Influence of Partially Hydrolyzed Guar Gum, Psyllium and Inulin as on Physicochemical, Characteristics of *Shrikhand*

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ABSTRACT

Background: Generally cow or buffalo milk is used for manufacture of chakka, but we use cow milk. Inulin, PHGG and psyllium are a natural source of dietary fiber derived from chicory root, gaur gum and isabgol and so it has always been part of the human diet. As per WHO the requirement of dietary fiber in human diet is 23-27 gm/day. In order to solve this problem, dietary fiber can be used, which can improve sensory properties of products in addition to being functional. Milk and milk products considered as a vehicle for dietary fiber would not only take care of their own role in human health but could also enhance the heath fullness of the diet as a whole.

Methods: The process of development of fiber-enriched shrikhand was successfully optimized by using response surface methodology (RSM). The selected variables were different levels of fiber powder *viz.*, inulin (2-6%), psyllium (0.5-1.5%) and PHGG (2.5-7.5) and constant sugar concentration (40%). The levels of these factors were three and the experimental design was set up with experimental points having 6 replicates at the center. The center points of the experimental design were defined as 4% inulin 1% of psyllium and 5% partially hydrolyzed guar gum. Flavor, color and appearance, body and texture and overall acceptability were chosen as the responses. Each response is significantly affected by independent variables (p<0.05).

Result: The process was optimized by comparing inulin to 3.93%, psyllium 0.66% and 4.62% PHGG was suggested by the design expert software based on sensory evaluation. Optimized value shows a higher impact on the pH 4.37 ± 0.06^b, acidity 1.10 ± 0.02^a, viscosity (cp) 54.22 ± 0.06^a, fat (%) 6.10 ± 0.08^d, protein (%) 7.33 ± 0.07^a, moisture (%) 39.05 ± 0.08^e, ash (%) 3.48 ± 0.04^a, total solids (%) 60.95 ± 0.08^a, lactose (%) 2.14 ± 0.04^e, sucrose (%) 36.33 ± 0.02^d and TDF (%) 7.70 ± 0.04^a.

Key words: Dietary fiber, Inulin, Psyllium and Partially hydrolyzed gaur gum, *Shrikhand*.

INTRODUCTION

Shrikhand is a semi-solid, sweetish-sour fermented milk product is prepared by fermentation of milk with lactic acid bacteria expulsion of whey from the curd to yield chakka followed by mixing with sugar, flavoring agent and spices, charoli, cardamom, nutmeg, saffron and almond are added to improve the taste and nutritional quality. Generally, cow or buffalo milk is used for the manufacture of chakka which gives higher overrun and receives consumer preference (Aneja *et al.*, 1977). Nowadays, dietary fiber is gaining more importance in the human diet due to its important role in human health. As per WHO, the requirement for dietary fiber in the human diet is 23-27gm/day. Dietary fibers are the edible parts of plants or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine, with complete or partial fermentation in the large intestine. Dietary fiber includes two major classes depending on its intestinal solubility: soluble (pectins, mucilage and a large range of non-digestible oligosaccharides including inulin) and insoluble (cellulose, lignin) (Anita and Abraham, 1997). Inulin is a naturally soluble dietary fiber derived from chicory root, garlic, wheat, bananas and artichokes and so it has always been part of the human diet (Niness, 1999). Nutritionally, inulin and its derived fructooligosaccharides can stimulate health-promoting gut microflora, relieve constipation and improve calcium availability (Lopez-Molina *et al.*, 2005). The inulin

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dietary fiber contains moisture 4.82 per cent, protein 0.57 per cent, fat 0.52 per cent, total carbohydrate 97.47 per cent and minerals 0.31 mg zinc (Zn) /100 gm, 0.89 mg iron (Fe) /100 gm, 34.75 mg calcium (Ca) /100 gm and 31.59 mg potassium (K) /100 gm. (Mundannayake *et al.,* 2015). In India, the use of isabgol is as old as the Ayurveda system of medicine. The seeds are sweet, astringent, refrigerant, emollient, mucilaginous, diuretic, laxative, anti-inflammatory antiseptic, expectorant, aphrodisiac, roborant and tonic. The isabgol husk is used mainly for the treatment of stomach disorders, tri dosha, burning sensation, habitual constipation, strangury, gastritis, chronic diarrhea, dysentery and

colonalgia. Besides this, nowadays it is used in food industries for the preparation of buttermilk, shrikhand, ice cream, candy, *etc*. (Jat *et al.,* 2015). Guar gum is obtained from the seed of the guar plant, *i.e*., *Cyamopsis tetragonolobus*. Currently, guar gum is commercially utilized as a stabilizer and thickener in various products such as sauces, soups, dairy products and baked food products. Guar gum mainly consists of high molecular weight polysaccharides composed of galactomannans. The galactomannans generally have mannose to galactose in a ratio of 2:1. Partially hydrolyzed guar gum has been extensively studied for its beneficial action as a soluble dietary fiber. Native guar gum is a high molecular weight galactomannan that exhibits very high viscosity when dissolved in an aqueous solution. This property of guar gum makes it unfit for its use as a soluble dietary fiber as it cannot be incorporated into food products at the higher levels that are desired for physiological benefits. Hence, native guar gum is enzymatically hydrolyzed to prepare partially hydrolyzed guar gum having a low molecular weight and low viscosity. As a result, it can be used as a source of soluble dietary fiber for fortification in various food products without influencing their sensory quality as it is tasteless, colorless, odorless and very less viscous in nature. (Mudgil and Barak 2017). Dietary fibers have three primary mechanisms: bulking, viscosity and fermentation. The main actions of dietary fiber are to change the nature of the contents of the gastrointestinal tract and to change how other nutrients and chemicals are absorbed. Soluble fiber binds to bile acids in the small intestine, making them less likely to enter the body; this in turn lowers cholesterol levels in the blood. Soluble fibers also attenuate the absorption of sugar, reduce sugar response after eating and normalize blood lipid levels. Once fermented in the colon, they produce short-chain fatty acids as byproducts with wide-ranging physiological activities (FSSAI, 2010; EU, 2008). Milk and milk products considered as a vehicle for dietary fiber would not only take care of their own role in human health but could also enhance the health fullness of the diet as a whole. Hence considering the benefits of supplementation of fiber in the diet; concerning its nutritional, medicinal value and technological properties. It is decided to study the Inûuence of Partially Hydrolyzed Guar Gum, Psyllium and Inulin as on Physicochemical, Characteristics of *Shrikhand.*

MATERIALS AND METHODS

The whole, fresh, clean cow milk require for research was collect from the Cattle Cross Breeding Project, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani.

For preparation of dahi, culture was made available from parbhani local market. The *dahi* culture was used during the shrikhand preparation @ 1.5 per cent.

Chemicals

The readymade edible inulin powder was procured from Sanjeevanam AVA products and services AT-19/3, Murthy Nagar Kathirvedu, Chennai.

The edible psyllium powder was procured from NATURES VELVET LIFECARE, 103, Liberty Plaza, Himayat nagar, Hyderabad, Telangana.

The edible PHGG powder was procured from JSYS 703, Lotus Business Park, Rambaug Lane, Chincholi Bunder, off SV Road, Near HP Petrol pump, Malad West. Mumbai, Maharashtra-400 064.

All chemical of Analytical Reagent (AR) grade were obtained from Department of Animal Husbandry and Dairy Science, College of Agriculture, Vasantrao Naik Marathwada Krushi Vidyapeeth, Parbhani, (Maharashtra), India.

Preparation of *shrikhand*

The whole, fresh, clean cow milk require for research was collect from the Cattle Cross Breeding Project, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. This milk was standardized to 3.5 per cent fat before preparation of chakka. Shrikhand was prepared according to the method given by Patel, (2013). Process flow chart for the preparation of shrikhand is given in Fig 1.

Optimization of the fiber powder level for the preparation fiber enriched shrikhand

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 and Wrolstad, 2001; Klaypradit and 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 different levels of fiber powder *viz*., inulin (2-6%) psyllium (0.5-1.5%) and PHGG (2.5-7.5) and sugar concentration (40 %). respectively. The levels of these factors were three and experimental design was setup with experimental points having 6 replicates at the centre. A CCRD was used to design the experiments comprising of three independent processing parameters (Table 1). Twenty trials were performed taking into account three factors *viz*., level of inulin, psyllium and PHGG powder. A good model must be significant and the lack of fit must be insignificant. Coefficient of determination (R^2) values should be close to 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. flavour, colour and appearance, body and texture and overall acceptability were used as responses and were used as quality evaluating parameters for optimization of fiber enriched *shrikhand*.

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:

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 fiber enriched *shrikhand*.

$$Y= b_0+b_1X_1+b_2X_2+b_3X_3+b_4X_4+b_5X_5$$

Where,

Y= Response (dependent variable).
x_i= Level of inulin (coded independent variable).
x_2= Level of psyllium (coded independent variable).
x_3= Level of PHGG (coded independent variable).
b_0, b_1, b_2, b_3, b_4 and b_5= Response model coefficient.

Physico-chemical analysis of *shrikhand*

The Physico-chemical attributes of shrikhand were analyzed in terms of its Ph, Acidity, Viscosity (cp), Fat, Protein, Moisture, Ash, Total solids, Lactose, Sucrose and TDF at Department of Animal Husbandry and Dairy Science and College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani.

RESULTS AND DISCUSSION

It is evident from the Table 1. that the actual sensory score of fiber enriched *shrikhand* with inulin, psyllium and PHGG was slightly higher over predicted, though statistically the
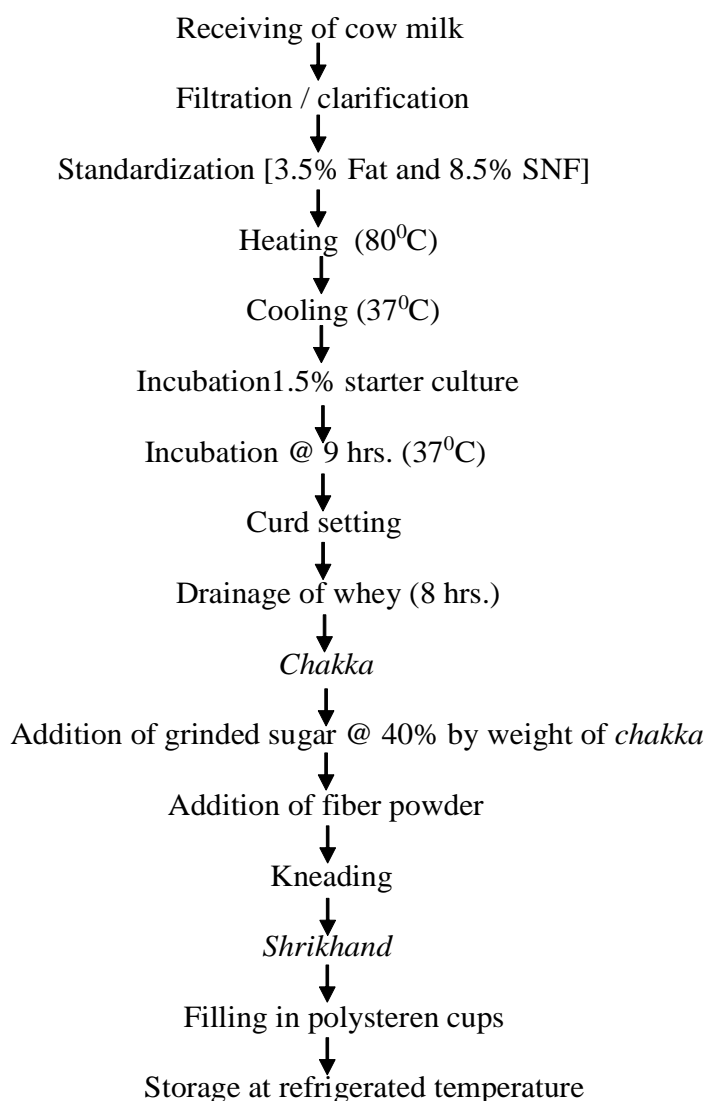
Receiving of cow milk

↓

Filtration / clarification

↓

Standardization [3.5% Fat and 8.5% SNF]

↓

Heating (80^{0}C)

↓

Cooling (37^{0}C)

↓

Incubation1.5% starter culture

↓

Incubation @ 9 hrs. (37^{0}C)

↓

Curd setting

↓

Drainage of whey (8 hrs.)

↓

Chakka

↓

Addition of grinded sugar @ 40% by weight of *chakka*

↓

Addition of fiber powder

↓

Kneading

↓

Shrikhand

↓

Filling in polysteren cups

↓

Storage at refrigerated temperature

Fig 1: Flow chart for preparation of *shrikhand* enriched with fiber powder.

difference was non-significant because calculated t value was less than the tabulated t value. The optimized combination comprising inulin 3.93%, psyllium 0.66% and 4.62% PHGG resulted in fiber enriched *shrikhand* rated 8.6 score which was for flavour, 8.5 for body and texture, 8.4 for colour and appearance and 8.5 for overall acceptability. Thus it had highly desirable sensory quality.

Physico-chemical composition of optimized and markets *shrikhand*

The best product selected on the basis of sensory evaluation was subjected to the further study along with market sample. Here the physico-chemical composition of optimized and market *shrikhand* were analyzed.

The requisite samples of *shrikhand* enriched with fiber and market samples were subjected for analysis *viz.* acidity, pH, fat, protein, sucrose lactose, moisture, total solid, total dietary fiber and ash. The result obtained on account of this parameter is presented in forthcoming table.

pH content of *shrikhand*

From the above Table 2 indicates that the mean pH value of optimized and market samples was 4.37, 4.08, 4.12, 4.43 and 4.55 per cent in O_1, M_1, M_2, M_3 and M_4, respectively. It is also observed that the lowest pH content was observed in M_2 and the highest in M_4 Treatment O_1 was significantly different from remaining all market samples except M_3 which were at par to each other. The pH of M_4 *shrikhand* sample was significantly superior (P<0.05) over markets and optimized samples, while M_1 and M_2 at par with each other.

Titratable acidity content of *shrikhand*

From the above Table 2 indicates that the mean titratable acidity content of optimized and market samples was 1.10, 1.02, 0.97, 1.03 and 0.98 per cent in O_1, M_1, M_2, M_3 and M_4, respectively. It is also observed that the lowest titratable acidity was observed in M_2 and the highest in O_1. Optimized sample O_1 was significantly different from remaining all market samples except M_3 which were at par to each other. The titratable acidity of M_2 and M_4 *shrikhand* sample at par with each other also M_1 and M_3 at par with each other.

Viscosity of *shrikhand*

From the above Table 2 it is observed that the mean of viscosity content of optimized and market samples was 54.22, 49.65, 50.55, 49.06 and 49.76 per cent in O_1, M_1, M_2, M_3 and M_4, respectively. The viscosity of optimized sample of *shrikhand* was significantly superior (P<0.05) over other markets samples; There is significant difference in viscosity content of *shrikhand* between all samples. It is also observed that the lowest viscosity was observed in M_3 and the highest in O_1.

Moisture content in *shrikhand*

From the above Table 2 it is observed that the mean of moisture content of optimized and market samples was 39.05, 42.32, 45.60, 43.12 and 44.11 per cent in O_1, M_1, M_2, M_3 and M_4, respectively. The moisture content of optimized sample O_1 of *shrikhand* was significantly inferior (P<0.05) over other markets samples; There is significant difference in moisture content of *shrikhand* between all samples. The

Table 1: Comparison of predicted and actual values of sensory parameters for validation of solution.

Parameter	Predicted score	Actual score*	Calculated *t value
Flavour	8.5	8.6	1.08 [NS]
Body and texture	8.4	8.5	1.12[NS]
Colour and appearance	8.1	8.4	1.26 [NS]
Overall acceptability	8.3	8.5	1.38 [NS]

*Average of triplicate experiments;
Table t 0.05 is 4.30.

Table 2: Significance of differences in mean values of physico-chemical comparison between optimized and market shrikhand.

Characteristics	Composition					CD at 5%
	Optimized	M_1	M_2	M_3	M_4	
pH	4.37±0.06[b]	4.08±0.02[c]	4.12±0.04[c]	4.43±0.03[b]	4.55±0.035[a]	0.0648
Acidity	1.10±0.02[a]	1.02±0.06[bc]	0.97±0.054[c]	1.03±0.034[ab]	0.98±0.014[c]	0.0849
Viscosity (cp)	54.22± 0.06[a]	49.65±0.07[d]	50.55±0.038[b]	49.06±0.060[e]	49.76±0.033[c]	0.0985
Fat (%)	6.10±0.08[d]	6.30±0.02[c]	6.57±0.033[b]	6.30±0.021[c]	6.76±0.025[a]	0.0509
Protein (%)	7.33±0.07[a]	6.49±0.06[d]	6.81±0.025[c]	6.99±0.029[b]	7.07±0.023[b]	0.0839
Moisture (%)	39.05±0.08[e]	42.32±0.01[d]	45.60±0.039[a]	43.12±0.41[c]	44.11±0.033[b]	0.0857
Ash (%)	3.48±0.04[a]	0.53±0.02[d]	0.94±0.032[c]	0.93±0.023[c]	0.99±0.019[b]	0.0414
Total solids (%)	60.95±0.08[a]	57.52±0.04[b]	54.20±0.022[e]	56.83±0.030[c]	55.94±0.52[d]	0.0797
Lactose (%)	2.14±0.04[e]	2.48±0.07[a]	2.32±0.025[b]	2.21±0.025[c]	2.34±0.030[b]	0.0786
Sucrose (%)	36.33±0.02[d]	41.74±0.07[a]	37.56±0.047[d]	40.54±0.044[b]	38.60±0.039[c]	0.0866
TDF (%)	7.70±0.04[a]	0.00±0.00[b]	0.00±0.00[b]	0.00±0.00[b]	0.00±0.00[b]	0.0320

moisture content of market sample M_2 of *shrikhand* was significantly superior (P<0.05) over other market and optimized sample. It is also observed that the lowest moisture content was observed in O_1 and the highest in M_2.

Fat content in *shrikhand*

From the above Table 2, it is observed that the mean of fat content of optimized and market samples was 6.10, 6.30, 6.57, 6.30 and 6.76 per cent in O_1, M_1, M_2, M_3 and M_4, respectively. The fat content of optimized sample O_1 of *shrikhand* was significantly inferior (P<0.05) over other markets samples; There is significant difference in fat content of *shrikhand* between all samples. The moisture content of market sample M_4 of *shrikhand* was significantly superior (P<0.05) over other market and optimized sample. It is also observed that the lowest fat content was observed in O_1 and the highest in M_4.

Protein content in *shrikhand*

From the above Table 2, it is observed that the mean of protein content of optimized and market samples was 7.33, 6.49, 6.81, 6.99 and 7.07 per cent in O_1, M_1, M_2, M_3 and M_4, respectively. The protein content of optimized sample O_1 of *shrikhand* was significantly superior (P<0.05) over other markets samples; There is significant difference in superior of *shrikhand* between all samples, except M_3 and M_4 at par with each other. The protein content of market sample M_1 of *shrikhand* was significantly inferior (P<0.05) over other market and optimized sample. It is also observed that the lowest protein content was observed in M_1 and the highest in O_1.

Sucrose content in *shrikhand*

From the above Table 2, it is observed that the mean of sucrose content of optimized and market samples was 36.33, 41.74, 37.56, 40.54 and 38.60 per cent in O_1, M_1, M_2, M_3 and M_4, respectively. The sucrose content of optimized sample O_1 of *shrikhand* was significantly inferior (P<0.05) over other markets samples; There is significant difference in *shrikhand* between all samples, except O_1 and M_1 at par with each other. The sucrose content of market sample M_1 of *shrikhand* was significantly superior (P<0.05) over other market and optimized sample. It is also observed that the lowest sucrose content was observed in O_1 and the highest in M_1.

Lactose content in *shrikhand*

From the above Table 2, it is observed that the mean of lactose content of optimized and market samples was 2.14, 2.48, 2.32, 2.21 and 2.34 per cent in O_1, M_1, M_2, M_3 and M_4, respectively. The lactose content of optimized sample O_1 of *shrikhand* was significantly inferior (P<0.05) over other markets samples; There is significant difference in *shrikhand* between all samples, except M_2 and M_4 at par with each other. The lactose content of market sample M_1 of *shrikhand* was significantly superior (P<0.05) over other market and optimized sample. It is also observed that the lowest lactose content was observed in O_1 and the highest in M_1.

Total solid content in *shrikhand*

From the above Table 2, it is observed that the mean of total solid of optimized and market samples was 60.95, 57.52, 54.20, 56.83 and 55.94 per cent in O_1, M_1, M_2, M_3 and M_4, respectively. The total solid content of optimized sample O_1 of *shrikhand* was significantly superior (P<0.05) over other markets samples; There was significant difference in *shrikhand* between all samples. The total solid content of market sample M_2 of *shrikhand* was significantly inferior (P<0.05) over other market and optimized sample. It is also observed that the lowest total solid content was observed in M_2 and the highest in O_1.

Ash content in *shrikhand*

From the above Table 2, it is observed that the mean of ash content of optimized and market samples was 3.48, 0.53, 0.94, 0.93 and 0.99 per cent in O_1, M_1, M_2, M_3 and M_4, respectively. The ash content of optimized sample O_1 of *shrikhand* was significantly superior (P<0.05) over other markets samples; There was significant difference in *shrikhand* between all samples, except M_2 and M_3 at par with each other. The ash content of market sample M_3 of *shrikhand* was significantly inferior (P<0.05) over other market and optimized sample. It is also observed that the lowest ash content was observed in M_3 and the highest in O_1.

TDF content in *shrikhand*

From the above Table 2, it is observed that the mean of dietary fiber content of optimized and market samples was 7.70, 0.00, 0.00, 0.00 and 0.00 per cent in O_1, M_1, M_2, M_3 and M_4, respectively. The ash content of optimized sample O_1 of *shrikhand* was significantly superior (P<0.05) over other markets samples; There was significant difference in *shrikhand* between optimize and market samples, It is also observed that the dietary fiber content absent was observed in market samples and the highest in O_1.

The results recorded for above in present investigation where comparable with below mentioned research worker. Chopade *et al.,* (2011) reported that the highest mean value of fat was found in treatment T_1 *i.e.* 8.15 T_1, followed by 7.68 T_3, 3.93 per cent T_2. The higher mean value (1.47) of titratable acidity was found in treatment T1. The higher mean value of protein was found in treatment *i.e.* 7.29, T_1 followed by 6.30 T3 and 3.56 per cent T2. The highest mean value of total solid was found in treatment *i.e.* 58.59 T_1, 55.58 T_2 and 47.04 per cent T_3.

Jaybhay (2020) reported that the average of moisture content in samples 40.50% to 44.09%. The total solid content in samples was 55.50% to 59.13%. The fat content in *shrikhand* samples were 8.33, 8.10, 5.73, 7.57 and 7.00 whereas the average protein content were 7.10, 7.12, 5.5, 5.75 and 7.20 in KS1, KS2, KS3, KS4 and KS5 respectively. However, the mean of total sugar content of *shrikhand* samples in KS1, KS2, KS3, KS4 and KS5 were 42.32, 43.43, 43.83, 43.25 and 41.68 percent respectively. The average acidity (% LA) of market sample of *shrikhand* KS1, KS2,

KS3, KS4, KS5, were 1.01, 1.20, 1.45, 1.00 and 1.50, respectively whereas, the pH in *shrikhand* sample was ranged from 4.00 to 5.13. The ash content in market sample of *shrikhand* ranged from 0.75 to 0.90.

CONCLUSION

In conclusion, the trials were conducted according to the experiments and CCRD were used to study the quality parameters of fiber enriched shrikhand at various levels of fiber powder. The RSM was used to optimize the processing conditions using physico-chemical analysis results shows that the addition of 4% inulin, 0.66% psyllium and 4.66% partially hydrolyzed gaur gum in *shrikhand* decreased moisture, fat, content significantly in finished product as compare to market sample. Per cent ash, fiber, total solid and total carbohydrate content were increased significantly in treated product as compared to market sample.

Conflict of interest: None.

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