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STUDY ON ORGANOLEPTIC CHARACTERIZATION OF JELLY SUPPLEMENTED WITH HYDROCOLLOIDS USING RESPONSE SURFACE METHODOLOGY

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ABSTRACT

Hydrocolloids are used to improve the rheological and textural characteristics of food systems and often used as food additives for enhancing viscosity, creating gel-structures and lengthening the physical stability. Response Surface Methodology (RSM) is the statistical tool used extensively for optimizing processes in the tropical fruit juice production. The objectives of the present work were to development and optimization of hydrocolloids incorporated jelly and to analyse the physico-chemical parameters of the developed products and to assess organoleptic evaluation of the developed products. The physical properties such as total soluble solids and pasting properties were analysed. The Jelly prepared with the help of Jelly powder and CMC as Hydrocolloids characterized for its Appearance (Y_1), Colour (Y_2), Flavor (Y_3), Taste (Y_4), Texture (Y_5) and Overall Acceptability (Y_6) Measured for Response Variables. To consider all the responses simultaneously for optimization, the multiple regressions was used to get compromise optimum conditions and it as found that the scores were 8 for appearance, colour and overall acceptability while flavor, taste and texture have 7 as optimum level respectively. The optimum condition of jelly powder (X_1) 90gm and CMC (X_2) 0.4gm. The Total Soluble Solids (TSS) of V_3 have the maximum range of (24 °Brix) while V_4 has higher (23° Brix) followed by V_5, V_6 and V_{11} (22 °Brix).

Keywords: Optimization, hydrocolloids, viscosity, pasting, jelly.

INTRODUCTION

Hydrocolloids are water-soluble, high molecular weight polysaccharides that find wide application in food industry because of their ability to improve the rheological and textural characteristics of food systems and often used as food additives for enhancing viscosity, creating gel-structures and lengthening the physical stability Dziezak (1991). Examples of hydrocolloids are carboxymethylcellulose (CMC), guar gum, starch, xanthan gum, pectin, gelatine etc. Glickman (1991). Response Surface Methodology (RSM) is the statistical tool used extensively for optimizing processes in the tropical fruit juice production Lee *et al.,* (2006), Nazni and Gracia, (2014); Nazni and Karuna Thara, (2011), Nazni and Garcia, 2010, Nazni and Shemi George, 2012, Shemi George and Nazni, 2012 and Durgadevi and Nazni, 2012. It usually uses an experimental design to fit a first- or –second-order polynomial by a least significance technique Ying *et al.,* (2006). This graphical optimization technique has been used in other juice treatments such as mango juice Ying *et al.,* (2006). One of the major problems encountered in the preparation of fruit juices is cloudiness due primarily to the presence of pectin Abdullah (2007).

The objectives of the present work were development and optimization of hydrocolloids incorporated jelly. To analyse the physico-chemical parameters of the developed products and to assess organoleptic evaluation of the developed products.

MATERIAL AND METHODS

Jelly crystals were procured from a local market in Salem and other raw materials like sugar will be procured from the local market and Hydrocolloids (CMC) Carboxy Methyl Cellulose and citric acid from Science Corporation Salem.

PREPARATION OF JELLY

Boil the required amount of water and add Jelly crystals and stirred continuously. Pour it into the moulds. Allow it for 1 hour at room temperature.

PHYSICAL AND CHEMICAL ANALYSIS OF PREPARED JELLY

A) TOTAL SOLUBLE SOLIDS (°BRIX)

Degree brix (°brix) was determined using Hand Refractometer (portable refractometerHB-32ATC). The sample was placed on the prism of refractometer then the daylight plate was closed, and the scale where the boundary line intercepts was read as oBrix. All measurements were performed in triplicates and mean values obtained. **.**

B) PASTING PROPERTIES OF THE INGREDIENTS USED FOR JELLY PREPARATION

A Rapid Visco Analyzer was used to determine the apparent viscosity of starch suspension. About 5 g of acid thinned starch (corrected for 14% moisture basis) was mixed with distilled water in an aluminium canister. The level of addition was 3% w/w on starch basis. Sample was first agitated at 960 rpm for 10 sec to impart thorough dispersion, following with holding at 50ºC for 1 min, heating from 50ºC to 95ºC at 12ºC/min and 160 rpm, holding at 95ºC for 2.5 min before cooling to 50ºC at the same stirring rate and lastly holding at 50ºC for 2 min. Pasting parameters such as Pasting temperature, Peak viscosity, Trough Viscosity, Breakdown Viscosity, Final viscosity and setback Viscosity were determined.

C) NUTRIENT CALCULATION OF JELLY

The nutrient such as Energy, Carbohydrate, Protein, Fiber, β carotene and Vitamin C were calculated using NIN.

EXPERIMENTAL DESIGN OF OPTIMIZED IDLI

The Central Composite Rotatable Deign was used for selecting the level of parameters in the experiments. The levels of these variables along with experimental plan consisting of two variables at three levels have been presented in Table-1.

Table-1 -Observed values of dependent variables for Jelly in different runs of optimization experiments

Variables	Symbols	Coded level		
		–1	**0**	**+1**
Jelly powder	X_1	90	95	100
CMC	X_2	0.2	0.4	0.6
Design point	**Uncoded**		**Coded**	
	X_1	**X_2**	**x_1**	**x_2**
S	100	0	+1	0
V_1	90	0.2	-1	-1
V_2	100	0.2	+1	-1
V_3	90	0.6	-1	+1
V_4	100	0.6	+1	+1
V_5	85.2	0.4	-α	0
V_6	104.6	0.4	+α	0
V_7	95	0.16	0	-α
V_8	95	0.88	0	+α
V_9	95	0.4	0	0
V_{10}	95	0.4	0	0
V_{11}	95	0.4	0	0
V_{12}	95	0.4	0	0
V_{13}	95	0.4	0	0

X_1, x_1 = Coded and uncoded value of Jelly powder

X_2, x_2 = Coded and uncoded value of CMC

The variables were standardized to simplify computation and deduce their relative effect of variables on the responses.

$$X_1 = \frac{\text{Jelly powder-95}}{5}$$

$$X_2 = \frac{\text{CMC} - 0.4}{0.2}$$

Response Surface Methodology was applied to the experimental data using a commercial statistical package (Design expert, Trial version 6.0, State Ease Inc., Minneapolis, IN statistical software) for the generation of response surface plot and optimization of process variables. The experiments were conducted according to Central Composite Rotatable Design (CCRD) (Khuri. AI and Cornell. JA, 1997. Each design point consists of three replicates. For the statistical analysis the numerical levels were standardized to –1, 0, and 1. The experiments were carried out in randomized order (Gacula and Singh, 1984, Nazni and Gracia, 2014, Nazni and Bhuvaneswari, 2011). The standard scores were fitted to a quadratic polynomial regression model for predicting individual Y responses by employing at least square technique (Wanasaundara and Shahidi, 1996; SPSS, 2007). The response surface was generated for different interactions of any two independent variables, whole holding the value of third variables as constant at the central level.

The coded terms and actual values are presented in table-1. Regression analysis was performed on the data obtained. A second order polynomial equation was used to fit the data multiple regression procedure. The three dimensional graphical representation of model equation representation of model equation represents the individual and interaction effect of the test variables on the response. For a model equation

$$\mathbf{Y = ß + X_1 + X_2 + X_1{}^2 + X_2{}^2 + X_1{}^2 * X_2{}^2}$$

Whereas, Y → predicated response

$X_1$and X_2 → linear coefficient

$X_1{}^2$and $X_2{}^2$ → squared coefficients

$X_1{}^2 * X_2{}^2$ → independent variable.

The central composite experimental design with quadratic model is employed to study the combined effect of two independent variables namely Jelly crystals (X_1) and CMC (X_2) will be selected for optimization. The dependent variables (Y) to be measured are Appearance (Y_1), Colour (Y_2), Flavour (Y_3), Taste (Y_4), Texture (Y_5), and Overall acceptability (Y_6) of the developed Jelly.

SENSORY ANALYSIS

Sensory evaluation was carried out on the samples for Overall acceptability using 9-point Hedonic scale, where a score of 1 indicated poor sensory attribute and a score of 9 indicated excellent sensory attribute. A panel of 10 judges familiar with Jelly were selected and presented with the coded samples. Panelists were instructed to rinse their mouth between samples test to avoid effects of residual flavours (Ihekoronye and Ngoddy, 1985; Madamda, 2002).

RESULT AND DISCUSSION

PASTING PROPERTIES OF THE INGREDIENT USED FOR PREPARING JELLY

The pasting properties of the ingredient used for the Jelly were given in the table-2.

Table-2 -Pasting properties of the ingredient used for preparing Jelly

Variations	Peak viscosity	Trough viscosity	Breakdown viscosity	Final viscosity	Setback viscosity	Pasting temperature
S	8276	8276	0.00	8276	0.00	50.45
V_1	259	92	167	263	171	60.95
V_2	203	70	133	150	80	50
V_3	203	70	133	150	80	50
V_4	475	110	365	303	193	54.60
V_5	229	97	132	222	125	52.83
V_6	207	61	146	148	87	53.80
V_7	968	328	640	424	96	50.40
V_8	91	34	57	57	23	50
V_9	147	328	97	86	36	50
V_{10}	147	328	97	86	36	50
V_{11}	147	328	97	86	36	50
V_{12}	147	328	97	86	36	50
V_{13}	147	328	97	86	36	50

(193RVU) in V_4 variation indicates cohesive paste and that starch will retrograde faster than other processed millet flour under the same condition. The Pasting temperature ranged between 50-60.95ºC. The Pasting temperature provides an indication of minimum temperature required for cooking the samples. The Final viscosity is the most commonly used parameters to determine a particular starch based sample quality. The Final viscosity of the V_7 recorded the highest value of 424 rapid viscosity units (RVU).

TOTAL SOLUBLE SOLIDS (^{0}BRIX) OF THE PREPARED JELLY

The Total Soluble Solids (TSS) of V_3 have the maximum range of (24°Brix) while V_4 has higher (23°Brix) followed by V_5, V_6 and V_{11} (22 °Brix). The V_7, V_{12} and V_{13} variation have the least range (19 °Brix) followed by V_2 variation (19.8 °Brix) while V_1 and V_{10} have (20 °Brix) respectively. The other variations such as V_8 and V_9 have (21 °Brix) compared to standard (18 °Brix).

OPTIMIZATION OF JELLY

The Jelly prepared with the help of Jelly powder and CMC as characterized for its Appearance (Y_1), Colour (Y_2), Flavor (Y_3), Taste (Y_4), Texture (Y_5) and Overall Acceptability (Y_6) Measured for Response Variables.
The Peak viscosity of ingredients for jelly ranges fr

SENSORY PROPERTIES OF CMC INCORPORATED JELLY

The sensory properties of CMC incorporated Jelly was given in table-3.

Table-3 - Sensory properties of Jelly

Sl. No	Uncoded value		Appearance	Colour	Flavor	Taste	Texture	Overall acceptability
	X_1	X_2						
S	100	0	8	8	7	6	7	7
V_1	90	0.2	8	8	7	7	8	8
V_2	100	0.2	7	8	7	7	7	7
V_3	90	0.6	8	8	7	7	7	7
V_4	100	0.6	8	7	8	6	6	6
V_5	87.93	0.4	8	7	8	7	7	8
V_6	102.07	0.4	8	8	8	7	8	7
V_7	95	0.12	8	8	8	8	6	8
V_8	95	0.68	7	8	7	6	7	6
V_9	95	0.4	7	8	7	7	7	6
V_{10}	95	0.4	8	8	7	7	8	8
V_{11}	95	0.4	8	8	7	7	6	8
V_{12}	95	0.4	7	7	7	6	6	7
V_{13}	95	0.4	8	8	7	8	7	8

X_1 – Jelly powder X_2 – CMC

The appearance, colour and flavour of Jelly may be ranged from 7 to 8 while the taste, texture and overall acceptability may range from 6 to 8 respectively for the developed jelly.

TOTAL SOLUBLE SOLIDS (^{0}BRIX) OF THE PREPARED JELLY

The Total Soluble Solids (TSS) of V_3 have the maximum range of (24 °Brix) while V_4 has higher (23 °Brix) followed by V_5, V_6 and V_{11} (22 °Brix). The V_7, V_{12} and V_{13} variation have the least range (19 °Brix) followed by V_2 variation (19.8 °Brix) while V_1 and V_{10} have (20 °Brix) respectively. The other variations such as V_8 and V_9 have (21 °Brix) compared to standard (18 °Brix).

EFFECT OF VARIABLES ON JELLY

Regression analysis and ANOVA were conducted on the fitted model to examine the statistical significance of model terms. The estimated regression coefficients of the quadratic polynomial models for the response variables along with the corresponding R^2 and coefficient of variation values are given.

APPEARANCE

Table-4 - ANOVA and estimated coefficients for Appearance of Jelly

Source	Coefficient	df	SS	F-value	P-value Prob>F
Model	7.60	5	0.72	0.49	0.78
X_1	-0.13	1	0.13	0.43	0.53
X_2	-0.52	1	0.02	0.07	0.79
X_1^2	0.20	1	0.28	0.95	0.36
X_2^2	-0.05	1	0.02	0.06	0.81
X_1X_2	0.25	1	0.25	0.85	0.39
Residual		7	2.05		
Lack of fit		3	0.85		
R^2	0.26				
Adj R^2	-0.27				
Pred R^2	-1.87				
Adeq R^2	2.04				
Std Dev	0.54				
C.V%	7.04				

df —> Degree of freedom **X_1** —> Jelly powder
SS—>Sum of squares **X_2** —> CMC
* —>5% level of significant ** —>1% level of significant

COLOUR

The polynomial model and estimated coefficients for Colour of Jelly are given in the below table-5.

Table-5 -ANOVA and estimated coefficients for Colour of Jelly

Source	Coefficient	df	SS	F-value	P-value Prob>F
Model	7.80	5	0.65	0.55	0.73
X_1	0.05	1	0.02	0.09	0.77
X_2	-0.13	1	0.13	0.53	0.49
X_1^2	0.10	1	0.16	0.66	0.44
X_2^2	-0.25	1	0.07	0.29	0.60
X_1X_2	-0.15	1	0.25	1.06	0.34
Residual	-	7	1.65	-	-
Lack of fit	-	3	0.85	1.42	0.36
R^2	0.28				
Adj R^2	-0.23				
Pred R^2	-2.17				
Adeq R^2	2.27				
Std Dev	0.49				
C.V%	6.26				

df —> Degree of freedom **X_1** —> Jelly powder
SS—>Sum of squares **X_2** —> CMC
* —>5% level of significant ** —>1% level of significant

ANOVA showed that the models were not significant for Colour of the Jelly. The lack of fitness of the model is not significant. The R^2 value of the CMC incorporated Jelly as 0.28 for the regression model, which shows 28% variability in the data

FLAVOUR

The polynomial model and estimated coefficients for Flavour of Jelly are given in the below table-6.

Table-6 -ANOVA and estimated coefficients for Flavour of Jelly

Source	Coefficient	df	SS	F-value	P- value Prob>F
Model	7.00	5	1.42	1.46	0.31
X_1	0.12	1	0.13	0.65	0.45
X_2	-0.05	1	0.02	0.11	0.75
X_1^2	0.38	1	0.98	5.06	0.06
X_2^2	0.13	1	0.11	0.56	0.48
X_1X_2	-0.05	1	0.25	1.29	0.29
Residual	-	7	1.35	0.19	-
Lack of fit	-	3	1.35	0.45	-
R^2	0.51				
Adj R^2	0.16				
Pred R^2	-2.47				
Adeq R^2	3.10				
Std Dev	0.44				
C.V%	6.02				

df —> Degree of freedom **X_1** —> Jelly powder
SS—>Sum of squares **X_2** —> CMC
* —>5% level of significant ** —>1% level of significant

ANOVA showed that the models were significant for Colour of the Jelly. The lack of fitness of the model is not significant. The R^2 value of the colour of CMC incorporated Jelly as 0.51 for the regression model, which shows 51% variability in the data.

TASTE

The polynomial model and estimated coefficients for Taste of Jelly are given in the below table-7.

Table-7 -ANOVA and estimated coefficients for Taste of Jelly

Source	Coefficient	df	SS	F-value	P- value Prob>F
Model	7.00	5	2.26	1.18	0.40
X_1	-0.13	1	0.13	0.33	0.58
X_2	-0.48	1	1.83	4.81	0.06
X_1^2	-0.06	1	0.03	0.07	0.79
X_2^2	-0.06	1	0.03	0.07	0.79
X_1X_2	-0.25	1	0.25	0.66	0.44
Residual	-	7	2.67	-	-
Lack of fit	-	3	0.67	0.45	0.73
R^2	0.46				
Adj R^2	0.07				
Pred R^2	-0.60				
Adeq R^2	3.65				
Std Dev	0.62				
C.V%	8.92				

df —> Degree of freedom **X_1** —> Jelly powder
SS—>Sum of squares **X_2** —> CMC
* —>5% level of significant ** —>1% level of significant

ANOVA showed that the models were significant for Taste of the Jelly. The lack of fitness of the model is not significant. The R^2 value of the CMC incorporated Jelly as 0.46 for the regression model, which shows 46% variability in the data.

TEXTURE

The polynomial model and estimated coefficients for Texture of Jelly are given in the below table-8

Table-8 -ANOVA and estimated coefficients for texture of jelly

Source	Coefficient	df	SS	F-value	P- value Prob>F
Model	6.80	5	1.21	0.30	0.9004
X_1	-0.07	1	0.043	0.053	0.8252
X_2	-0.07	1	0.043	0.053	0.8252
X_1^2	0.00	1	0.85	1.04	0.3409
X_2^2	0.35	1	0.16	1.19	0.6747
X_1X_2	0.15	1	0.000	0.000	1.0000
Residual	-	7	0.82		
Lack of fit	-	3	0.97	1.39	0.3681
R^2	0.17				
Adj R^2	-0.41				
Pred R^2	-2.62				
Adeq R^2	1.96				
Std Dev	0.90				
C.V%	13.10				

df —> Degree of freedom **X_1** —> Jelly powder
SS—>Sum of squares **X_2** —> CMC
* —>5% level of significant ** —>1% level of significant

ANOVA showed that the models were significant for Texture of the Jelly. The lack of fitness of the model is not significant. The R^2 value of the CMC incorporated Jelly was 0.17 for the regression model, which shows 17% variability in the data.

OVERALL ACCEPTABILITY

The polynomial model and estimated coefficients for Overall acceptability of Jelly are given in the below table-9.

Table-9 -ANOVA and estimated coefficients for Overall acceptability Jelly

Source	Coefficient	df	SS	F-value	P- value Prob>F
Model	7.00	5	4.85	0.97	1.97
X_1	0.12	1	1.46	1.46	2.95
X_2	-0.05	1	2.91	2.96	5.91
X_1^2	0.38	1	1.08	1.08	2.20
X_2^2	0.13	1	0.48	0.48	0.97
X_1X_2	-0.05	1	0.000	0.00	0.00
Residual	-	7	3.45		0.97
Lack of fit	-	3	0.25	0.49 0.085	0.11
R^2	0.51				
Adj R^2	0.16				
Pred R^2	-2.47				
Adeq R^2	3.10				
Std Dev	0.44				
C.V%	6.02				

ANOVA showed that the models were significant for Overall acceptability of the Jelly. The lack of fitness of the model is not significant. The R^2 value of the CMC incorporated jelly as 0.51 for the regression model, which shows 51% variability in the data.

OPTIMIZATION OF INDEPENDENT VARIABLES

For the optimization variables, the responses i e., Appearance, Colour, Flavor, Taste, Texture and Overall acceptability were selected on the basis that these responses had direct effect on the acceptability and quality of Jelly.

Table-10 -Criteria of optimum value for the responses

Process variable	Optimum value	Response	Optimum value
Jelly powder	90gm	Appearance	8
		Colour	8
CMC	0.4gm	Flavor	7
		Taste	7
		Texture	7
		Overall acceptability	8

To consider all the responses simultaneously for optimization, the multiple regression was used to get compromise optimum conditions and it as found that the scores were 8 for appearance, colour and overall acceptability while flavor, taste and texture have 7 as optimum level respectively. The optimum condition of jelly powder (X_1) 90gm and CMC (X_2) 0.4gm. the same findings were resulted by Nazni and Pradeepa, (2010).

SUMMARY AND CONCLUSION

Cloud is composed of a complex mixture of proteins, pectins, lipids, hemicellulose, cellulose and other minor components (Klavons *et al*. 1991; Baker and Cameron 1999). During storage, unstable turbid juices (freshly squeezed, concentrated or preserved) result in a cloud loss (Basak and Ramaswamy 1996, Parameshwari and Nazni, 2012). Cloud loss is objectionable to consumers who generally consider the presence of insoluble matter in clear beverages as an indicator of spoilage (Beveridge, 2002). The appearance, colour and flavour of Jelly may be ranged from 7 to 8 while the taste, texture and overall acceptability may range from 6 to 8 respective The Peak viscosity of ingredients for jelly ranges from 91-968RVU where as the standard peak viscosity was 8276RVU.

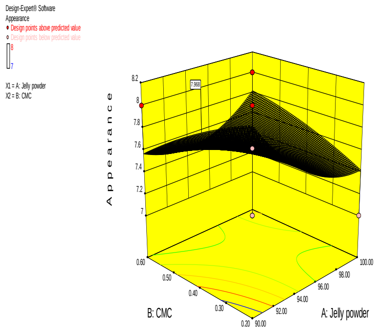

Figure-1 -3D graph for the Effect of CMC and Jelly powder on Appearance

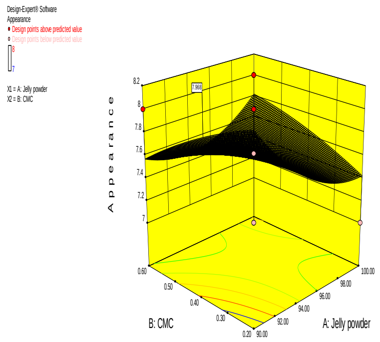

Figure-2 -3D graph for the Effect of CMC and Jelly powder on Colour

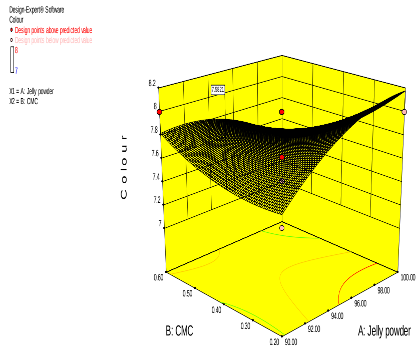

Figure-3 -3D graph for the Effect of CMC and Jelly powder on Flavour

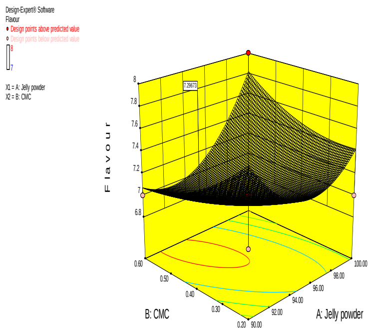

Figure-4 -3D graph for the Effect of CMC and Jelly powder on Taste

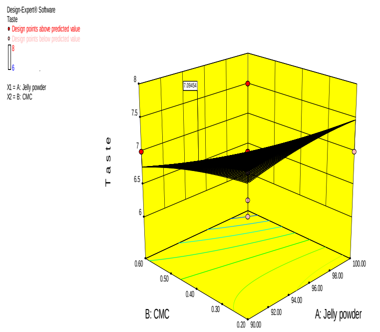

Figure-5 -3D graph for the Effect of CMC and Jelly powder on Texture

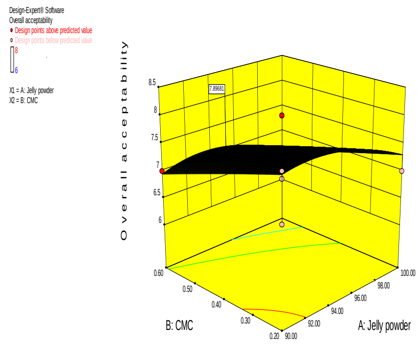

Figure-6 -3D graph for the Effect of CMC and Jelly powder on Overall acceptability

The Final viscosity of the ingredients for Jelly ranges from 57-424RVU, while for the standard value obtained was 8276RVU. The Set back is an index of retrogradation higher Set back (193RVU) in V_4 variation indicates cohesive paste and that starch will retrograde faster than other processed millet flour under the same condition. The Pasting temperature ranged between 50-60.95ºC.vely for the developed jelly. To consider all the responses simultaneously for optimization, the multiple regression was used to get compromise optimum conditions and it as found that the scores were 8 for appearance, colour and overall acceptability while flavor, taste and texture have 7 as optimum level respectively. The optimum condition of jelly powder (X_1) 90gm and CMC (X_2) 0.4gm. The Total Soluble Solids (TSS) of V_3 have the maximum range of (24 ^{O}Brix) while V_4 has higher (23^{O} Brix) followed by V_5, V_6 and V_{11} (22 ^{O}Brix). The V_7, V_{12} and V_{13} variation have the least range (19 ^{O}Brix) followed by V_2 variation (19.8 ^{O}Brix) while V_1 and V_{10} have (20 ^{O}Brix) respectively. The other variations such as V_8 and V_9 have (21 ^{O}Brix) compared to standard (18 ^{O}Brix)

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