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## Study the color parameters of fiber enriched and market shrikhand samples

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### Abstract

The present study was carried out for the Color Parameter of fiber-enriched shrikhand. 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. The results were represented by the L\* a\*, b\* notation 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. L Value of optimized and market samples were 85.91, 82.53, 80.57, 82.67 and 82.04 percent in O<sub>1</sub>, M<sub>1</sub>, M<sub>2</sub>, M<sub>3</sub> and M<sub>4</sub>, respectively, a value of optimized and market samples were 0.34, -1.05, 0.67, 0.77 and -1.10 percent in O<sub>1</sub>, M<sub>1</sub>, M<sub>2</sub>, M<sub>3</sub> and M<sub>4</sub>, and the b value of optimized and market samples was 17.09, 15.85, 15.80, 18.80 and 20.19 percent in O<sub>1</sub>, M<sub>1</sub>, M<sub>2</sub>, M<sub>3</sub> and M<sub>4</sub>, respectively. The fiber powder showed maximum influence on L a and b value.

**Keywords:** Dietary fiber, inulin, *Shrikhand*, psyllium and partially hydrolyzed guar gum

### 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) [1]. 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) [2]. 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) [15]. Nutritionally, inulin and its derived fructooligosaccharides can stimulate health-promoting gut microflora, relieve constipation, and improve calcium availability (Lopez-Molina *et al.*, 2005) [11]. The inulin dietary fiber contains moisture 4.82 percent, protein 0.57 percent, fat 0.52 percent, total carbohydrate 97.47 percent, 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) [13]. 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 colonicgia. Besides this, nowadays it is used in food industries for the preparation of buttermilk, shrikhand, ice cream, candy, etc. (Jat *et al.*, 2015) [9]. 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 2020) [14].

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) [5,4]. 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 color parameter of fiber enriched and market *shrikhand* samples.

### Materials and Method

The whole, fresh, clean cow milk require for research was collect from the Cattle Cross Breeding Project, Vasantrya 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 percent.

### Chemicals

The readymade edible inulin powder was procured from Sanjeevanam AVA products and services AT-19/3, Murthy Nagar Kathirvedu, Chennai-600066.

The edible psyllium powder was procured from NATURES VELVET LIFECARE, 103, Liberty Plaza, Himayat nagar, Hyderabad – 500029, 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-400064.

### Colour parameter

Colour measurements were conducted using Color Flex Calorimeter (at Department of Horticulture, Vasantrya Naik Marathwada Krishi Vidyapeeth, Parbhani) color measurement system equipped with dual beam xenon flash lamp and universal Software. The instrument was calibrated prior to

sample measurements with standard black, white and green tile as prescribed by the supplier. The results were represented by the  $L^*$   $a^*$ ,  $b^*$  notation. It is a 3D colour presentation method in which  $L^*$  is the lightness of colour and equals 0 for black and 100 for white. The  $a^*$  is the amount of red (0 to 60) or green (0 to -60) while  $b^*$  is the yellowness (0 to 60) or blueness (0 to -60).

### Preparation of shrikhand

The whole, fresh, clean cow milk require for research was collect from the Cattle Cross Breeding Project, Vasantrya Naik Marathwada Krishi Vidyapeeth, Parbhani. This milk was standardized to 3.5 percent fat before preparation of *chakka*. *Shrikhand* was prepared according to the method given by Patel, (2013) [16] Process flow chart for the preparation of *shrikhand* is given in Figure 1.

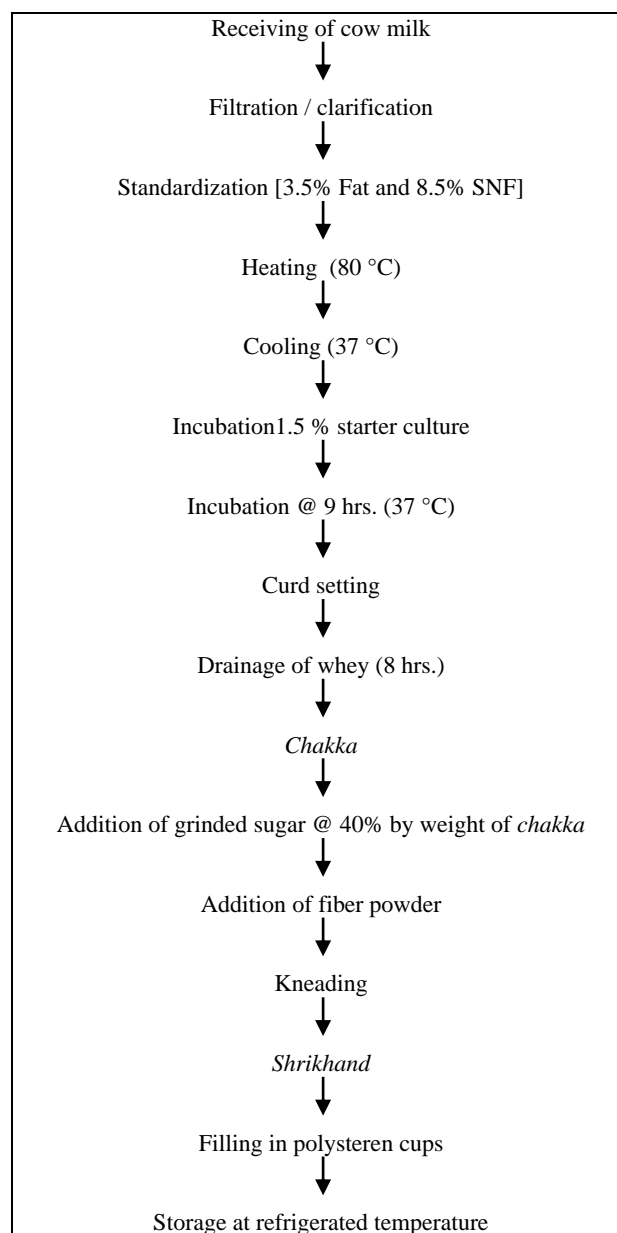


Fig 1: Flow chart for preparation of *shrikhand* enriched with fiber powder

### 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 & Wrolstad, 2001; Klaypradit & Huang, 2008) [17]. 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) [18]. 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 center. 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<sup>2</sup>) values should be close to R<sup>2</sup> explains the percentage of the variability of the result. The predicted R<sup>2</sup> value should be in reasonable agreement with the adjusted R<sup>2</sup>. 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 & appearance, body & 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<sub>1</sub> = level of inulin (coded independent variable),

X<sub>2</sub> = level of psyllium (coded independent variable),

X<sub>3</sub> = level of PHGG (coded independent variable)

b<sub>0</sub>, b<sub>1</sub>, b<sub>2</sub>, b<sub>3</sub>, b<sub>4</sub> and b<sub>5</sub> = response model coefficient.

### Sensory Evaluation

The organoleptic attributes of shrikhand were analyzed in terms of its flavour, color and appearance, body and texture and overall acceptability by a semi-trained panel consisting of ten members from the Department of Animal Husbandry and Dairy Science and College of Food Technology, Vasant Rao Naik Marathwada Krishi Vidyapeeth, Parbhani using nine point hedonic scales (Gupta 1976). (1 = dislike extremely; 9 = like extremely). Sensory evaluation was done at room temperature [7].

### Results and Discussion

#### Effect of Process Variables on Sensory Attributes of fiber enriched shrikhand

The results of experiments with the development of fiber enriched shrikhand were presented in Table 1 and criteria and outputs of the numerical optimization of the responses for fiber enriched shrikhand 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 inulin, psyllium and partially hydrolyzed gaur gum (%). Most desirable solution of the experiment and significant level of powder responses using RSM were obtained.

**Table 1:** Effect of addition of dietary fiber on sensory qualities of *shrikhand*.

| Standard Order | Inulin% | Psyllium% | PHGG% | Flavour | Colour and Appearance | Body and Texture | Overall acceptability |
|----------------|---------|-----------|-------|---------|-----------------------|------------------|-----------------------|
| 1              | 2.00    | 0.50      | 2.50  | 7.00    | 8.00                  | 8.50             | 7.80                  |
| 2              | 6.00    | 0.50      | 2.50  | 7.50    | 7.50                  | 8.00             | 7.60                  |
| 3              | 2.00    | 1.50      | 2.50  | 7.00    | 7.00                  | 6.50             | 6.80                  |
| 4              | 6.00    | 1.50      | 2.50  | 7.50    | 6.50                  | 6.00             | 6.60                  |
| 5              | 2.00    | 0.50      | 7.50  | 8.00    | 7.00                  | 8.00             | 7.60                  |
| 6              | 6.00    | 0.50      | 7.50  | 7.50    | 8.00                  | 7.50             | 7.60                  |
| 7              | 2.00    | 1.50      | 7.50  | 6.00    | 6.50                  | 6.50             | 6.30                  |
| 8              | 6.00    | 1.50      | 7.50  | 6.50    | 7.00                  | 6.50             | 6.60                  |
| 9              | 0.64    | 1.00      | 5.00  | 5.50    | 7.50                  | 7.50             | 6.80                  |
| 10             | 7.36    | 1.00      | 5.00  | 6.00    | 7.50                  | 7.00             | 6.80                  |
| 11             | 4.00    | 0.16      | 5.00  | 8.50    | 7.50                  | 8.00             | 8.00                  |
| 12             | 4.00    | 1.84      | 5.00  | 7.50    | 6.00                  | 5.00             | 6.10                  |
| 13             | 4.00    | 1.00      | 0.80  | 8.00    | 7.50                  | 7.50             | 7.60                  |
| 14             | 4.00    | 1.00      | 9.20  | 7.50    | 7.50                  | 7.50             | 7.50                  |
| 15             | 4.00    | 1.00      | 5.00  | 8.50    | 8.00                  | 8.50             | 8.30                  |
| 16             | 4.00    | 1.00      | 5.00  | 8.50    | 8.00                  | 8.00             | 8.10                  |
| 17             | 4.00    | 1.00      | 5.00  | 8.50    | 8.00                  | 7.50             | 8.00                  |
| 18             | 4.00    | 1.00      | 5.00  | 8.00    | 8.50                  | 8.00             | 8.10                  |
| 19             | 4.00    | 1.00      | 5.00  | 8.50    | 8.00                  | 8.00             | 8.10                  |
| 20             | 4.00    | 1.00      | 5.00  | 8.00    | 8.00                  | 8.50             | 8.10                  |

**Table 2:** Coefficient of full second order polynomial model for coded sensory responses to different levels of ingredients in fiber enriched *shrikhand*.

| Factor             | Flavour | Colour and appearance | Body and texture | Overall acceptability |
|--------------------|---------|-----------------------|------------------|-----------------------|
| Intercept          | 2.88    | 2.84                  | 2.84             | 2.85                  |
| A- Inulin          | *0.027  | **0.0068              | *-0.032          | ** -0.0011            |
| B- Psyllium        | -0.063  | 0.080                 | -0.16            | -0.10                 |
| C- PHGG            | *-0.026 | ** -0.0067            | ** -0.0056       | *-0.013               |
| A <sup>2</sup>     | -0.17   | *0.037                | *-0.049          | -0.084                |
| B <sup>2</sup>     | *-0.019 | *0.088                | -0.11            | -0.066                |
| C <sup>2</sup>     | *-0.034 | *0.037                | *-0.032          | *-0.034               |
| AB                 | *0.024  | ** -0.012             | **0.0096         | **0.007               |
| AC                 | *-0.022 | *0.058                | *0.03            | **0.017               |
| BC                 | -0.071  | **0.012               | *0.024           | ** -0.007             |
| R <sup>2</sup>     | 0.97    | 0.96                  | 0.96             | 0.98                  |
| Adequate Precision | 23.46   | 9.653                 | 20.002           | 21.79                 |
| PRESS              | 0.059   | 0.024                 | 0.094            | 0.032                 |
| Model 'F' value    | 43.50   | 8.62                  | 35.34            | 63.00                 |

\*Significant at 5% level \*\* Significant at 1% level

Only one formulation comparing inulin 3.93%, psyllium 0.66% and 4.62% PHGG was suggested by the design expert software and predicted sensory score was rated 8.6 for flavour, 8.3 for body and texture 8.1 for colour and appearance and 8.3 for overall acceptability. Verification of these formulations was done by preparing the product for three times and evaluated for their sensory status. Results presented in table 4.12 shows that predicted and actual score obtained by the suggested formulation.

**Table 3:** 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 <sup>NS</sup>  |
| Body and Texture      | 8.4             | 8.5            | 1.12 <sup>NS</sup>  |
| Colour and appearance | 8.1             | 8.4            | 1.26 <sup>NS</sup>  |
| Overall acceptability | 8.3             | 8.5            | 1.38 <sup>NS</sup>  |

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

It is evident from the table 3 that the actual sensory score of fiber enriched *shrikhand* with inulin, psyllium and PHGG was slightly higher over predicted, though statistically the

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.

#### Comparison of colour parameters between optimized and market *shrikhand*.

Colour of *Shrikhand* samples were measured by reflectance spectroscopy technique employing reflectance meter, Colourflex® (Hunter lab, Reston, Virginia, USA) supplied with the Universal Software (version 10). Before the test, the instrument was calibrated with standard black and white tiles as specified by the manufacturer. The light source was dual beam xenon flash lamp. The colour values *chakka* and *shrikhand* were expressed in terms of L\* (Lightness) ranging from 0 (black) to 100 (white), a\* (Redness) ranging from +60 (red) to -60 (green) and b\* (Yellowness) ranging from +60 (yellow) to -60 (blue) as per the international colour system. The samples were filled in sample container up the 0.8-1 mm height and measured at 20 °C. The colour indices of the samples were measured in triplicate.

**Table 4:** Significance of differences in mean values of colour parameters between optimized and market *shrikhand*.

| Characteristics | L* (Lightness)          | a* (Redness)            | b*(Yellowness)          |
|-----------------|-------------------------|-------------------------|-------------------------|
| Optimized       | 85.91±0.02 <sup>a</sup> | 0.34±0.01 <sup>b</sup>  | 17.09±0.02 <sup>c</sup> |
| M <sub>1</sub>  | 82.53±0.02 <sup>b</sup> | -1.05±0.01 <sup>d</sup> | 15.85±0.02 <sup>d</sup> |
| M <sub>2</sub>  | 80.57±0.21 <sup>d</sup> | 0.67±0.03 <sup>a</sup>  | 15.80±0.03 <sup>d</sup> |
| M <sub>3</sub>  | 82.67±0.03 <sup>b</sup> | 0.77±0.03 <sup>c</sup>  | 18.80±0.03 <sup>b</sup> |
| M <sub>4</sub>  | 82.04±0.06 <sup>c</sup> | -1.10±0.03 <sup>c</sup> | 20.19±0.03 <sup>a</sup> |
| CD at 5%        | 0.22134                 | 0.050813                | 0.054515                |

Values in a row with different superscripts are significantly different at  $p < 0.05$  1 L\* (Lightness)

L \* indicates the lightness of the product. A value of zero indicates complete dark (black) colour whereas 100 complete white.

The L\* (Lightness) value of *shrikhand* enriched with fiber and market samples were tabulated in table 4.

From the above table 4 it is observed that the mean of L Value of optimized and market samples was 85.91, 82.53, 80.57, 82.67 and 82.04 percent in O<sub>1</sub>, M<sub>1</sub>, M<sub>2</sub>, M<sub>3</sub> and M<sub>4</sub>, respectively. The L Value of optimized sample O<sub>1</sub> of *shrikhand* was significantly superior ( $p < 0.05$ ) over other

markets samples; There was significant difference in *shrikhand* between optimize and market samples, except M<sub>1</sub> and M<sub>3</sub>. It is also observed that the lowest L value was observed in market samples M<sub>2</sub> and the highest in O<sub>1</sub>.

#### 2 a\* (Redness)

The a\* (redness) value of *shrikhand* enriched with fiber and market samples were tabulated in table 4.

From the above table 4 it is observed that the mean of a value of optimized and market samples were 0.34, -1.05, 0.67, 0.77



and -1.10 percent in O<sub>1</sub>, M<sub>1</sub>, M<sub>2</sub>, M<sub>3</sub> and M<sub>4</sub>, respectively. The a value of optimized sample M<sub>4</sub> of *shrikhand* was significantly superior ( $p < 0.05$ ) over other markets samples; There was significant difference in *shrikhand* between optimized and market samples. It is also observed that the lowest a value was observed in market samples M<sub>4</sub> and the highest in M<sub>3</sub>

### 3 b\* (Yellowness)

The b\* (Yellowness) value of *shrikhand* enriched with fiber and market samples were tabulated in table 4.

From the above table 4 it is observed that the mean of b value of optimized and market samples was 17.09, 15.85, 15.80, 18.80 and 20.19 percent in O<sub>1</sub>, M<sub>1</sub>, M<sub>2</sub>, M<sub>3</sub> and M<sub>4</sub>, respectively. The b value of optimized sample M<sub>4</sub> of *shrikhand* was significantly superior ( $p < 0.05$ ) over other markets samples; There was significant difference in *shrikhand* between optimized and market samples except M<sub>1</sub> and M<sub>2</sub> at par with each other. It is also observed that the lowest a value was observed in market samples M<sub>2</sub> and the highest in M<sub>4</sub>.

Srinivas *et al.* (2017) reported that the control *shrikhand* with 40% sugar, L value 46.45, a value 10.75 and b value 6.16. The SWB *shrikhand* with 3% WPC and 0.5% beet root powder for that L value of 62.96, a value 13.17 and b value 6.99. The maximum colour change for *shrikhand* was observed in L\* value followed by a\* and b\* with respect to control sample and was significant at  $p < 0.05$  [18].

### Conclusion

For the development of fiber enriched *shrikhand* the optimum condition was obtained based on flavour, colour & appearance, body & texture and overall acceptability which were all significantly affected by the level of fiber powders. According to the results of the desirability (0.96) function the combination of a inulin 3.93%, psyllium 0.66% and 4.62% PHGG provided the best results in relation to the average score of flavour, colour & appearance, body & texture and overall acceptability of the fiber enriched *shrikhand* were 8.60, 8.40, 8.50 and 8.55 respectively.

In conclusion, the trials were conducted according to the experiments and CCRD were used to study the color parameters of fiber enriched *shrikhand* show there was significant difference in *shrikhand* between optimized and market samples.

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