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OPTIMIZATION OF SPRAY DRYING PARAMETERS FOR BEETROOT JUICE POWDER ON HIGROSCOPICITY AND POWDER YIELD USING RESPONSE SURFACE METHODOLOGY (RSM)-CENTRAL COMPOSITE DESIGN

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ABSTRACT

The optimization of beetroot juice powder was devised using response surface methodology to optimize the spray drying parameters of inlet air temperature (IAT) (160–180 C), maltodextrin (MD) addition rate (5–15%) and feed flow rate (FFR) (400–600 ml/h). The experimental results were ($p < 0.05$) fitted into the second-order polynomial model to describe and predict the response in terms of the powder yield, hygroscopicity. The powder yield significantly ($p < 0.01$) increased with increasing inlet temperature, whereas the redness value, BR, and RSA decreased. With the increasing rate of MD addition, redness value, BR, and RSA increased. The hygroscopicity values decreased with increasing feed flow rate. The effect of feed flow rate on the rest of responses was found non significant at a level of $p > 0.05$ except hygroscopicity. The optimum conditions were found as 170 degree C inlet air temperature and 400 ml/h feed flow rate and a maltodextrin concentration of 10% with using desirability function. The properties of dried powder were investigated in terms of powder yield and hygroscopicity. The experimental run and enhancement work were planned utilizing Central composit outline of Response Surface Approach. The ideal operation conditions for most elevated powder yield and least hygroscopicity were acquired at gulf drying temperature of 160 °C; bolster stream rate of 10.5 ml/min and suction apparatus rate of 98.33 %. The ideal properties of shower dried powder got from this examination were 41.33% of powder yield and 14.46% of hygroscopicity.

KEYWORDS: Betalains, Powder, Drying & Optimized

INTRODUCTION

Regular shading as colours is blended and aggregated in living natural cells of green growth, vertebrates, spineless creatures, parasites, lichens, or microorganisms. The red shading in nourishment industry comes for the most part from two shades: anthocyanin and betalains. Betalains, got from beetroot are water-solvent nitrogenous shades that stop or postpone the oxidation procedure and show hostile to- tumor and antiatherosclerotic impacts. The business beetroot red (mostly betalains) is allowed generally in dairy items, for example, frozen yogurt, sherbet, and yogurt, dry soda pop blend alongside confectionaries, soups, and bacon items. Betalains are chiefly made out of red-violet betacyanin and yellow-orange betaxanthin containing betalamic corrosive as the bioactive unit. The strength of betalains changes with various levels of water movement, temperatures, presentation to oxygen, and light. The wealthiest normal sources of betalains incorporate red beet, Amaranthus, Hylocereuspolyrhizus (red pitaya), and Opuntiaficus (thorny pear). Shower drying is a technique for drying an answer, suspension or slurry, keeping in mind the end goal to deliver a powder with great quality, low water movement and less demanding transport and capacity (Abadio et al., 2004; Cano-Chauca, 2005; Quek, 2007) nitrate advancement by beetroot juice moves forward practice resilience through vascular control and hoisted O2 conveyance to skeletal muscles. The powder created from shower drying beetroot juice without a transporter is extremely hygroscopic and is unfortunate for application in nourishment including low quality and steadiness (Gokhale and Lele, 2011). Likewise, parchedness of beetroot while keeping up a high substance of betalains is a challenge. For this reason, high sub-atomic weight drying bearers (maltodextrin) are included with sugarcontaining juices to maintain a strategic distance from the stickiness of divider chamber and among the dried particles. The dextrose identical (DE) of maltodextrin decides their lessening limit and is conversely identified with their normal sub-atomic weight. A lower DE consequently the lower expansion proportion for maltodextrin by and large prompts better maintenance of typifies (Krishnan et al., 2005; Adhikari et al., 2009) and furthermore diminishes the wellbeing dangers for <30% proportion of drying transporter.

Equipment

Splash drying includes atomization into a shower and contact between the shower and drying medium bringing about dampness vanishing. Shower drying has been utilized widely in pharmaceutical and nourishment ventures in lack of hydration of liquid sustenance, for example, espresso and natural product juices. Shower drying will bring about powders with low water movement and straightforwardness in transportation and capacity. The physicochemical properties of shower process factors, for example, the normal for fluid term of weight and temperature and also the sort of atomizer.

Optimization Method

In this examination, the point is to decide the ideal splash drying process parameters including bay air temperature; pump stream rate and maltodextrin convergence of beetroot squeeze on powder quality. The splash was broken down for its powder yield and hygroscopicity. Central composite design was picked as outline of investigation and the trial keeps running of focal composite configuration fills in as contributions to deciding the scientific model of splash dried powder. The numerical model can be created by utilizing the factual method, for example, reaction surface strategy. The most ordinarily utilize approximating capacities in quadratic polynomials. The polynomial condition can likewise be utilized to build a reaction surface demonstrating the impact of Free Parameters on Dependent Parameters. RSM has vital application in the outline, improvement, and detailing of new items, as well as in the change of existing item outline.

EXPERIMENT SECTION

Material and Methods

Sample Planning

Test beetroots acquisition was done from a neighborhood cultivator of Sangrur (Punjab, India). Beetroots were very much washed. The juice elaboration was finished by utilizing a juice extractor (Sujata, India) and the remaining wet mash produced from the main extraction was presented to a second squeeze extraction so as to amplify the juice yield which was trailed by filtration (100 work channel) and putting away in pre-sanitized glass bottles. The little scale research facility shower dryer is given more weakened feedstock due to simple obstructing of the atomizer with high thickness sustainance; In this way, beetroot juice was upgraded to 22% dissolvable solids (_Brix) at a fixation temperature of 55degree Celsius based on some useful properties, viz.

Spray Drying

Spray drying process was performed in a lab scale shower dryer. The blend was nourished into the principle chamber through a peristaltic pump and the encouraging stream rate was controlled by the pump revolution rate.

The weight of the packed air was kept up at 4 bar all through the trial. External air temperature differed from 120 to 160°C, the suction apparatus rate fluctuated from 80% to 100% while the encourage rate fluctuated from 5 to 15 ml/min as per an exploratory plan.

Hygroscopicity Test

Powder hygroscopicity was tried utilizing the strategy around 1 g of the powders of each powder was put into the measuring pontoon and weighed. The examples in the measuring watercraft were at that point set in a shut holder at 25 °C with immersed salt arrangement of NaCl which can give relative mugginess of 75.3%. Following one week, tests were weighed once more, and the hygroscopicity was communicated as g of adsorbed dampness per 100 g of dry solids (g/100g).

Powder Yield

Powder yield after effective splash drying was assessed in rate as aggregate solids gathered to the aggregate solids gave in the nourish suspension. Process yield was figured at the connection between the aggregate strong substance in the subsequent powder and the aggregate strong substance in the nourish blend.

- Inlet air temperature – A
- Feed stream rate-B
- Maltodextrin fixation C

RESULTS AND DISCUSSIONS

The trial consequence of level of powder yield and hygroscopicity of the powders are appeared in Table.1 A factual investigation was performed on the trial results to get the relapse models. For powder hygroscopicityquadratic model were huge. For yield, 2FI model was noteworthy. The straight model for every one of the reactions as far as coded factors are appeared in condition underneath Equation

- W = +207.63532-3.27163* A+0.34077* B+5.81401* C-1.32875E-003* A * B-0.024475* A * C-3.83750E-003* B * C+0.012444* A2-6.98392E-005* B2-4.86901E-003* C2
- X=+279.86454-2.77163* A-0.10845* B+0.80517* C+7.33750E-004* A * B-7.07500E-003* A * C+7.52500E-004* B * C+7.22924E-003* A2-2.93041E-005*B2-0.011255* C2

Table 1

Std	Group	Run	Factor 1 a:A 0c	Factor 2 B:B ML/H	Factor 3 C:C %	Response 1 W %	Response 2 X g/100g
18	1	1	170	500	1.33975	49.13	18.34
16	1	2	170	326.795	10	45.11	17.87
17	1	3	170	673.205	10	44.73	14.86
19	1	4	170	500	18.6603	44.17	14.46
24	2	5	170	500	10	47.42	16.73
23	2	6	170	500	10	48.51	16.43
25	2	7	170	500	10	41.31	14.71
6	3	8	180	600	5	54.31	19.23
8	3	9	180	600	15	47.82	16.45
5	3	10	180	400	5	54.63	18.94
7	3	11	180	400	15	47.82	15.04
11	4	12	170	500	10	54.63	16.56
9	4	13	170	500	10	42.42	17.56
10	4	14	170	500	10	48.03	17.39
22	5	15	170	500	10	44.96	16.52
21	5	16	170	500	10	50.78	18.32
20	5	17	170	500	10	53.34	19.62
15	6	18	187.321	500	10	51.54	17.33
14	6	19	187.321	500	10	48.93	19.67
13	7	20	152.679	500	10	56.55	20.68
12	7	21	152.679	500	10	47.81	19.67
2	8	22	160	600	5	54.32	16.29
1	8	23	160	400	5	41.33	19.32
3	8	24	160	400	15	47.41	16.45
4	8	25	160	600	15	44.73	15.31

- W- yield %
- X- hygroscopicity
- Inlet air temperature –

A- Feed flow rate

B- MaltodextrinConcentration

Powder Yield

The examination of fluctuation table demonstrated a noteworthy quadratic model and a non-critical absence of fit. The powder yield for dried beetroot juice changed in the vicinity of 41.33% and 56.55% for 25 runs (Table 2). Similar yields (around half) were accounted for by Obo' n et al. (2009) in the generation of red-purple nourishment colorant from Opuntiastricta natural products at three diverse splash drying bay air conditions. Greatest yield (54.63%) has been found for the blend of 15% MD at 170 degree celsius. The plot (Fig. 1) demonstrated a nonstop increment in the powder yield for an increment in bay air temperature. The raised delta air temperature prompted higher powder yield, which could be ascribed to the more prominent productivity of warmth and mass exchange forms. The higher yield with higher maltodextrin focus was most presumably due to the best expansion of aggregate solids through drying transporter and furthermore by the diminishment in stickiness by means of exemplification by maltodextrin. The variable FFR influenced adversely powder yield which may be caused by moderate warmth and mass exchange rate.

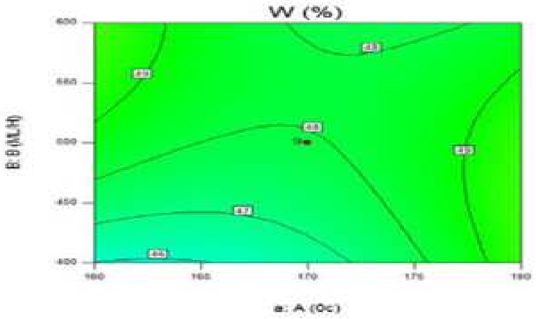

Figure 1

Hygroscopicity

Hygroscopicity relies upon natural pieces of item and furthermore on centralizations of the drying bearers. The qualities for hygroscopicity of dried beetroot juice particles extended between 14.46 and 20.68 g of water/100 g of dry issue. In figure 2, the FFR fundamentally influenced the hygroscopicity esteems and the expansion in hygroscopicity esteems was with an expansion in sustaining stream rate. The purpose behind this could be characterized by the lesser time for vanishing on account of high FFR announced a comparative pattern of higher hygroscopicity esteems with expanded FFR. Thedecreasing IAT prompted the diminishing hygroscopicity esteems which could be all around clarified by the expanding dampness content with bring down IAT.

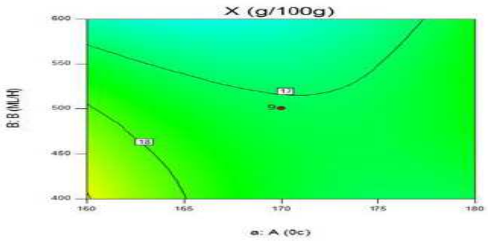

Fig:2

Figure 2

Optimization of Process Parameters and Confirmation of the Model

Each individual reaction viz. powder yield, hygroscopicity, was advanced in mix utilizing Design master programming. For fathoming the 'stationary point' issue, requirements were set in the Type of least (hygroscopicity) and most extreme (powder yield) go values for all free factors. Optimized parameter and reaction are given in the table. 2

Table 2

OPTIMISED PARAMETERS	RESPONSE
Inlet air temperature –A=160 to 170 Feed flow rate-B=400 to 500 Maltodextrin Concentration- C=5 to 10	W-Yield % 41.33 to 56.55 x- Hygroscopicity 14.46 to 20.68

CONCLUSIONS

Twenty-five unique things keep running as indicated by the central composite plan and were utilized to contemplate the Quality parameters of BJC powder at different levels of IAT, MD expansion rate, and FFR. All of the factors were profoundly noteworthy ($p< 0.05$) to the reactions separated from the nourish stream rate which was non huge to the reactions contemplated aside from hygroscopicity. The numerous reaction advancements uncovered the ideal conditions to boost the powder yield, RSA in the powder with low hygroscopicity. Generally speaking, the aftereffects of the present examination propose that the gotten demonstration is satisfactory for the enhanced maintenance of betalain content in BJC powder which can in this manner be connected to its huge scale generation.

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