temperature (C) resulted in the following equation:

Moisture = 3.637 - 0.143 * A - 0.070* B - 0.762* C - 0.025 * AB + 9.835E -16* AC + 1.281E - 15* BC + 0.029* A^2 + 0.010* B^2 + 0.070* C^2

The quadratic model was significant (P<0.0001). The coefficient of determination (R^2) was 0.99. Moisture content of bael powder varied from 2.6 to 5.2 %. The coefficient of estimation of showed that as the level of maltodextrin was increasing, moisture of the powder was decreasing, however as the level of Tri calcium Phosphate and inlet air temperature was increasing, the Moisture content of bael powder was decreasing (Fig2a, b, c). Patil *et al*. (2014) also reported that increase in inlet air temperature as well as maltodextrin concentration decreased the moisture content of guava powder. Loh *et al*. (2005) reported that moisture content was decreased by increasing the inlet air temperature during spray drying of the encapsulated pandan extract.





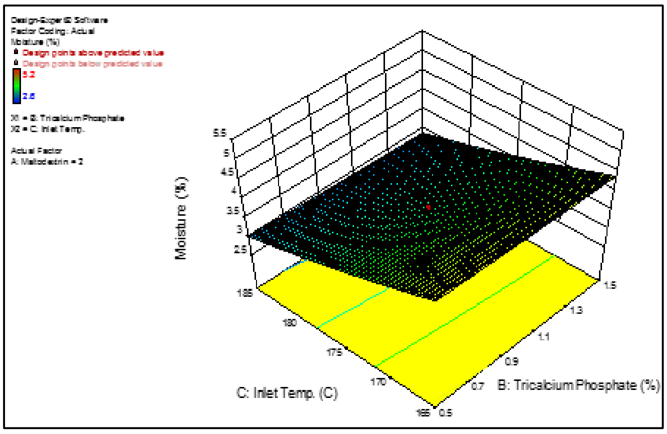


Fig 2: Effect of (a) Tricalcium phosphate and Maltodextrin concentration and (b) Inlet temperature and Maltodextrin concentration (c) Effect of Inlet temperature and Tricalcium phosphate concentration on Moisture percentage Solubility.

Solubility, the quadratic equation obtained by the response surface analysis of the data showing the effect of maltodextrin (A), Tri calcium Phosphate (B) and inlet air temperature (C) resulted in the following equation

Solubility = 91.834 - 2.670 * A - 1.00* B + 3.792 * C - 0.55* AB0.6* AC - 0.525* BC - 2.154 * A^2 - 1.041* B^2 - 0.511 * C^2

The quadratic model was highly significant (P<0.0001). Solubility was in the range of 80.30-95.30%. The coefficient of determination (R^2) for the relationship between effect of variables viz. maltodextrin, Tricalcium Phosphate and inlet air temperature on solubility was 0.96. The coefficient of estimation of solubility of bael powder showed that as the level of maltodextrin and tricalcium phosphate was decreasing, solubility of the powder was increasing while when inlet air temperature was increasing, solubility of the powder was increasing (Fig 3a, b, c). It may be due to the presence of less amount of insoluble residue and formation of very few lumps as a result of the use of lower amount of additive i.e. maltodextrin (Abadio *et al*. 2004; Jaya and Das 2004) [21]. It was also reported when reducing the additives viz., maltodextrin concentration during drying of pineapple and mango fruit juices the values of solubility was increased drastically (Abadio *et al*. 2004, Jaya and Das 2004) [21].

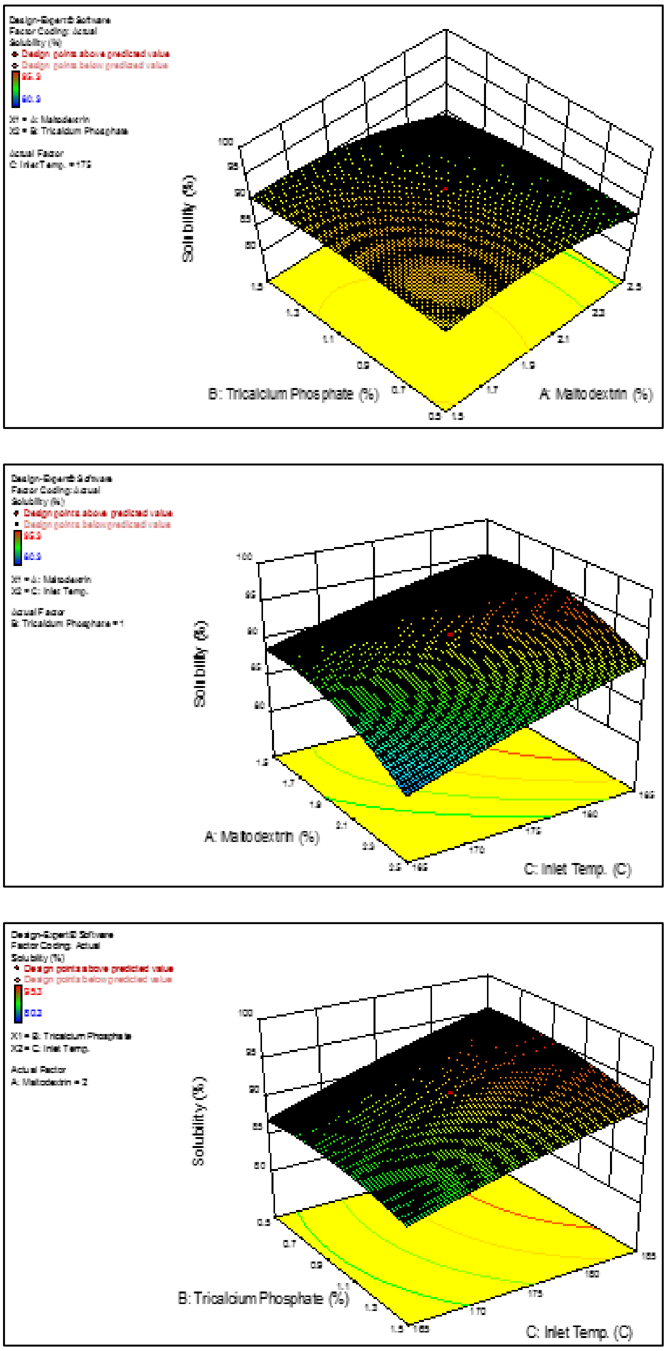


Fig 3: Effect of (a) Tricalcium phosphate and Maltodextrin concentration (b) Inlet temperature and Maltodextrin concentration (c) Inlet temperature and Tricalcium phosphate concentration on Solubility percentage.

Dispersibility

The quadratic equation obtained by the response surface analysis of the data showing the effect of maltodextrin (A), Tri calcium Phosphate (B) and inlet air temperature (C) resulted in the following equation:

Dispersibility = 85.958 + 1.903* A - 0.913* B - 0.171* C + 0.062* AB + 1.21* AC - 1.23* BC + 2.013 * A^2 - 1.814* B^2 + 0.491* C^2

The quadratic model was highly significant ($P<0.0001$). Dispersibility of bael powder varied from 79.5 to 93.6%. The coefficient of determination (R^2) was 0.76. The coefficient of estimation of dispersibility showed that as the level of maltodextrin was increasing, dispersibility of powder was increasing whereas, as the level of tricalcium phosphate and inlet air temperature increases dispersibility of powder was slightly decreasing (Fig 4a, b, c). Patil *et al.* (2014) also reported that increase in the maltodextrin concentration level in the fruit juice slurry increased the dispersibility values of the guava powder.

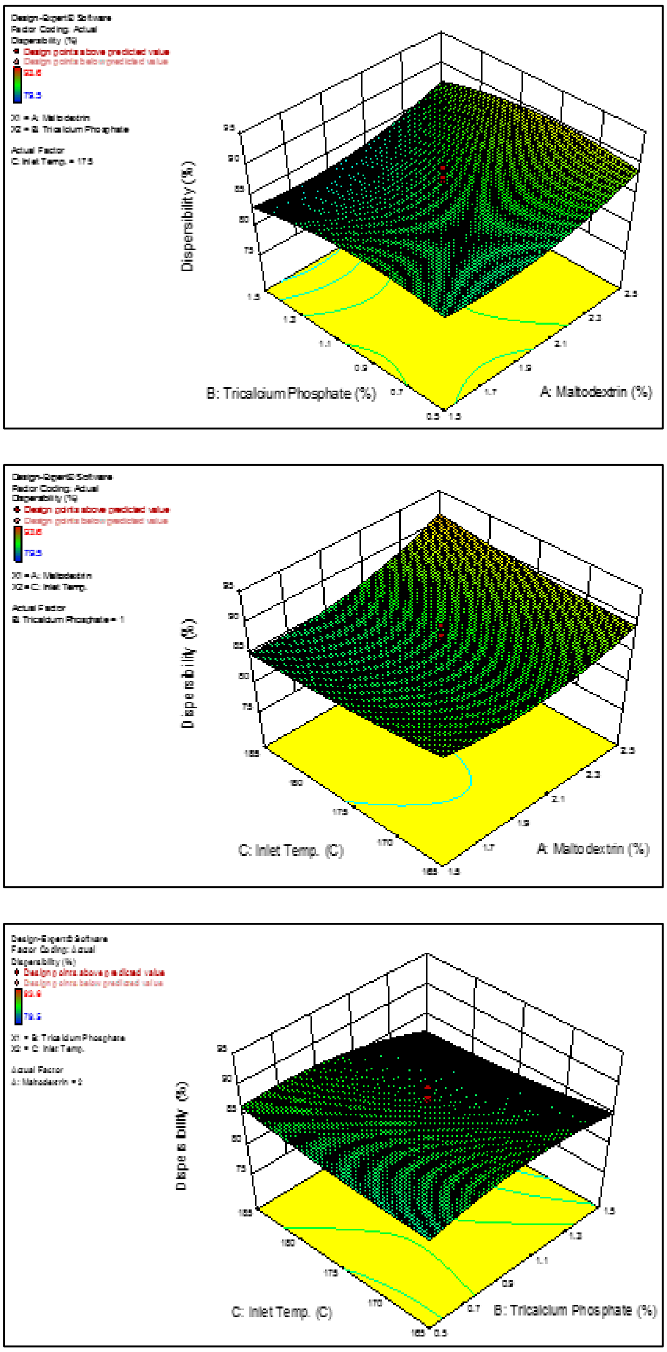


Fig 4: Effect of (a) Tricalcium phosphate and Maltodextrin concentration (b) Inlet temperature and Maltodextrin concentration (c) Inlet temperature and Tricalcium phosphate concentration on Dispersibility percentage.

Ascorbic acid content

The quadratic equation obtained by the response surface analysis of the data showing the effect of maltodextrin (A), Tri calcium Phosphate (B) and in inlet air temperature (C) resulted in the following equation:

Ascorbic acid = 26.182 - 0.225 * A - 0.097 * B - 2.093* C + 6.51E-15 * AB - 0.025 * AC - 0.025* BC + 0.114* A^2 + 0.094 * B^2-0.088 * C^2

Inlet air temperature was found to have maximum influence on ascorbic acid content followed by maltodextrin concentration. Ascorbic acid of bael powder varied from 24.0 to 29.8%. The coefficient of determination (R^2) was 0.976.The coefficient of estimation indicate the Ascorbic acid (AOAC, 1990) content of the bael powder increased significantly by reducing the spray-drying condition i.e. inlet air temperature and food additive i.e. maltodextrin concentration in the bael pulp. (Fig 5a, b,c). Loss of ascorbic acid could be due to the use of high temperature during processing (Patil *et al*. 2014). Similar loss in ascorbic acid content during spray drying of guava puree pulp was reported at such type of varying temperature levels (Muralikrishna *et al*. 1969) [24].

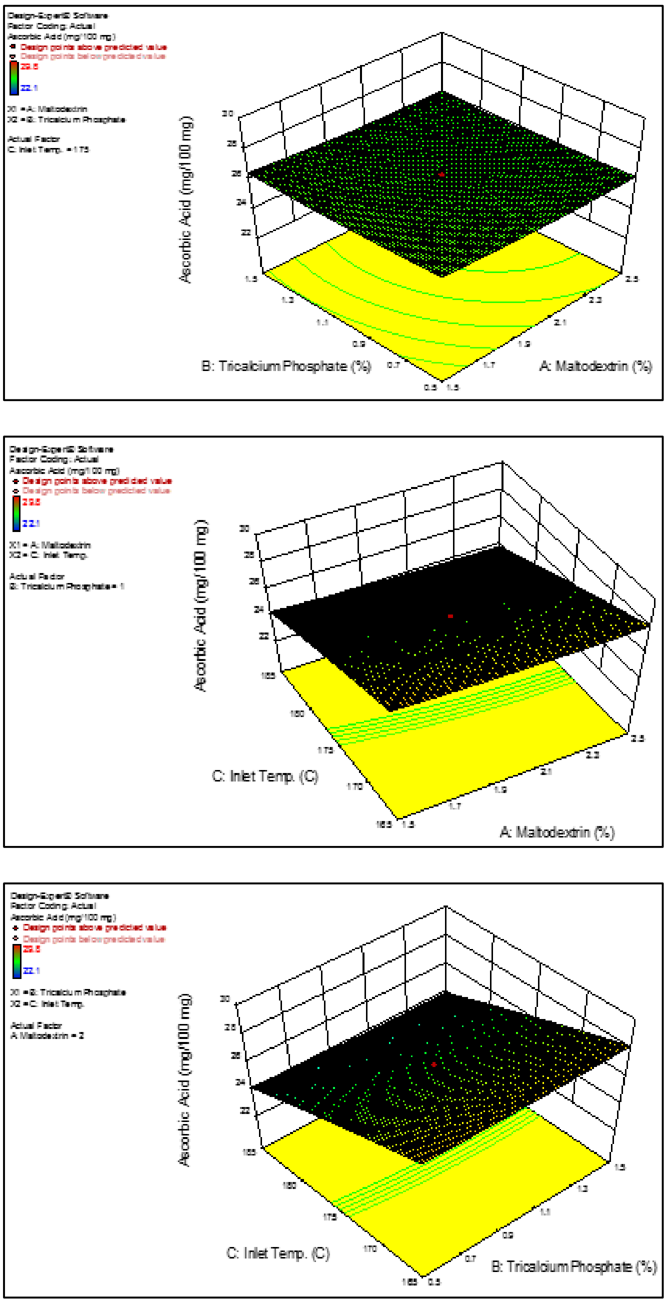


Fig 5: Effect of (a) Tricalcium phosphate and Maltodextrin concentration (b) Inlet temperature and Maltodextrin concentration (c) Inlet temperature and Tricalcium phosphate concentration on Ascorbic Acid percentage.

Optimization of bael pulp powder processing

Numeric and graphic optimizations were carried out for the process parameters of the bael pulp powder. The desired goals for each variable and response were chosen as summarized in Table 2. The limit for each variable was narrowed down to obtain an optimal region. Each goal was chosen to be as follows: to minimize and also to maximize based on the moisture content, solubility, dispersibility, and ascorbic acid content difference value of the developed product, because at this desired level only the free flowing characteristics of the bael pulp powder can be obtained i.e. by using low moisture content levels; improved instantanization properties can be achieved by maximizing the levels of solubility and dispersibility; and enhanced nutritive value can be obtained with higher ascorbic acid content. Table 3 shows the software generated most desirable solution of the experiment that produces optimum conditions of independent variables with the predicted values of responses; in the inlet air temperature it is at maximum level 165 °C and in maltodextrin and tricalcium phosphate concentration it is also at minimum level 2.48 % and 1.5% respectively for achieving the minimum moisture content 4.27 %, maximum solubility 80.30 %, maximum dispersibility 87.74 % and maximum ascorbic acid content 28.12 %. From the set of constraints and outputs given in (Fig. 2a, b, c) to (Fig. 5a, b, c) relevant and statistically significant responses were generated, and the overlaying of those plots is displayed. The shaded area in (Fig. 2a, b, c) to (Fig. 5a, b, c) represents the maltodextrin, tricalcium phosphate, inlet temperature and domain satisfying the imposed criteria. Thus, optimum processing conditions can be drawn from this shaded area to achieve a specific goal.

3.5. Spray Drying

During initial trials of spray drying of clear juice, powder was not manufactured due to the low solids and absence of a drying aid in the feed. Therefore, the higher solids bael juice was selected for spray drying. Spray drying was difficult due to the high sucrose content and burn on the equipment resulting from the high temperatures used. When maltodextrin was added to the concentrate, it formed a fi lm around the solids in the feed that facilitated production of a non-hygroscopic, free flowing, flour-like powder. All the powders produced by spray drying were creamish yellow in appearance irrespective of the color of the feed material. The spray dried powders produced in this study were extremely stable at room temperature and could be reconstituted after blending with room temperature water (Cuq *et al*. 2011) [8]. The moisture content of all the spray-dried powders was lower than that of the freeze-dried powders. There was an increase in ° brix and total titratable acidity and a decrease in pH following drying, which may be the result of concentration accompanied by release of sugars and acids from maltodextrin during drying. Similar observation have been reported by Hymavathi and Khader (2005) [16] in beta-carotene rich mango powder, Jaya *et al*. (2006) [22] in vacuum dried mango powder, Gabas *et al*. (2007) [14] in vacuum dried pineapple powder. Ascorbic acid was lost during drying as a result of the high temperatures and oxidation.

Table 1: The experimental data for response surface analysis of the effect of processing conditions on the quality of bael powder.

Std	Run	Factor 1 A: Maltodextrin	Factor 2 B: Tricalcium Phosphate	Factor 3 C: Inlet Temperature	Response 1 Moisture (%)	Response 2 Solubility (%	Response 3 Dispersibility (%)	Response 4 Vitamin C (mg/100 g %)
8	1	2.5	1.5	185	2.7	88.5	88.3	24
13	2	2	1	158	5.2	85.2	86	29.8
9	3	1.2	1	175	3.9	92.1	87.8	26.7
7	4	1.5	1.5	185	3.1	93.2	79.7	24.6
10	5	2.8	1	175	3.6	80.7	93.6	26.1
4	6	2.5	1.5	165	4.2	80.3	87.7	28
3	7	1.5	1.5	165	4.6	86.2	88.2	28.4
1	8	1.5	0.5	165	4.7	86.7	85.6	28.6
18	9	2	1	175	3.6	92.3	81.8	26.4
20	10	2	1	175	3.7	92.5	85.2	25.4
6	11	2.5	0.5	185	2.9	93.3	90.4	24.3
17	12	2	1	175	3.5	90.8	88	26.3
5	13	1.5	0.5	185	3.2	94.6	86.3	24.8
19	14	2	1	175	3.6	91.7	84	26.4
2	15	2.5	0.5	165	4.4	81.8	89.1	28.1
16	16	2	1	175	3.7	92.6	87.4	26.5
12	17	2	1.8	175	3.6	87.7	79.5	26.2
15	18	2	1	175	3.7	91.2	89.5	26.2
14	19	2	1	191	2.6	95.3	88	22.1
11	20	2	0.2	175	3.8	90.8	82.3	26.5

Table 2: Criteria and outputs of the numerical optimization of the responses for bael powder processing.

Name	Goal	Lower Limit	Upper Limit	Lower Weight	Upper Weight	Importance
A:Maltodextrin	is in range	1.5	2.5	1	1	3
B:Tricalcium Phosphate	is in range	0.5	1.5	1	1	3
C:Inlet Temp.	minimize	165	185	1	1	3
Soloubility	minimize	80.3	95.3	1	1	3
Dispersibility	is in range	79.5	93.6	1	1	3
Ascorbic Acid	maximize	22.1	29.8	1	1	3

Table 3: Most desirable solution of the experiment.

Solutions No.	Maltodextrin	Tricalcium Phosphate	Inlet temperature	Moisture	Solubility	Dispersibility	Vitamin C	Desirability	
1	2.483636186	1.5	165.0004	4.276006	80.30010464	87.74352012	28.121503	0.703506	Selected
2	2.485313566	1.49564	165.0001	4.276306	80.30002861	87.78731901	28.120621	0.703164	
3	2.486384813	1.5	165.09145	4.267175	80.30044434	87.75814081	28.10372	0.703136	
4	2.479577366	1.49998	165.00002	4.276941	80.36470956	87.7060473	28.121418	0.703102	
5	2.492062734	1.49986	165.27637	4.249283	80.3000243	87.79069705	28.067542	0.702301	

Table 4: Significant level of powder responses using RSM.

p>F	Moisture (%)	Solubility (%)	Dispersibility (%)	Vitamin C (mg/100 g %)
Model	3.19236E-09	7.81E-06	0.030867	6.16E-07
A-Maltodextrin	9.63676E-05	1.65E-05	0.016368	0.058281
B-Tricalcium Phosphate	0.012182068	0.016093	0.197209	0.377085
C-Inlet Temp.	1.29826E-11	6.33E-07	0.798721	2.1E-09
AB	0.415190869	0.244124	0.942595	1
AC	1	0.206734	0.182517	0.856962
BC	1	0.264786	0.17444	0.856962
A^2	0.23415921	0.000125	0.014205	0.317409
B^2	0.670141172	0.01532	0.023448	0.403494
C^2	0.010475125	0.163078	0.465177	0.409913
Lack of Fit	0.468974426	0.055605	0.821325	0.602809

Conclusion

Twenty different experimental treatments according to the CCRD were used to investigate the quality parameters of bael powder on various levels of inlet air temperature, maltodextrin and tricalcium phosphate concentration. The response surface methodology was used to optimize the processing conditions using moisture content, solubility, dispersibility and ascorbic acid content value as responses. The models for moisture content, solubility, dispersibility and ascorbic acid content were statistically significant. By superimposing the graphs, an optimum spray-drying process i.e. inlet air temperature level of 165 °C, maltodextrin and tricalcium phosphate concentration level 2.48% and 1.5% respectively for drying bael slurry was recommended with predicted responses close to experimental values. The spray dried bael powder contains higher amounts of ascorbic acid when compared to commercial fruit juice powders and also found to be free flowing without any physical alterations such as caking, stickiness, collapse and crystallization. The bael powder sample developed using the optimized spray-drying process compared well with the commercial fruit juice powder sample in terms of nutritional properties.

References

1. William-Gardner, Industrial Drying. Chemical and Process Engineering Series,Leonardo Hill, London UK, 1971.
2. AK Chauhan, V Patil, Effect of packaging material on storage ability of mango milk powder and the quality of reconstituted mango milk drink, Powder Technol. 2013; 239:86-93.
3. AM Goula, KG Adamopoulos. A new technique for spray drying orange juiceconcentrate, Innovative Food Sci. Emerg. Technol. 2010; 11:342-351.
4. AM Goula, KG Adamopoulos. Effect of maltodextrin addition during spray drying of tomato pulp in dehumidified air: I. Powder properties, Dry. Technol. 2008; 26:726-737.
5. AS Gupta, Spray drying of citrus juice, American Institute of Chemical Engineers, 7th Annual meeting, 1978, 55.
6. Amit Kumar Singhand, AK Chaurasiya. Post Harvest Management and value addition in Bael (*Aegle marmelos* Corr.), International Journal of Interdisciplinary and Multidisciplinary Studies (IJIMS). 2014; 1(9):65-77.
7. AOAC, Official Methods of Analysis, 14th edn. AOAC, Washington, 1984.
8. Cuq E Rondet, J Abecassis, Food powders engineering, between knowhowand science: constraints, stakes and opportunities, Powder Technol. 2011; 208:244-251.
9. M Crowe, Chemical Plant Simulation: An Introduction to Computer-AidedSteady-State Process Analysis, Prentice-Hall International Series in the Physicaland Chemical Engineering Sciences, New York, 1971.
10. Charoensiddhi S, Anprung P. Bioactive compounds and volatile compounds of Thai bael fruit (*Aegle marmelos* L. Correa) as a valuable source for functional food ingredients. Int. Food Res J. 2008; 15(3):287-295.
11. Chemical Engineers' Handbook, Evaporative Cooling and Solids Drying, Mc GrawHill Professional, 2007, 12.
12. DH Huntington, The in fl uence of the spray drying process on product properties, Dry. Technol. 2004; 22(6):1261-1287.
13. GR Chegini, B Ghobadian, Spray dryer parameters for fruit juice drying, World J.Agr. Sci. 2007; 3:230-236.
14. Gabas AL, Telis VRN, Sobral PJA, Telis-Romero J Effect ofmaltodextrin and Arabic gum in water vapour sorption thermodynamic properties of vacuum dried pineapple pulp powder. JFood Eng. 2007; 82(2):246-252
15. Gehlot R, Dhawan SS. Bael A Valuable Tree. Food & Pack. 2005; 5(7):28-29.
16. Hymavathi TV, Khader V. Development of value added beta-carotene rich mango (Mangifera indica L.) powders for culinaryuse. J Food Sci Technol. 2005; 41:292-296.
17. IAL, Normas analiticas: metodos fisicosy quimicos para analisede alimentos, IAL, Sao Paulo Brazil, 1977.
18. J Pisecky, Standards, Specifications and Test Methods for Dry Milk Products: Concentration and Drying of Foods, Elsevier Science Publishing Co Delhi, India, 1985.
19. J Vander-lijn, Simulation of Heat and Mass Transfer in Spray Drying, Centre for Agricultural Publishing and Documentation, Wageningen, 1976.
20. Jauhari OS, Singh RD. Bael a valuable fruit. Indian Hort. 1971; 16(1):9-10.
21. Jaya S, Das H. Accelerated storage, shelf life and colour of mango powder. J Food Process Preserv. 2004; 29(1):45-62.
22. Jaya S, Das H, Mani S. Optimization of maltodextrin andtricalcium phosphate for producing vacuum dried mango powder.Int J Form Prop. 2006; 9:13-24.
23. K Masters, in: CGJ Baker (Ed.), Industrial drying of foods; spray drying, Blackie Academic & Professional, London, 1997.
24. M Muralikrishna, AM Nanjundaswamy, GS Siddappa, Guava powder preparation,packaging and storage studies, J. Food Sci. Technol. 1969; 6:93-98.
25. Morton J. Bael Fruit, In: Friits of Warm climates. Julia F. Morton, Miami, Fl, 1987, 187-190.
26. PS Madamba, Optimization of the drying process: an application to the drying of garlic, Dry. Technol. 1997; 15(1):117-136.
27. Parmar C, Kaushal MK. Wild fruits of the sub-Himalayan region. New Delhi, India: Kalyani Publishers.
28. R. Murugesan, V. Orsat, Spray drying for the production of nutraceutical ingredients—a review, Food Bioprocess Technol. 2011-1982; 8:1-12.
29. SK Sharma, SJ Mulvaney, SS Rizvi, Food Process Engineering: Theory and Laboratory Experiments, 9, Wiley-interscience A John Wiley & Sons inc Publication, New York USA, 2000.
30. Sagar VR, Kumar R. Effect of drying treatments and storage stability on quality characteristics of bael powder. J Food Sci Technol DOI 10.1007/s13197-012-0727-7. 2012.
31. Sharma PC, Bhatia V, Bansal N, Sharma A. A review on bael tree. Natural Products Radiance. 2007; 6:171-178.
32. Singh RN, Roy SK. The Bael: Cultivation and Processing, ICAR, New Delhi, 1984.
33. TK Lim, KC Khoo, Guava in Malaysia: production, pests, and diseases, Tropicalpress, Kuala Lumpur, Malaysia, 1990.