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Optimization of parameters for the in-container manufacture of *kheer*

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Abstract
Kheer, a cereal- based dairy delicacy, is popular throughout India. The present investigation was undertaken to optimize the parameters for in-container manufacture of ready to eat *kheer*. The process parameters like pre-cooking time-temperature combination and combination of level of concentrated milk, rice and sugar were optimized using Response Surface Methodology to choose the best combination for acceptable quality of kheer. All the 20 experimental samples were evaluated for sensory and selected physico-chemical characteristics. A standardized process was developed for manufacture of kheer which consisted of Pre-cooking of rice at 90 ˚C for 10 min., blending of all raw materials and filled into cans which were subjected for thermal treatment in autoclave.

Keywords: *Kheer*, optimization, standardization, process, manufacture, Response surface methodology

Introduction
Kheer is deeply embedded in Indian traditional food habits and is a part of dietary pattern throughout the country. In spite of its religious value, nutritional significance and commercial potential, this product remained confined to domestic kitchens. Now a days people are more and more concern with their health, easy to use and availability of quality food. So the development of such kind of technology is more relevant in this era. As far as the demands of traditional dairy desserts are concerned considered, there is no methodology available for ready to eat desserts. In this fast moving world Indian people have also started preference to ready to eat foods rather than the conventional cooking. Most of the rural places in India have undergone urbanization. So the demand of readymade foods has drastically increased.
The increasing consumer demand for high quality convenient ready-to-eat food products has led to an increase in the commercial production of ready-to-eat products (Kamatt et al., 2005; Karadag and Gunes, 2008) [5]. The present study is planned to standardize the process for in-container manufacture of kheer and to evaluate the quality attributes of the kheer.

Material and Method
This experiment anticipated the process standardization for in-container manufacture of *Kheer*. It involved optimization of selected important process parameter such as varying level of milk concentration, rice and sugar addition which has influenced the quality of the final product. It involved pre-cooking of rice to improve rice cooking and viscosity of the final product. To carry out optimization of final product formulation, an advanced statistical software program named Design Expert 8.0.3 and Central Composite Rotatable Design (CCRD) was employed. These parameters act as base for deciding the final treatments as suggested by the software. Based on the trials (about 20), a standardized process was suggested by software. This standardized process of manufacture was replicated three times and final process was decided. All the trials and experimental samples manufactured were analyzed for their sensory quality.
The methodologies and materials employed for the trials leading to process standardization is described below:

Selection of Raw Materials
Milk: The standardized pasteurized milk having 4.5% milk fat and 8.5% SNF was used in preparation of kheer during all experimental trials.

Rice (Oryza sativa): Basmati long grain, variety of rice was selected for the preparation of kheer and obtained from the local market of Anand.

Sugar: A fine crystalline sugar (sucrose) of commercial grade was obtained from the local market of Anand.

Additives: Good quality green cardamom, nutmeg and *charoli* were obtained from the local market of Anand, Gujarat.

Standardization of Process for Manufacture of Kheer Response Surface Method (RSM) using design expert 8.0.3 software was used for the development of kheer and process standardization. Before Standardizing the various parameters and compositional attributes for the manufacture of kheer, various parameters and their ranges were selected. On the basis of the data of the previous studies and the preliminary trials the ranges of the selected three process parameters at varying levels *viz.* Level of concentration of milk, rice and sugar addition were selected. These ranges were entered in statistical tool i.e. Design Expert 8.0.3. Based on these data and the numbers of selected process parameters, it has suggested the treatments encompassing different combination or level of the selected process parameters (factors). The details of these combinations of treatments to be conducted as part of this experimentation for the manufacture of kheer is tabulated in Table 1. The process for manufacture of kheer as outlined in Fig 1 was employed and final product obtained thus were evaluated for their sensory characteristics. Based on the analytical results obtained from above 20 trials, the software suggested the optimized most desirable standardized process with appropriate experimental process parameters. This optimized process was then replicated three times. The mean result of the replications was compared with the values which were suggested by the software.

Concentration of Milk

Open Pan Concentration: A Batch type open pan (Khoa Kettle) was used for concentration of milk (Figure 2). The capacity of kettle was 40 liter and 10 liter of milk (4.5% fat & 8.5% SNF) was taken for the concentration. A steel scrapper was used for continuous agitation of milk to avoid burning of particle at the surface of kettle.

Scraped Surface Heat Exchanger: The SSHE used for concentration of milk was installed in the laboratory of Dairy Engineering, SMC College of Dairy Science, AAU, Anand (Figure 3).

Filling and Sealing of Cans: All the cans were filled manually at Dairy Engineering laboratory. Cans purchased from Kaira Can Company, Ltd., India. 300*203 SPGL/ARL cans were used. Concentrated milk, pre-cooked rice, sugar and flavouring were filled into each can manually at temperature 50-60 ˚C. Weight of each can was kept between 175-180gm. After that all the cans were sealed in a specially designed can sealer having a sealing capacity of 500-600 cans per minute (Figure 4).

Cooking Cum Sterilization: The sealed cans were immediately transferred to autoclave cage (Figure 5). It accommodates 50 cans.

Autoclave: For experiment on process development for long life kheer, the pilot-scale Autoclave Steam Sterilizer (Nova Instruments Pvt, Ltd. India) was used (Figure 6). The autoclave was having a chamber in which the product can be subjected to the required thermal process. Mild steel was used for its construction; the autoclave can withstand a working pressure of 1.0 bars. A 3.5 kW heater is provided at bottom level of the autoclave to heat the water for steam production. A float valve is provided for indication of water level. Pressure gauge, safety valve and pressure relief valve is provided at the top of the cover. The autoclave was operated at the set time temperature combinations during all the thermal treatment. It was set at 118˚C for 15 min. at steam pressure of 1.0 bar.

Cooling of Cans: At the ends of the heating cycle cans were taken out from the autoclave and cooling was done with potable water. Cans were immersed into the cooled water at a 22-25˚C to bring down the can temperature up to 30–40˚C.The cooled cans were then removed from the water and wiped with clean & dry cloth.

Sensory Evaluation: The quality of products prepared in the autoclave were judged by a panel of 8 judges with 9 point hedonic score card.

Table 1: Experimental Design Expert Response Surface Methodology for levels of factors: Concentration of milk, Rice and sugar addition.

Run	A: Concentration of Milk	B:Rice % of Conc. Milk	C:Sugar % of Conc. Milk
1	2.0	3.6	11.0
2	2.0	7.0	11.0
3	2.5	5.0	9.0
4	1.5	9.0	9.0
5	1.2	7.0	11.0
6	1.5	5.0	13.0
7	2.0	7.0	11.0
8	2.5	9.0	9.0
9	1.5	9.0	13.0
10	1.5	5.0	9.0
11	2.0	7.0	7.6
12	2.0	7.0	11.0
13	2.0	7.0	11.0
14	2.5	5.0	13.0
15	2.0	10.4	11.0
16	2.0	7.0	11.0
17	2.5	9.0	13.0
18	2.0	7.0	14.4
19	2.8	7.0	11.0
20	2.0	7.0	11.0

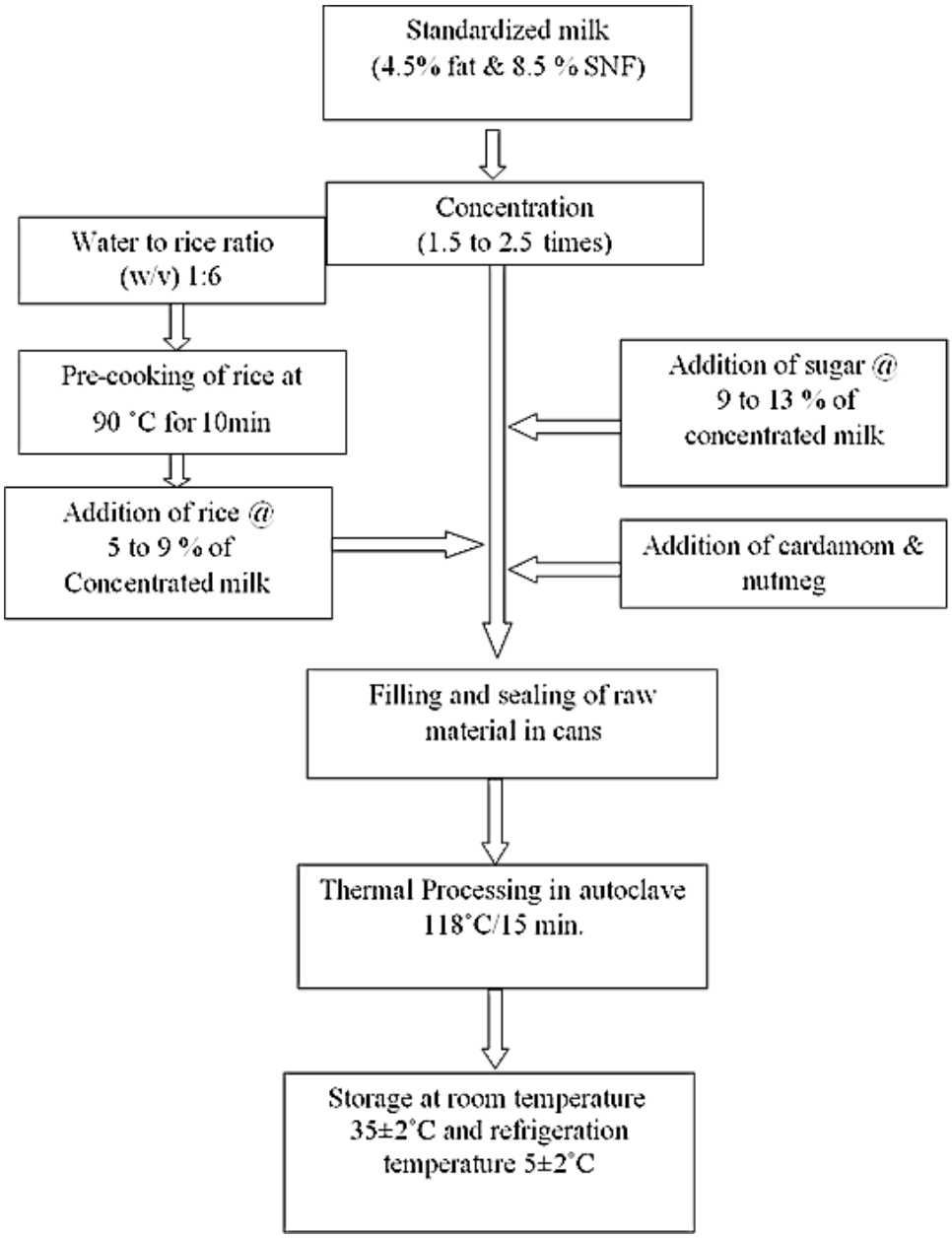

Fig 1: Flow Diagram for Manufacture of *Kheer*

Fig 2: Open Pan Kettle

Fig 3: Scraped Surface Heat Exchanger

Fig 4: Sealing Machine

Fig 5: Cage

Fig 6: Autoclave

Results and Discussion

The data obtained during this investigation were statistically analyzed employing Design Expert 8.0.3 and results interpreted. The preliminary trials were conducted to develop a tentative method for manufacture of kheer (Chauhan *et al*., 2018) [1]. Response surface methodology (RSM) is an effective tool for optimizing a variety of food processes (Ozdemir et al., 2008; Singh et al., 2010) [6, 7]. The kheer prepared with different levels of rice, milk concentration and sugar addition as shown in design matrix of three factor CCRD deign consisting of 20 experiments as shown in Table 1 were evaluated for sensory characteristics.

Effect of Different Levels of Milk Concentration, Level of Rice and Level of Sugar on Sensory Properties of Kheer

The sensory data along with formulations as per their run order is shown in Table 2. The scores of flavour, body, colour and appearance and overall acceptability were well fitted in quadratic model. The quadratic model for sensory parameters namely flavour, body, colour and appearance and overall acceptability were obtained through successive regression analysis. The model F values (Table 4) for flavour, body, colour and appearance and overall acceptability were 23.56, 13.81, 15.87 and 8.71 respectively. It can be observed from Table 4 that the calculated F values are more than the Table F values at 5 per cent level of significance which indicate the significance of the model terms. Furthermore, the coefficient of determination (R2) shown in Table 4 which reflects the proportion of variability in data explained or accounted by the model for flavour, body, colour and appearance and overall acceptability score were 0.95, 0.93,0.93 and 0.89 respectively. A larger R2 values suggest a better fit of the quadratic model. The adequate precision measures the signal to noise ratio, the value of which should be greater than 4.0. The adequate precision value for flavour, body, colour and appearance and overall acceptability were 13.54, 10.36, 10.16 and 9.59 respectively, which were greater than 4, hence it is considered to be supporting the suitability of the model to navigate the design.

Effect on Flavour of *Kheer*: The most important criteria for evaluating the quality of traditional Indian dairy products are flavour, which in turn determines its acceptability. The flavour score of *kheer* ranged from 5.5 to 8.0 on 9 point hedonic scale. *Kheer* prepared by using level of milk concentration 2.5 times, scored the lowest for flavour by the panelists (Table 2).

The coefficient of determination (R^2) is the proportion of variability in the data explained or accounted for the model and high value (0.95) of R^2 (Table 4) indicate a better fit of the model to the data. Also the adequate precision value of 23.56 recommends the use of this response to navigate the design.

Table 2: Experimental design matrix and sensory scores of *kheer*

Run Order	Milk Conc. (A)	Level of Rice (% of conc. mik) (B)	Level of Sugar (% of conc. milk) (C)	Flavour Score	Body Score	C&A* Score	OA# Score
1	2.0	3.6	11.0	5.8	5.5	5.7	5.5
2	2.0	7.0	11.0	8.0	8.1	8.0	8.2
3	2.5	5.0	9.0	5.5	6.5	5.6	7.0
4	1.5	9.0	9.0	7.8	6.7	7.8	7.5
5	1.2	7.0	11.0	8.0	6.0	7.0	7.0
6	1.5	5.0	13.0	7.8	7.5	7.8	7.6
7	2.0	7.0	11.0	8.0	8.1	8.0	8.2
8	2.5	9.0	9.0	5.8	7.0	7.0	7.2
9	1.5	9.0	13.0	7.9	7.0	7.2	7.6
10	1.5	5.0	9.0	7.5	6.8	7.2	6.8
11	2.0	7.0	7.6	6.7	7.8	7.8	7.5
12	2.0	7.0	11.0	8.0	8.1	8.0	8.2
13	2.0	7.0	11.0	8.0	8.1	8.0	8.2
14	2.5	5.0	13.0	5.8	6.0	7.0	7.2
15	2.0	10.4	11.0	6.2	6.1	6.0	5.7
16	2.0	7.0	11.0	8.0	8.1	8.0	8.2
17	2.5	9.0	13.0	5.6	7.3	6.5	7.2
18	2.0	7.0	14.4	7.8	7.5	7.6	7.9
19	2.8	7.0	11.0	6.0	6.5	6.0	6.7
20	2.0	7.0	11.0	8.0	8.1	8.0	8.2

*Colour and Appearance; #Overall Acceptability

Note: The sensory scores are based on 9 Point Hedonic Scale

The values presented in Table 3 reveal that the P value for level of milk concentration showed it's significant ($P \leq 0.01$) negative effect on flavour score, whereas the level of rice and sugar (@ concentrated milk) had non-significant ($P > 0.01$) effect on flavour score at linear level. However, milk concentration showed significant negative effect at quadratic level while level of rice and sugar (@ concentrated milk) showed non-significant negative effect at quadratic level. The negative sign indicates the negative significant effect on flavour score at quadratic level.

Table 3: P values and partial coefficients of regression equation of suggested model for sensory properties of *kheer*

Factors		Flavour		Body		Colour &Appearance		Overall Acceptability	
		P Value	Partial Coefficient	P Value	Partial Coefficient	P Value	Partial Coefficient	P Value	Partial Coefficient
Model		< 0.0001	7.99	0.0002	8.08	<0.0001	7.98	0.0011	8.17
Linear Level	A	< 0.0001*	-0.8540	0.7368	-0.0299	0.0006*	-0.3794	0.3281	-0.1028
	B	0.3172	0.0858	0.0981	0.1580	0.3595	0.0735	0.3565	0.0966
	C	0.0611	0.1720	0.8399	0.0179	0.8788	0.0119	0.2235	0.1298
Interactive Effect	A×B	0.7322	-0.0375	0.0268#	0.2937	0.0071*	0.0625	0.6428	-0.0625
	A×C	0.7322	-0.0375	0.1977	-0.1562	0.5462	0.0625	0.5183	-0.0875
	B×C	0.4307	-0.0875	0.7073	0.0437	0.5462	-0.3375	0.4095	-0.1125
Quadratic Level	A^2	0.0014*	-0.3454	< 0.0001*	-0.5759	0.0002*	-0.4334	0.0060*	-0.3384
	B^2	< 0.0001*	-0.6990	< 0.0001*	-0.7350	<0.0001*	-0.6632	<0.0001*	-0.7892
	C^2	0.0089*	-0.2570	0.3596	-0.081	0.9042	-0.0092	0.7053	-0.0379

*****Significant at 1 per cent level ($P < 0.01$), #Significant at 5 per cent level ($P < 0.05$)

Note: A: milk concentration, B: level of rice (% of concentrated milk) and C: level of sugar (% of concentrated milk

Table 4: Coefficients of selected models for sensory properties of *kheer*

Response	Suggested Model	Intercept	Model F Value	Adequate Precision	R^2
Flavour	QUADRATIC	7.99	23.56	13.54	0.95
Body	QUADRATIC	8.08	13.81	10.36	0.93
C & A[1]	QUADRATIC	7.98	15.87	10.61	0.93
OA[2]	QUADRATIC	8.17	8.71	9.59	0.89

Again as shown in Table 3, the P values of milk concentration and rice (AB), milk concentration and sugar (AC) as well as rice and sugar (BC) had a non-significant ($P > 0.01$) effect on flavour score of *kheer*.

The square of factor indicates the effect of ingredient at highest level used in the product standardization. A significant ($P \leq 0.01$) negative effect on flavour was found with the higher level of milk concentration (A^2) and level of rice (B^2) and sugar (C^2). Which indicates that increase in the level of milk concentration, level of rice and level of sugar decrease the flavour score of the *kheer*.

A Multiple Regression equation is generated to predict the flavour score as affected by different factors in terms of actual factors which is shown below where, A,B and C refer to the milk concentration, level of rice and level of sugar respectively.

Flavour	=	–14.7334 + 4.494361A + 2.805127B + 1.728088C - 0.0375AB -0.0375AC -0.02187BC – 1.38186A^2– 0.17475B^2 – 0.06427C^2

The response surface plots for the values obtained are shown in Fig 7, Fig. 8 and Fig. 9 which are based on the above model with varying levels of the two variables studied within the experimental range. These observations suggest that milk concentration was affects the flavour score of *kheer* by

increasing it significantly (P<0.01), the effect being higher but on negative up on increase of concentration. The rice and sugar has non-significant (P>0.05) effect on flavour score but negative on increase of addition.

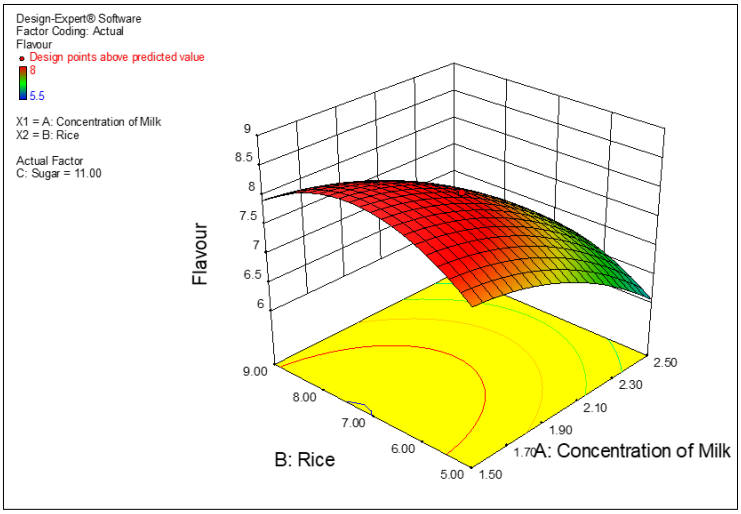

Fig 7: Response surface of flavour as influenced by level of milk concentration (A) and level of rice (B)

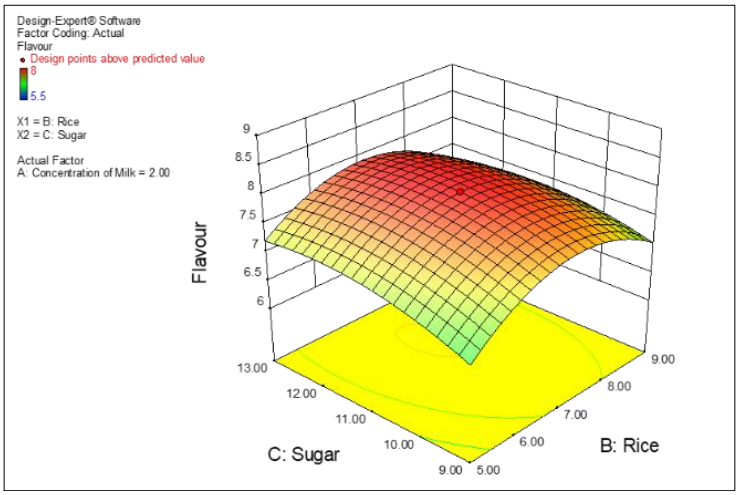

Fig 8: Response surface of flavour as influenced by level of rice (B) and level of sugar(C)

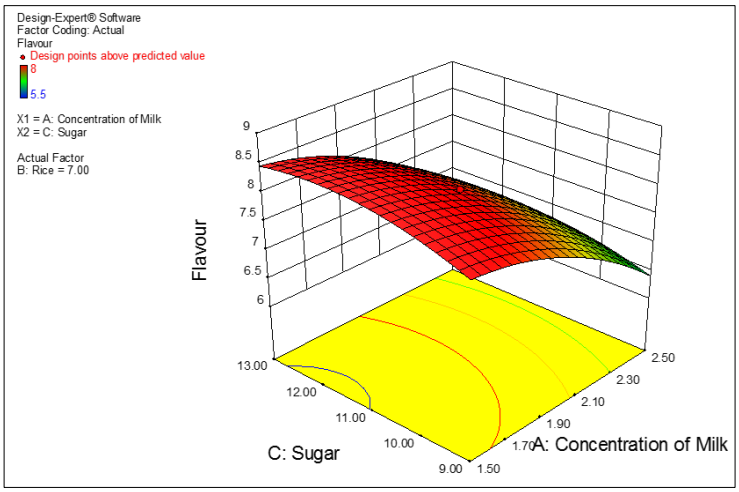

Fig 9: Response surface of flavour as influenced by level of milk (A) and level of sugar(C)

Effect on Body of *Kheer*: Body is the standing up properties of food. Texture is that property of food which is associated with the sense of feel or touch experienced by fingers or the mouth. The body scores of *kheer* depicted in Table 2 indicated variation from 5.5 to 8.1 (out of 9) and the *kheer* prepared by using milk concentration @ 2 times, rice @ 3.6% (concentrated milk) and sugar @ 11% (concentrated milk) were rated lowest for body and texture score (Table 2). *Kheer* prepared by using milk concentration @ 2 times, rice @ 7% and sugar @ 11% per cent of concentrated milk scored the best for body by the panelists.

The coefficient of determination (R^2) is the proportion of variability in the data explained or accounted for the model and the high value (0.93) of R^2 indicate a better fit of the

model to the data as shown in Table 4. Also the adequate precision value of 10.36 recommends the use of this response to navigate the design.

The values presented in table 3 revealed that the P values of milk concentration (A), rice (B) as well as sugar (C) had a non-significant (P>0.05) effect on body and texture score of *kheer*. Also at extremely higher levels of milk concentration and rice, body scores decreased. Level of sugar had a non-significant positive effect on body score. At extremely high levels of milk concentration and level of rice the product became too thick and viscous resulting decrease in body scores.

Again as shown in Table 3, the P values of milk concentration and rice (AB) showed its significance in interactive terms. The positive sign indicates the positive effect of milk concentration and level of rice (AB) on body score. This indicates that the increase in milk conc. and level of rice increase the body and texture score significantly ($P \leq 0.05$).Milk concentration and sugar (AC) and rice and sugar (BC) had a non-significant (P>0.05) positive effect on body of *kheer* which indicates that both the ingredients are positively correlated and by increasing the level of one ingredient, the level of other ingredient has to be increased.

From Figure 10, Figure 11 and Figure 12 it can be observed that with increase in the level of concentrated milk, level of rice and sugar the scores for body increased up to the optimum level and then on further increase it gets reduced.

The square of factor indicates the effect of ingredient at highest level used in the product standardization. A significant ($P \leq 0.01$) negative effect on body was found with the higher level of milk concentration (A^2) and level of rice (B^2) and level of sugar(C^2) had non-significant (P>0.05) with negative effect on body of *kheer*.

A Multiple Regression equation generated to predict the body as affected by different factors in terms of actual factors is shown below where, A, B and C refer to concentrated milk, level of rice and sugar (@ concentrated milk) respectively.

Body	=	-11.5979 + 8.8181A + 1.94399B + 0.6904C + 0.02937AB - 0.15625AC + 0.01093BC – 2.3039A^2– 0.18377B^2 – 0.02025C^2

The response surface plots for the values obtained are shown in Fig 10, Fig. 11 and Fig. 12 which are based on the above model with varying levels of the two variables studied within the experimental range

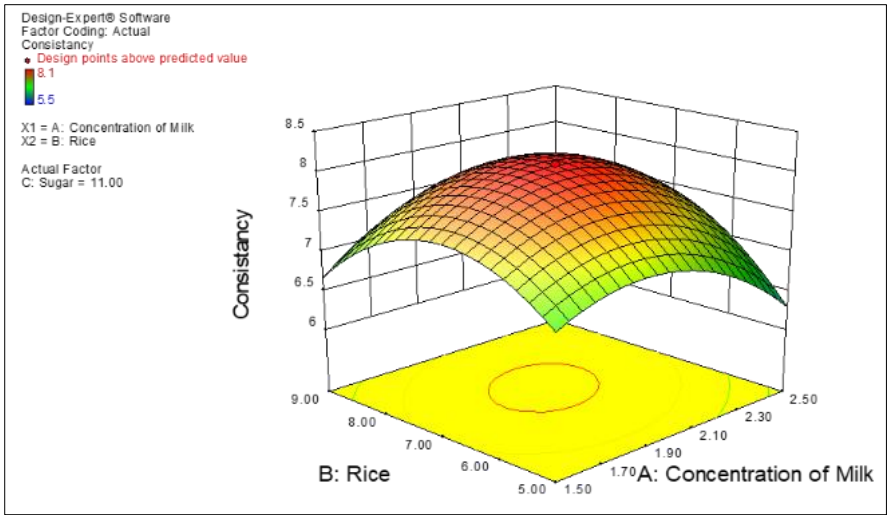

Fig 10: Response surface of body as influenced by level of milk concentration (A) and level of rice (B)

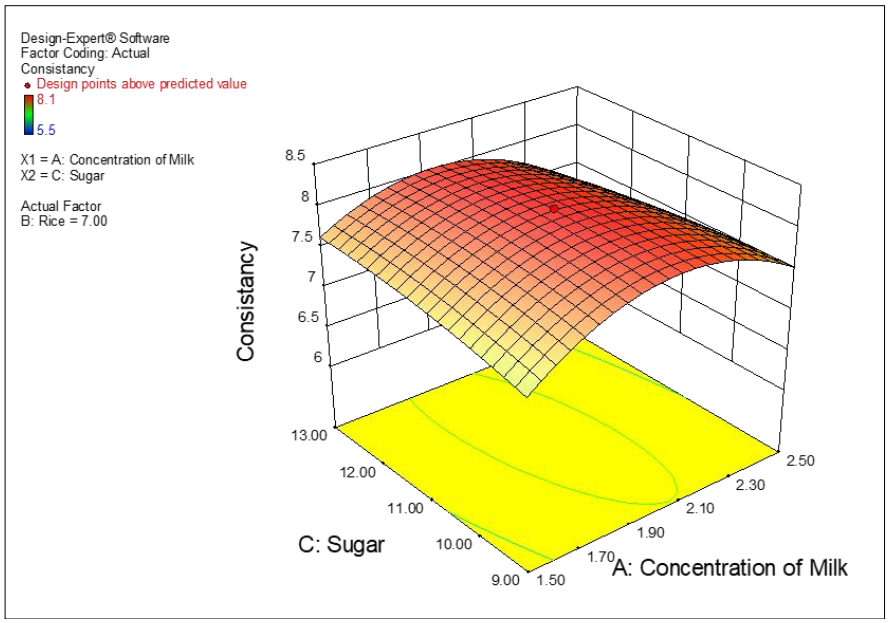

Fig 11: Response surface of body as influenced by level of milk concentration (A) and level of sugar (C)

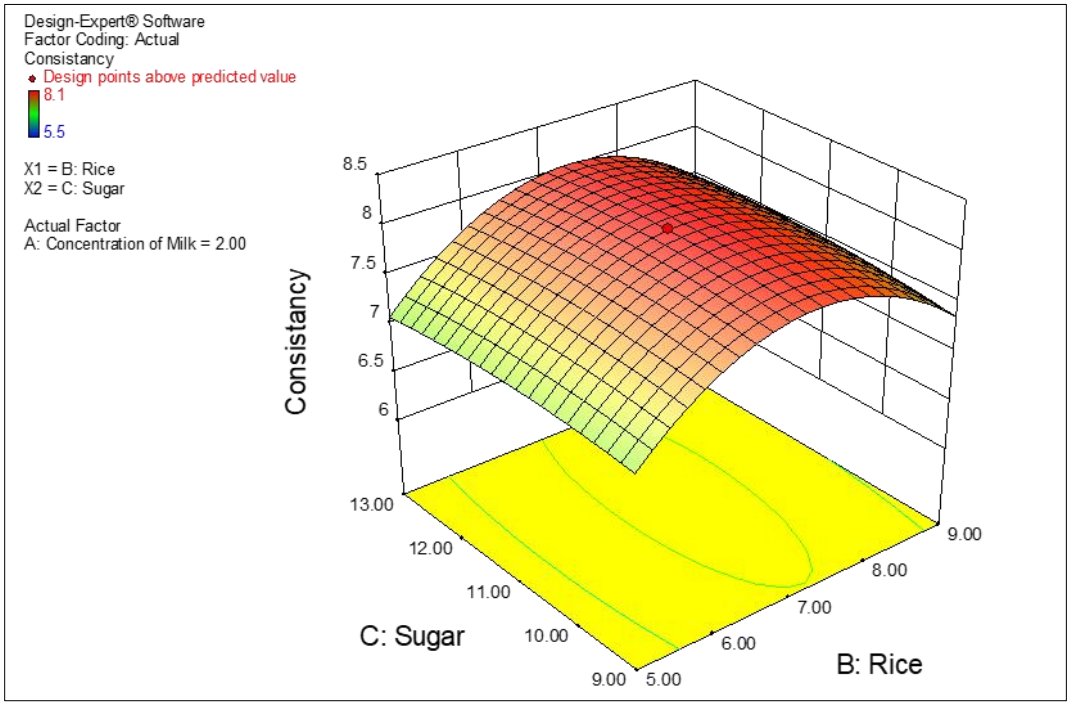

Fig 12: Response surface of body as influenced by level of rice (B) and level of sugar (C)

These observations suggest that concentrated milk and level of rice is affects the body score of *kheer* by increasing it significantly ($P \leq 0.01$), the effect being higher but positive on increase of addition. It can be seen from Table 2 that as level of milk concentration and level of rice increased up to the optimum level the body scores improved.

Effect on Colour and Appearance of *Kheer*: Colour and appearance of the product is the visual perception, which in turn, defines product quality. The colour and appearance scores of *kheer* depicted in Table 2 indicated variation from 5.6 to 8.0 (out of 9) and the *kheer* prepared by using level of milk concentration 2.5, level of rice @ 5% of concentrated milk and level of sugar @ 9% of milk concentrated were rated lowest for colour and appearance scores (Table 2). *Kheer* prepared by using milk concentration @ 2 times, level of rice @ 7% of conc. milk and level of sugar @ 11% of conc. milk scored the best for colour and appearance by the panelists.

The coefficient of determination (R^2) is the proportion of variability in the data explained or accounted for the model and the high value (0.93) of R^2 indicate a better fit of the model to the data as shown in Table 4. Also the adequate precision value of 10.61 recommends the use of this response to navigate the design.

The values presented in Table 3 revealed that the P values of the level of milk concentration showed its significance in linear terms. The negative sign indicates the negative effect of the level of milk concentration on the colour and appearance score. This indicates that the increase in the level of milk concentration decrease the colour and appearance score significantly ($P \leq 0.01$). Also at extremely higher levels of milk concentration, colour and appearance scores decreased. Level of rice and sugar had a non-significant positive effect on colour and appearance score at linear level Again as shown in Table 3, the P values of milk concentration and level of rice (AB) had a significant ($p \leq 0.01$) negative effect on colour and appearance which indicates increase of the level of concentrated milk and level of rice decrease the colour and appearance score of *kheer*. Milk concentration and level of sugar (AC), level of rice and level of sugar (BC) had a non-significant (P>0.05) positive effect on colour and appearance of *kheer*. From Figure 13, Figure 14 and Figure 15 it can be observed that with increase in the level of milk concentration, level of rice and level of sugar, the scores for colour and appearance increased up to the optimum level and then on further increase it gets reduced.

The square of factor indicates the effect of ingredient at highest level used in the product standardization. A significant ($P \leq 0.01$) negative effect on colour and appearance was found with the higher level of milk concentration (A^2), level of rice (B^2) and P value of level of sugar(C^2) had non-significant (P>0.05) negative effect on colour and appearance.

A Multiple Regression equation generated to predict the colour and appearance as affected by different factors in terms of actual factors is shown below where, A, B and C refer to milk concentration, level of rice and level of sugar respectively.

Colour & appearance	=	–10.4061 + 5.0515A +3.1613B + 0.5222C +0.0625AB + 0.0625AC – 0.08437BC – $1.7338A^2$– $0.16582B^2$ – $0.0023C^2$

The response surface plots for the values obtained are shown in Fig 13, Fig 14 and Fig 15 which are based on the above model with varying levels of the two variables studied within the experimental range. These observations suggest that when increased level of milk concentration and level of rice was added in *kheer*, it affects the colour and appearance score by increasing it significantly ($P \leq 0.01$), the effect being higher but negative on increase of addition.

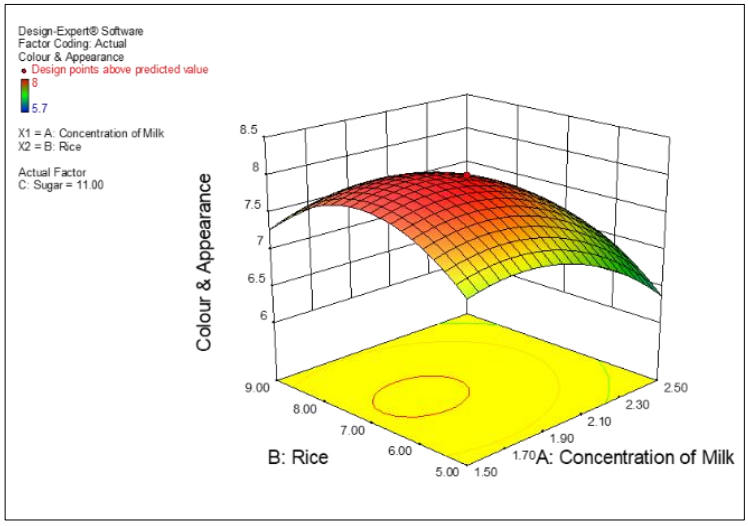

Fig 13: Response surface of colour and appearance as influenced by level of milk concentration (A) and level of rice (B)

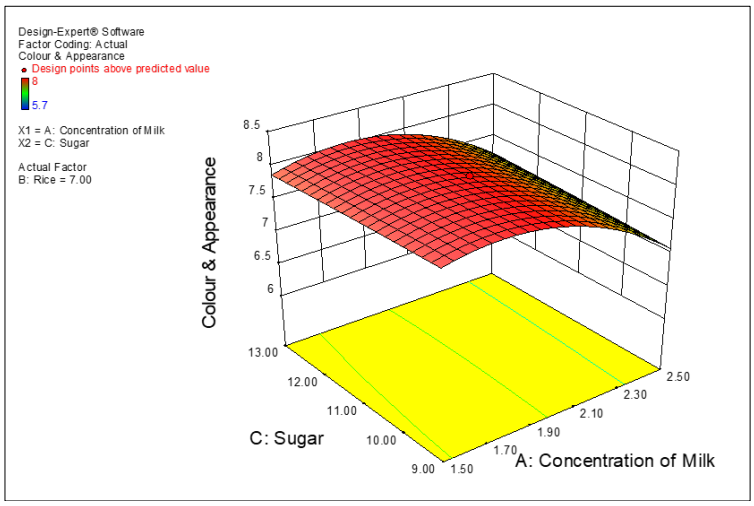

Fig 14: Response surface of colour and appearance as influenced by level of milk concentration (A) and level of sugar (C)

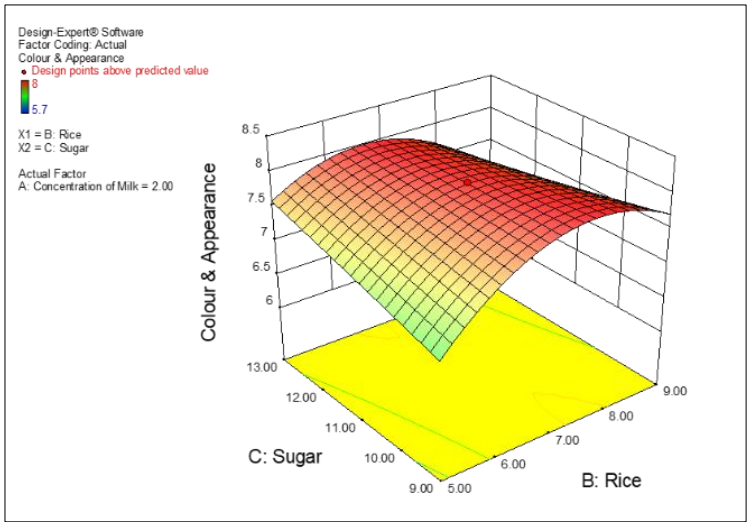

Fig 15: Response surface of colour and appearance as influenced by level of rice (B) and level of sugar (C)

Effect on Overall acceptability of *Kheer*: The overall acceptability is the indicative parameter of sensory quality of product in totality and consists of appearance, flavour, body characteristics. The overall acceptability scores of *kheer* depicted in Table 2 indicated variation from 5.5 to 8.2 (out of 9) and the *kheer* prepared by using milk concentration @ 2 times, level of rice @ 3.6% (concentrated milk) and level of sugar @ 11% (concentrated milk) were rated lowest for overall acceptability scores (Table 2). *Kheer* prepared by using milk concentration @ 2 times, level of rice @ 7% and level of sugar @ 11% scored the best for overall acceptability by the panelists (Table 2).

The coefficient of determination (R^2) is the proportion of variability in the data explained or accounted for the model and the high value (0.89) of R^2 indicate a better fit of the model to the data as shown in Table 4. Also the adequate

precision value of 9.59 recommends the use of this response to navigate the design.

The values presented in Table 3 revealed that the P values of level of milk concentration, level of rice and level of sugar showed its non-significance in linear terms. The negative sign indicates the negative effect of level of milk concentration on the overall acceptability score.

Again as shown in Table 3, the P values of milk concentration and level of rice (AB), milk concentration and level of sugar (AC) and level of rice and level of sugar (BC) had a non-significant (P>0.05) effect on overall acceptability of *kheer*. From Figure 16, Figure 17 and Figure 18 it can be observed that with increase in the level of milk concentration, level of rice and level of sugar, the scores for overall acceptability increased up to the optimum level and then on further increase it gets reduced.

The square of factor indicates the effect of ingredient at highest level used in the product standardization. A significant ($P \leq 0.01$) negative effect on overall acceptability was found with the higher level of milk concentration (A^2) and level of rice (B^2). This indicates that the increase in the level of milk concentration and level of rice decreases the overall acceptability score significantly ($P \leq 0.01$). Level of sugar (C^2) had a non-significant effect on overall acceptability score and it has a significant negative effect.

A Multiple Regression equation generated to predict the overall acceptability as affected by different factors in terms of actual factors is shown below where, A, B and C refer to milk concentration, level of rice and level of sugar respectively.

Overall acceptability	=	–13.6646 + 6.6090A + 3.2449B+ 0.64522C - 0.0625AB-0.0875AC-0.02812BC–1.3536A^2–0.1973B^2–0.00948C^2

The response surface plots for the values obtained are shown in Fig 16, Fig 17 and Fig 18 which are based on the above model with varying levels of the two variables studied within the experimental range.

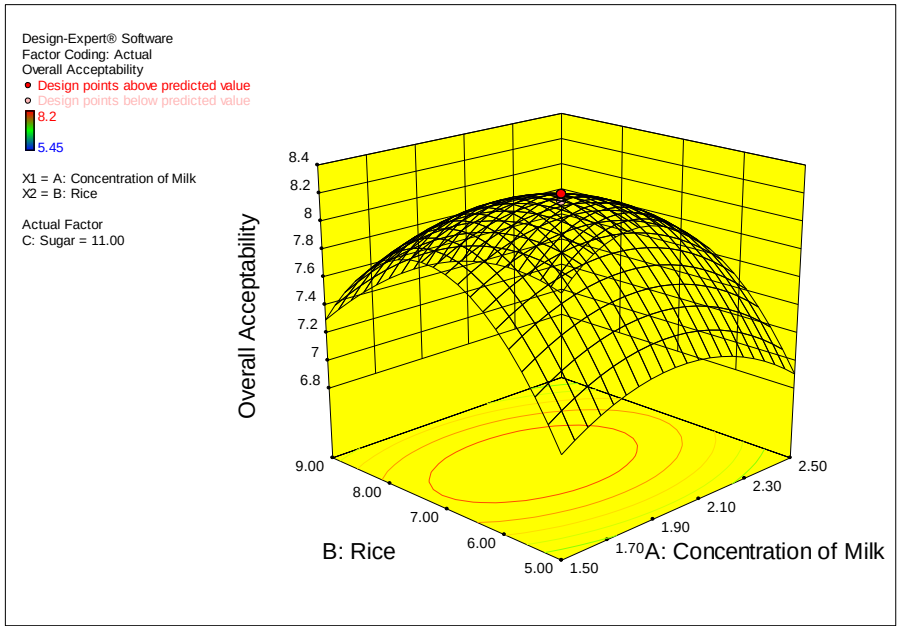

Fig 16: Response surface of overall acceptability as influenced by level of milk concentration (A) and level of rice (B)

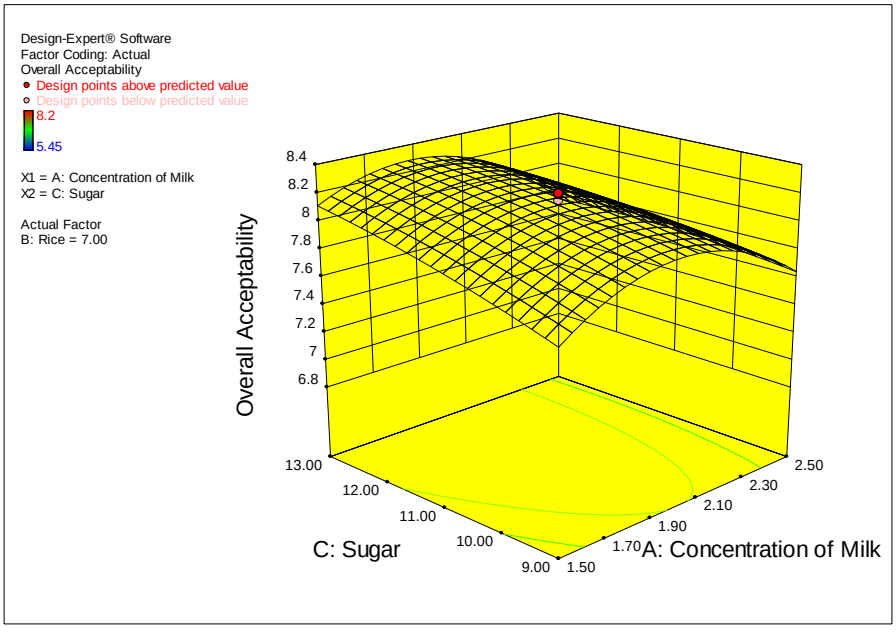

Fig 17: Response surface of overall acceptability as influenced by level of milk concentration (A) and level of sugar (C)

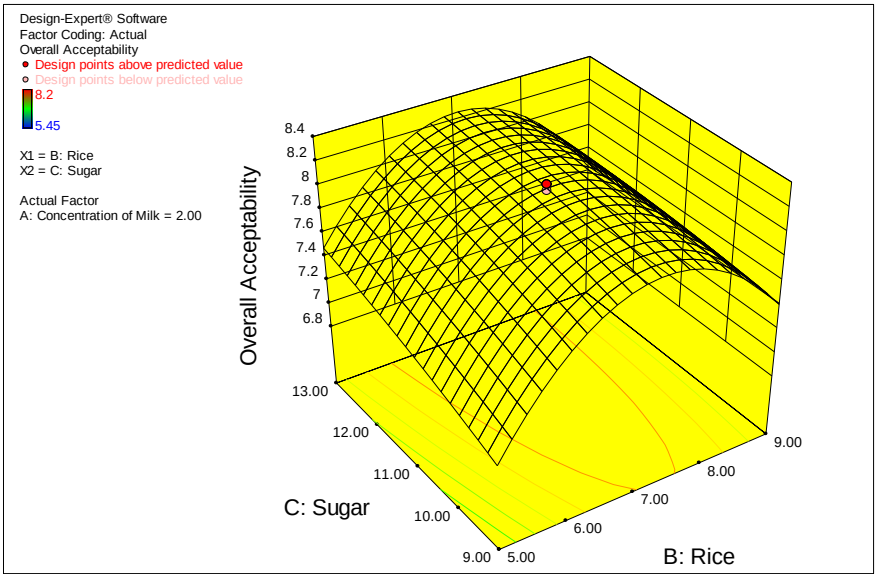

Fig 18: Response surface of overall acceptability as influenced by level of rice (B) and level of sugar (C)

These observations suggest that when milk concentration and per cent level of rice was added in *kheer*, it affects the overall acceptability score by increasing it significantly ($P \leq 0.01$), the effect being higher but negative on increase of addition. The sugar level had non-significant ($P > 0.05$) effect on overall acceptability score but negative significant ($P \leq 0.01$) effect on increase of addition.

Optimization of product formulation

Process optimization for the development of *kheer* was carried out with the objective of determining the best possible combination(s) of different levels of factors *viz.* milk concentration, level of rice(@ of concentrated milk) and level of sugar (@ of concentrated milk) that would lead to the most acceptable product in terms of sensory scores, compositional and physico-chemical attributes. The goals that were set for obtaining the best possible combination are illustrated in Table 5. The data were analyzed in Design Expert Package 8.0.3. Considering the constraints and their limits, the RSM suggested the one most suited solution (Table 6).

Table 5: Criteria/responses chosen for optimization process

Sr. No	Parameters	Goal	Lower Limit	Upper Limit	Level of Importance
1	Milk concentration	In range	1.5	2.5	3.0
2	Level of rice	In range	5.0	9.0	3.0
3	Level of sugar	In range	9.0	13	3.0
4	Flavour	Maximize	5.5	8.0	3.0
5	Body	Maximize	5.5	8.1	3.0
6	Colour and Appearance	Maximize	5.7	8.0	3.0
7	Overall acceptability	Maximize	5.6	8.2	3.0

Table 6: Suggested solution from RSM analysis for *kheer*

Solution No.	Solutions (%)			Desirability
	Milk concentration	Level of rice	Level of sugar	
1	2.0 (times)	7.0	11.50	0.99

Table 7: Predicted sensory scores of optimized *kheer* from RSM analysis

Solution No.	Flavour Score*	Body Score*	Colour and Appearance Score*	Overall Acceptability Score*
1	8.10	8.10	8.00	8.20

* Sensory scores obtained on 9 point hedonic scale

The final product was manufactured employing this suggested formulation and the actual results obtained were compared with these predicted values of the criteria/responses selected for process optimization. The calculated values of *t* for all the parameters are reported in Table 8. The values for t-test being less than the table values, it is inferred that there was no significant difference between the predicted and actual values of responses.

Table 8: Comparison of predicted v/s actual values of responses selected

Response	P Value	Predicted Value *	Actual Value @	Cal. t-Value#	Significance
Flavour[1]	0.14	8.10	8.03	1.74	NS
Body[1]	0.85	8.10	8.01	0.20	NS
Colour & Appearance[1]	0.06	8.00	7.96	2.24	NS
Overall acceptability[1]	0.38	8.20	8.17	0.95	NS

Sensory score on 9 point hedonic scale

* Predicted values of Design Expert 8.0.3 package

@ Actual values are average of five trials for optimized product
# t-values found non-significant at 5 per cent level of significance
NS = Non-significant
Tabulated t-value = 2.57 (Cal. t-value less than tabulated value)

On comparison of the predicted values of the responses under study with the actual values of the selected responses when the product was practically manufactured employing the suggested process parameters, it is confirmed that the selected combination is the best one in terms of the sensory and compositional responses delineated at the beginning of the study. The results are also validated statistically by t-test.

Conclusion

A standardized method of in-container manufacture of kheer was developed from this study. The optimized formulation consisted of level of milk concentration @ 2 times, addition of rice and sugar @ 7% and 11.5% of concentrated milk respectively.

References

1. Chauhan IA, Upadhyay JB, Patel RS. Development of a Process and Standardization of Parameters for the Manufacture of Kheer. International Journal of Advance Research and Innovation. 2018; 6(1):9-10.
2. De S, Thompkinson DK, Gahlot DP, Mathur ON. Studies on methods of preparation and preservation of kheer. Indian J Dairy Sci. 1976; 29:316-318.
3. Eapen KC, Mohan MS, Thangamani SR. The application of nisin lowering the process value of some canned Indian Dishes. Indian Food Packer. 1988; 42:15-18.
4. Kamatt SR, Chander R, Sharma A. Effect of radiation processing on quality of chilled meat products. Meat Sci. 2005; 69:269-275.
5. Karadag A, Gunes G. The effects of gamma irradiation on the quality of ready to cook meat balls. Turkish J veterinary and animal Sci. 2008; 32:269-274.
6. Ozdemir M, Ozen BF, Dock LL, Floros LD. Optimization of osmotic dehydration of diced green peppers by response surface methodology. Food Sci Technol. 2008; 41:2044–2050.
7. Singh B, Panesar PS, Gupta AK, Kennedy JF. Optimization of osmotic dehydration process of carrot cubes in mixtures of sucrose and sodium chloride solutions. Food Chem. 2010; 123:590–600.
8. Singh L, Mohan MS, Sankaran R. Nisin as an aid for thermal preservation of Indian dishes-upma and kheer. Indian J. Food Sci. and Technol. 1987; 24:277-280.
9. Srivatsa AN, Ramakrishna A, Gopinathan VK, Nataraju S, Leela RK, Jayaraman KS *et al*. Suitability of indigenously fabricated aluminium cans for canning of Indian foods. J. of Food Sci. and Technol. 1993; 30:429–434.