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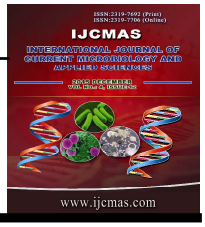


Original Research Article

Process Optimization for Development of Jamun (*Syzygium Cumini* L.) Enriched Shrikhand

Chandra Shekhar Singh* and Vinod Kumar Paswan

Centre of Food Science and Technology, Institute of Agricultural Sciences,
Banaras Hindu University, Varanasi -221005, India
**Corresponding author*

Keywords

Jamun Pulp Powder, Flavour, Response Surface Methodology, OSverall Acceptability

A B S T R A C T

The present study was carried out for the development of Jamun (*Syzygium cumini* L.) enriched shrikhand. The process of development of jamun enriched shrikhand (JES) was successfully optimized by using response surface methodology (RSM). The selected variables were different levels of jamun powder (7-15%) and sugar concentration (25-35 %). Colour, flavour, sweetness, body & texture and overall acceptability are choosing as the responses. Each response is significantly affected by independent variables ($p < 0.05$). The process was optimized with 12.78% jamun pulp powder and 30.66% concentration of sugar shows the higher impact on the colour (8.41), flavour (7.98), sweetness (8.41), Body & texture (8.69) & overall acceptability (8.33). The jamun pulp powder showed maximum influence on colour, flavour and overall acceptability where as the sugar concentration greatly affect the sweetness and Body & texture. The optimized JES retains higher amounts of nutritional and functional compounds with excellent sensory score.

Introduction

Jamun (*Syzygium cumini* L.) *is* commonly known as Indian Blackberry, Jambul, Black Plum & Java Plum and it belongs to the family Myrtaceae. Large trees cultivated throughout India for the edible fruits that are reported to contain huge amount of vitamin C, gallic acid, tannins, and anthocyanins includes cyanidin, petunidin, malvidinglucoside. The fruit has a combination of sweet, mildly sour and astringent flavor and tend to color the tongue purple due to presence of high amount of anthocyanins (Ugbabe et al. 2010). Jamun fruits have higher level of antioxidant activity compared to other popular fruits like sapota, papaya, banana and guava. The higher antioxidant activity attributed due to presence of vitamins, tannin and anthocyanins. Jamun fruits is widely used by traditional practitioners over many centuries for the treatment of a number of diseases due to presence of following pharmacological actions *viz.*, free radical scavenging, antioxidant, hepatoprotective, anti-diarrhoeal, hypoglycaemic, antidiabetic effects, antibacterial, antifungal, antiviral, anti-genotoxic, anti-inflammatory, anti-

ulcerogenic, cardioprotective, anti-allergic, anticancer, chemopreventive and radioprotective (Koley et al. 2011). The pulp of jamun is highly nutritive and contains important minerals like sodium, potassium, calcium, phosphorous, iron and zinc; water soluble vitamins like ascorbic acid, thiamine and niacin; carbohydrates like glucose, mannose, sucrose, maltose, fructose, galactose and mannose; free amino acids like alanine, asparagine, tyrosine, glutamine and cysteine (Knorr, 1998; Bhandari et al. 1997).

There is a great scope for the development of value added dairy products with this fruit not only because of their exotic flavor but also due to their nutraceutical importance and therapeutic values. Thus, processing of jamun fruit into value-added products result in a wide variety of exotically flavored product with better nutritional and sensory qualities may unveil new market for export.

Therefore, development, standardization and popularization of value-added products from jamun fruit are essential. Keeping in view the nutritional, medicinal and delicious significances of jamun fruit, we plan to develop value added JES. This precious fruit should be explored the nutritional and functional properties of shrikhand which provide promising health benefits.

Materials and Method

Fresh jamun fruits were procured from the local fruit market of Varanasi. Maltodextrin product, Maltrin 500® RM 1249 was obtained from Hi Media Mumbai.

The standard yoghurt culture was obtained from NDRI Karnal, Haryna, India. The milk was procured from the Department of A.H. & Dairying, BHU, Varanasi, India.

Preparation of Jamun Pulp Powder

The jamun pulp powder was prepared from pilot scale spray dryer. Before the samples fed in to spray dryer pulp was well mixed with appropriate proportion of water and maltodextrin. The standardized level of inlet air temperature and concentration of maltodextrin were 185°C and10 % respectively.

Preparation of Jamun Enriched Shrikhand

The process of preparation of JES was given in Fig. 1.

Optimization of the Spray-Drying Condition for the Development of JPP

The RSM was developed to overcome those disadvantages by reduction of the number of experimental trials needed to evaluate multiple parameters and their interactions, thus less time consuming compared to other approaches. RSM has been widely applied in optimization processes in food industries (Pisecky, 1985; Arnous et al. 2001; Giusti & Wrolstad, 2001; Klaypradit & Huang, 2008). The design of experiments (DOE) is mathematical and statistical techniques for designing experiments and evaluating the effects of factors. It also finds the optimum conditions of factors for desirable responses (Quek et al. 2007).

The variables taken for present research work were concentration of jamun pulp powder and sugar in the range of 7- 15 % and 25- 35 & respectively. A CCRD was used to design the experiments comprising of three independent processing parameters (Table 1). Thirteen trials were performed taking into account two factors viz., level of jamun pulp powder and sugar. A good model must be significant and the lack of fit

must be insignificant. Coefficient of determination (R^2) values should be close to 1. R^2 explains the percentage of the variability of the result. The predicted R^2 value should be in reasonable agreement with the adjusted R^2. Adequate precision measures signal to noise ratio and was computed by dividing the difference between the maximum predicted response and the minimum predicted response by the average standard deviation of all predicted responses. Colour, flavour, sweetness, body & texture and overall acceptability are used as responses and were used as quality evaluating parameters for optimization of JES.

Data Analysis

The experiments were performed and responses were fitted in the design. After each individual experiment, responses were analyzed to assess the effect of independent variables on them. The first order or second order polynomial equation (Eq.1) examines the statistical significance of the model and the following form was fitted to the responses:

Y =

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

(1)

Where,

Y = response variable

$\beta o, \beta_i, \beta_{ii}$ & β_{ij} = regression coefficient

X_i, X_j & X_{ij} = coded independent variables

Numerical optimization technique of the Design–Expert software (9.0.6.2) was used for simultaneous optimization of the multiple responses. The desired goals for each factor and responses were chosen. Responses obtained after each trials were analyzed to visualize the interactive effect of various parameters on sensory properties of JES.

Sensory Evaluation

A sensory score-card suggested by Amerine et al. (1965) with little modification was adapted to analyze the sensory characteristics of the JES. Sensory were evaluated by a panel of 7 semi-trained members from Centre of Food Science and Technology, Banaras Hindu University, Varanasi for colour, flavour, sweetness, body & texture and overall acceptability of the jamun enriched shrikhand. The tests were performed using 9-point hedonic scale, where 9 were like extremely and 1 was dislike extremely. Sensory evaluation was done at 25°C.

Results and Discussion

Effect of Process Variables on Sensory Attributes of JES

The results of experiments with the development of JES are presented in Table 1 and criteria and outputs of the numerical optimization of the responses for JES processing are presented in Table 2. The models that were significant for some responses, considering the 5% and 10% probability, eliminating the non-significant coefficients ($p>0.05$) and using the coded variables. The response surface models were generated by expressing the interaction between the variables jamun pulp powder (%) and sugar concentration (%). Most desirable solution of the experiment

and significant level of powder responses using RSM are represented in Table 3 and Table 4 respectively.

Colour

The effect of treatment parameters on the colour of JES is shown in Table 1. Jamun pulp powder and sugar concentration both affect the colour properties JES. This relation can be expressed by following relation.

Colour = + 8.49 – 0.16 *A – 0.15 *B – 0.02 *AB – 0.88 *A^2 – 0.60 *B^2 (2)

Where: A Jamun pulp powder; B = Sugar; A^2 = Jamun pulp powder ^{2}; B^2 = Sugar ^{2}
The range of colour was 5.3– 8.9 (Table 2). Most of colour values obtained through the experimental design were under the maximum effect on the sensory properties of shrikhand.

The colour variable was mainly affected by the level of jamun pulp powder (Table 1). When the sugar concentration increases the colour properties decreases significantly; while jamun pulp powder also had positive effect (Fig. 2 a).

Flavour

The flavour is an effective criterion for evaluating the attracting behavior of shrikhand in an aqueous solution. This is an important property of reconstitution. The flavour of JES were varies from 6.2 to 8.6 (Table 2). The interaction of jamun pulp powder and sugar concentration is described in equation 3.

Flavour = 7.65+ 0.67 *A + 0.16 *B …….(3)
In the development of JES flavour is greatly affected by the concentration of jamun pulp powder where as sugar had little positive effect on it (fig. 2 B). According to Ugbabe et al. (2010) jamun fruit has a combination of sweet, mildly sour and astringent flavor and tend to color the tongue purple due to presence of high amount of anthocyanins.

Sweetness

Sweetness is has the major effect on the taste of JES. The quadratic equation obtained by the response surface analysis (RSA) of the data showing the effect of jamun pulp powder and sugar is as follows:

Sweetness = + 8.27 + 0.34 *A +0.80 *B + 0.30 *AB + -0.21 *A^2 - 0.33 *B^2 (4)

The range of sweetness varies from 6.5 to 8.6 (Table 1). It is highly affected by the concentration of sugar and jamun pulp powder (Fig. 2-C).

Body and Texture and Overall Acceptability

The linear equation obtained by the RSA of the data showing the effect of A and B could be presented as follows:

Body & Texture = + 8.78 + 0.10 *A + 0.025 *B – 0.02 *AB - 0.670 *A^2 – 0.672 *B^2 (5)

Overall Acceptability = + 8.43 + 0.08 *A - 0.18 *B + 0.06 *AB – 0.49 *A^2 – 0.70 *B^2 (6)

The value of Body & Texture and Overall Acceptability varies 6.1 to 8.9 and 6.1 to 8.6 respectively (Table 1).

Body & Texture and Overall Acceptability were greatly affected with increases the concentration of jamun pulp powder where as the sugar effect is also had positive effect (Fig. 2 D- E).

Optimization of Jamun Enriched Shrikhand

For the development of JES the optimum condition was obtained based on colour, flavour, sweetness, body& texture and overall acceptability which were all significantly affected by the level of jamun pulp powder and sugar concentration. According to the results of the desirability (0.83) function the combination of a 12.78 % jamun pulp powder and a 30.66 % sugar concentration provided the best results in relation to the average score of colour, flavour, sweetness, body& texture and overall acceptability of the JES were 8.25, 7.98, 8.41, 8.69 and 8.3 respectively.

In conclusion, the trials were conducted according to the experiments and CCRD were used to study the quality parameters of JES at various levels of jamun pulp powder and sugar concentration. The RSM was used to optimize the processing conditions using colour, flavour, sweetness, body& texture and overall acceptability score as responses. The models for colour, flavour, sweetness, body& texture and overall acceptability score were statistically significant. By superimposing the graphs, an optimum development process i.e. jamun pulp powder level of 12.78 % and sugar concentration level 30.66 % for JES was recommended with predicted responses close to experimental values. The developed JES has maximum sensory attributes that are higher impact on consumer acceptability with promising health benefits.

Table 1 The Experimental Data for Response Surface Analysis of the Effect of Development Conditions on the Quality of Jamun Enriched Shrikhand.

Std	Run	Factor 1: A: Jamun pulp powder %	Factor 2: B: Sugar %	Response 1: Colour	Response 2: Flavour	Response 3: Sweetness	Response 4: Body & Texture	Response 5: Overall Acceptability
2	1	15.00	25.00	6.2	7.6	7.5	7.6	7.2
6	2	17.07	30.00	6.5	8.6	8.6	7.3	7.5
10	3	10.00	30.00	7.8	7.6	7.6	8.9	8.2
1	4	5.00	25.00	5.6	6.3	7.5	6.2	6.4
11	5	10.00	30.00	8.5	7.8	8.6	8.6	8.6
9	6	10.00	30.00	8.6	7.6	8.5	8.7	8.4
13	7	10.00	30.00	8.9	7.5	8.3	8.8	8.6
12	8	10.00	30.00	8.6	7.9	7.9	8.6	8.1
4	9	15.00	35.00	7	8.6	8.2	7.6	7.2
8	10	10.00	37.07	7.3	7.6	7.6	7.5	6.7
5	11	2.93	30.00	5.3	6.2	6.5	6.1	6.5
3	12	5.00	35.00	6.5	6.5	6.7	6.3	6.1
7	13	10.00	22.93	7.6	7.5	7.5	7.4	7.6

Table.2 Criteria and Outputs of the Numerical Optimization of the Responses for Development of Jamun Enriched Shrikhand

Name	Goal	Lower Limit	Upper Limit	Lower Weight	Upper Weight	Importance
A: Jamun pulp powder	is in range	7	15	1	1	3
B: Sugar %	is in range	25	35	1	1	3
Colour	maximize	5.3	8.9	1	1	3
Flavour	maximize	6.2	8.6	1	1	3
Sweetness	maximize	6.5	8.6	1	1	3
Body & Texture	is in range	6.1	8.9	1	1	3
Overall Acceptability	maximize	6.1	8.6	1	1	3

Table.3 Most Desirable Solution of the Experiment

olutions									
umber	Jamun pulp powder	Sugar	Colour	Flavour	Sweetness	Body & Texture	Overall acceptability	Desirability	
1	12.78	30.66	8.25	7.98	8.41	8.69	8.33	**0.8358**	Selected
2	12.77	30.65	8.25	7.97	8.40	8.69	8.32	0.8341	
3	12.76	30.65	8.24	7.96	8.40	8.68	8.30	0.8256	
4	12.74	30.66	8.24	7.96	8.36	8.68	8.31	0.8132	
5	12.74	30.64	8.22	7.95	8.39	8.67	8.30	0.8114	
6	12.73	30.64	8.23	7.93	8.36	8.67	8.30	0.8052	
7	12.75	30.63	8.22	7.92	8.35	8.66	8.29	0.7983	

Table.4 Significant Level of Responses using

p> F	Colour	Flavour	Sweetness	Body & Texture	Overall acceptability
Model	0.0001	< 0.0001	0.0002	< 0.0001	0.0004
A: Jamun pulp powder	0.9030	0.6153	0.7456	0.6231	0.8652
B: Sugar	0.0007	0.0102	0.0176	0.0040	0.0095
AB	0.0459	0.9756	0.1842	0.0010	0.7116
A^2	0.0070	0.1558	0.0894	0.0438	0.1329
B^2	0.0006	0.0328	0.0212	0.0250	0.0263
Lack of fit	0.0989	0.0826	0.2015	0.8631	0.0807

Figure.1 Flow-Diagram for the Manufacture of Jamun Enriched Shrikhand

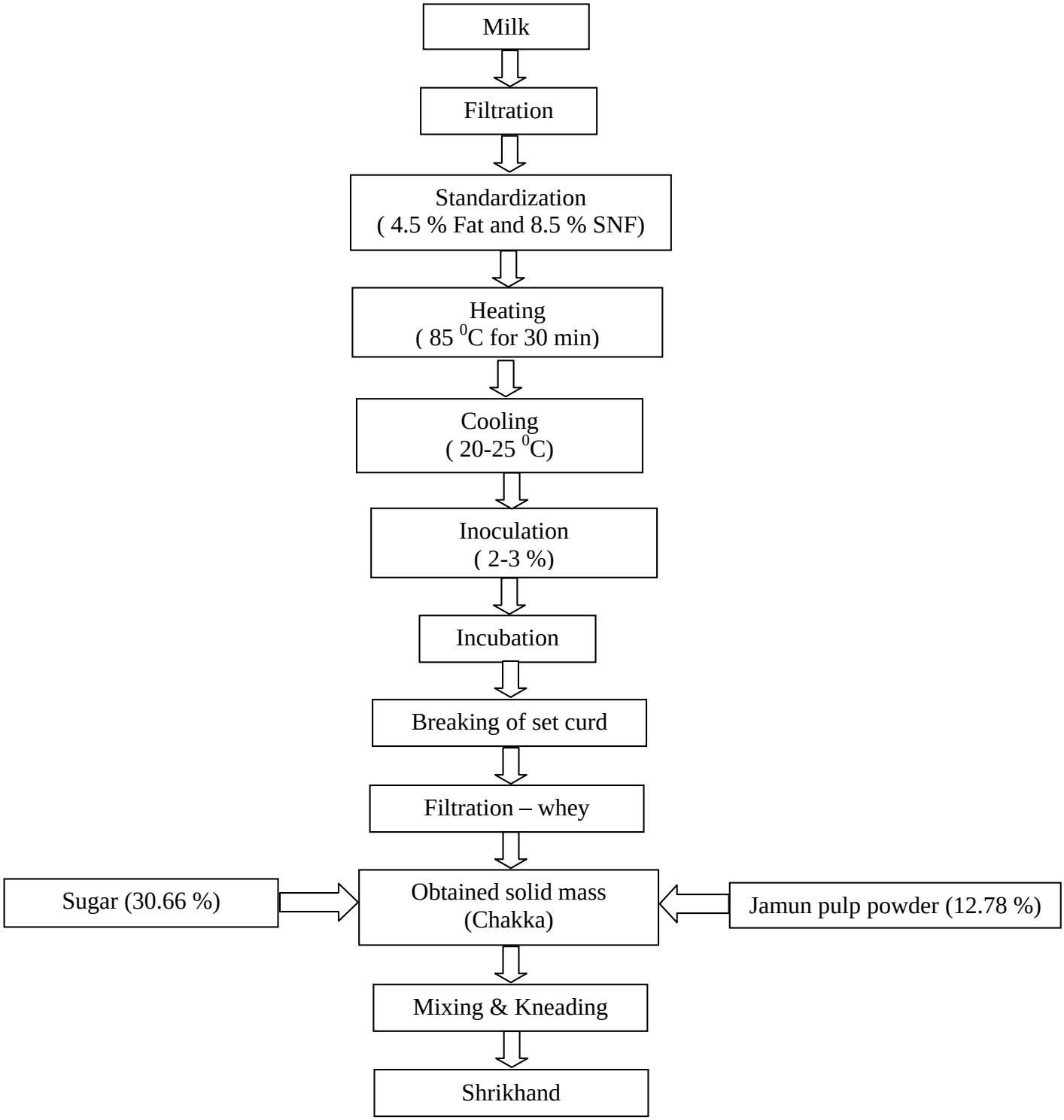
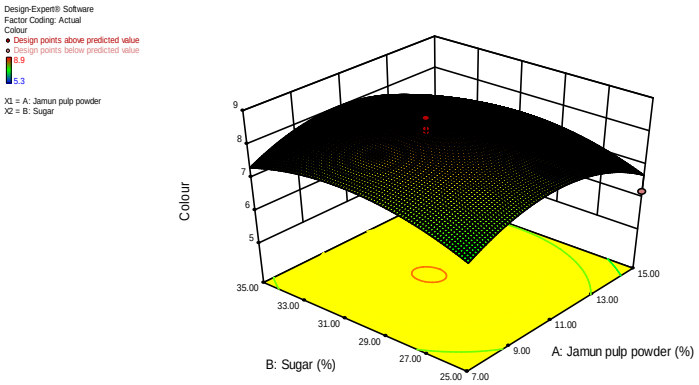
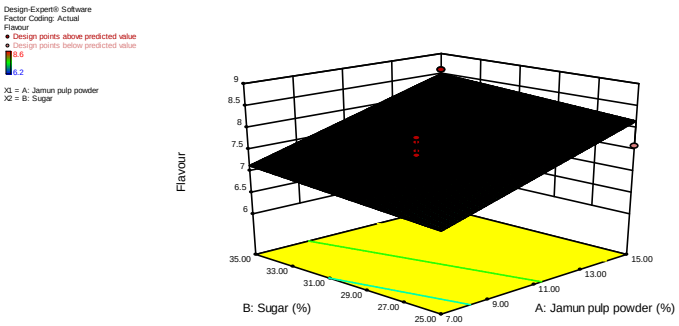


Figure.2 Effect of Jamun Pulp Powder and Sugar Concentration on Different Responses of Jamun Enriched shrikhand: (a) Colour (b) Flavour (c) Sweetness (d) Body & Texture (e) Overall Acceptability

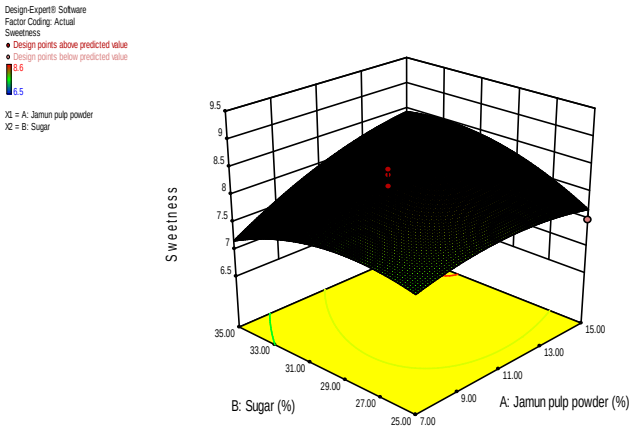
a) Colour



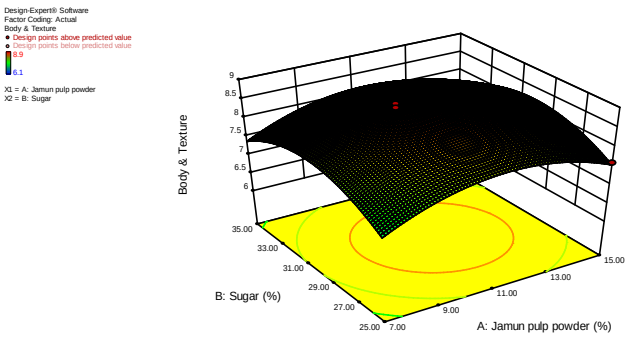
b) Flavour



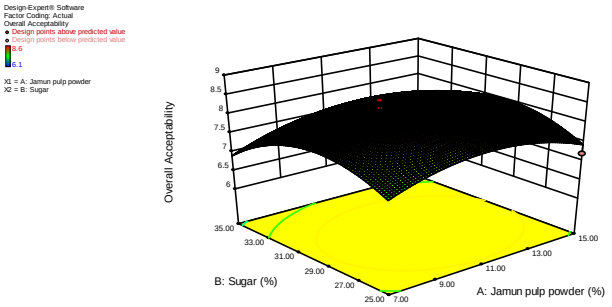
c) Sweetness



d) Body and Texture



e) Overall Acceptability



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