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RESEARCH ARTICLE

Process development for goat milk shrikhand added with kiwi fruit

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ABSTRACT

This study was undertaken with the objectives of to develop nutritious goat milk shrikhand added with kiwi fruit pulp. Having the multifarious properties of goat milk and kiwi fruit. Chakka was prepared through goat milk with culture addition. The level of sugar and kiwi fruit pulp in goat milk chakka was optimized through RSM with 13 different samples. The best combination of shrikhand containing 6.85% kiwi fruit pulp and 40% sugar was selected on based on sensory analysis (9 point hedonic)i.e. sensory evaluation score was 8.00, 7.83, 7.91, 7.82, 7.87 for colour, sweetness, taste & flavour, texture & consistency and overall acceptability. The selected concentration was evaluated for sensory, Physico-chemical analysis. Kiwifruit is rich in vitamin C with good source of other nutrients such as folate protein, carbohydrate, potassium, and dietary fibre which is good for health and goat milk contains good amount of fat, protein, lactose and vitamins.

Keywords: Shrikhand, Kiwi, health benefits, goat milk, response surface methodology

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INTRODUCTION

India is one of the largest production hub of milk and milk product as well as byproduct of various milk products. India's market potential is unstable, but in future dairy fermented market potential is all set to boom highest for fermented milk products. Fermented products play an important role in human nutrition and the virtues of different products were known to humans during ancient period of civilization (Patange et al., 2018). An estimated 50 to 55 percent of the milk produced in India is converted into a variety of traditional milk products, using processes such as coagulation, desiccation and fermentation (Devi et al., 2018). Around 9 % of milk throughout the total production in India is used to produce fermented dairy products. Different dairy products are been produced i.e shrikhand, dahi, yogurt, flavoured acetic products, with different buttery milk fermented products using starter cultures.

The name Shrikhand is derived from the Sanskrit word "Shrikarini" which means a curd prepared with the addition of sugar, flavouring material, etc. In western india, shrikhand is a semisolid, sweetish-sour wholesome, indigenous fermented milk product. (Shridharrao 2012).

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In Asian and African countries, specifically in India, goat and sheep milk plays a significant role in the national and especially the rural economy. Goat and sheep milk is widely used for home consumption and to produce different cheeses and yoghurt, which makes them of particular economic value in countries (Pandya et al., 2007). Among important nutrients which are found in goat milk fat, protein, lactose, vitamins, enzymes and mineral salts, etc. Most of the components of goat milk are greater than that of other milk producing animals. For instance, goat's milk contains 25% more vitamin B6, 47% more vitamin A and 13% more calcium than cow's milk (Getaneh et al., 2016)

Fruit and vegetables contain significant levels of biologically active components with physiological and biochemical functions which benefit human health (Tavarini et al., 2007). Anyhow now a day's peoples are aware of health consciousness and how fruits having antioxidant, nutritional benefits and having different vitamins which enhances human body. The kiwi fruit which is known as "Actinidia deliciosa" in scientific language is originated from the valley of northern China and Zhejiang Province on the coast of eastern China is now famous and is been cultivated to many different country.

Kiwi fruit is now worldwide famous having its different nutritional properties such as bioactive compounds with antioxidant activity, high in fiber, minerals, vitamins also kiwi is rich in vitamin C, E, phenolics and flavonoids compounds (Soquetta et al., 2016).

MATERIALS AND METHODS

Fresh Goat milk was procured from the Pant vihar, unchgaon, Kolhapur from goat farm, whereas kiwi fruit was procured from the local market yard of Kolhapur and also fine crystalized sugar were procured from the local market of Kolhapur.

Preparation of kiwi fruit pulp

For the preparation of kiwi fruit pulp, fresh kiwi fruit were washed under running tap water then outer peel of fruit was removed and were crushed with in a grinder for 2-3 min thus the fruit pulp was ready.

Manufacturing of goat milk shrikhand added with kiwi fruit

Goat milk chakka was prepared with the method suggested by of Ghanbahadur (2016) with slight modification. Previously the goat milk is heated about 85ºC for about 15 min, then it is cooled about at 30ºC and the L40 culture is used as inoculum for the microbial growth to form curd then the milk was incubated for about 45ºC for 4hrs in incubator, the curd was then strained with the muslin cloth to obtained viscous goat milk chakka.

Selection of kiwi fruit pulp added into shrikhand

The kiwi fruit pulp contains vitamin C which is nothing but ascorbic acid that causes coagulation in goat milk chakka hence optimized level of kiwi fruit pulp is necessary to avoid coagulation so 5 different samples were taken to optimse kiwi fruit pulp in shrikhand. The samples were taken @ 1, 3, 5, 7, 9% of kiwi fruit pulp, on the sensory organoleptic basis 3%, 5%, 7% kiwi fruit pulp was selected for the further studies of shrikhand.

Optimisation of sugar % into shrikhand

In preliminary experiment of goat milk shrikhand, sugar was optimized in chakka with different levels @ 35, 40, 45, 50, was evaluated with the sensory evaluation and from that evaluation sugar added with goat milk chakka @ 35%, 40% and 45% got selected for further studies of goat milk shrikhand.

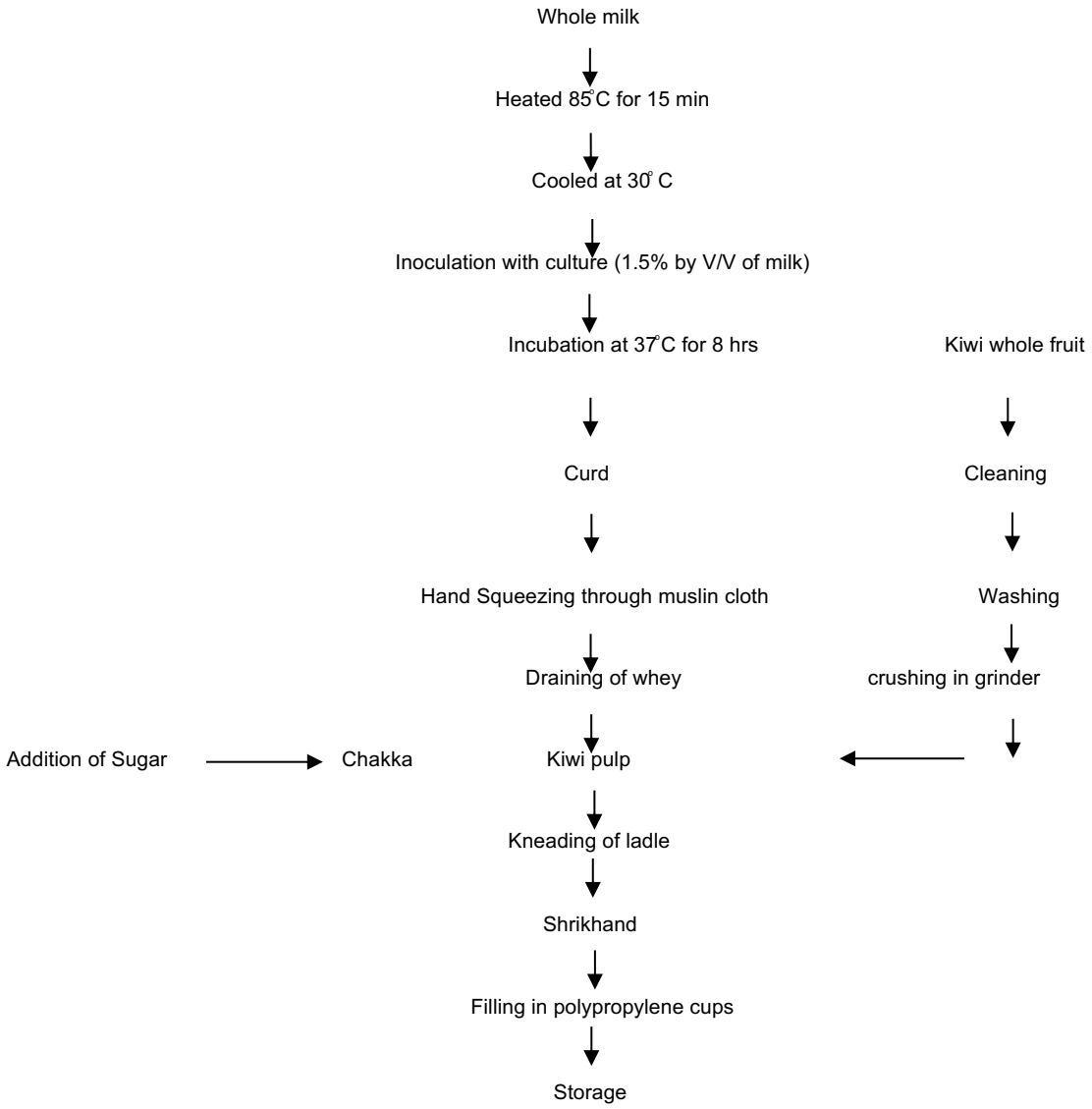

Fig.1: Preparation of shrikhand

Optimization of level of kiwi fruit pulp and sugar through RSM

Central Composite Rotatable Design (CCRD) of Response Surface Methodology (RSM) was used to optimize the level of kiwi fruit pulp and sugar which were two factors as independent variables (www.statease.com).The level of ingredients of the design matrix for the experiment is presented in Table1.

The data generated was analyzed using Design-Expert Software and a generalized polynomial equation was obtained for each response. Adequacy of model was evaluated using F ratio and co-efficient of determination (R2). The lack of fit was calculated. Model was considered adequate when F-calculated was more than Table F-value and R2 will be more than 70 per cent (Henika, 1972). The effect of the variables at linear, quadratic and interactive levels on individual responses was described using different levels of confidence. From the results obtained through sensory evaluation of goat milk shrikhand added kiwi fruit with different levels of kiwi fruit pulp and sugar, most desirable combination was selected by verification of their sensory qualities.

Physico-chemical analyses

The product was analyzed for moisture, ash (AOAC, 1990), protein (AOAC, 1965), fat, crude fiber and carbohydrate, vitamin C as per the procedures given by (AOAC, 2000). pH was estimated by using Oroion 3 star pH bench top pH meter according to the mentioned standard procedure. DPPH method was used for antioxidant, Folin–Ciocalteu method (Liang, et al, 2017) was used for phenolic compounds and flavonoids.

Sensory evaluation

Sensory evaluation of goat milk shrikhand added with kiwi fruit samples were carried out by a semi-trained panel of judges from the staff of the department of technology, shivaji university, Kolhapur, by using 9- point Hedonic scale (Appendix -I) as described by (Hue, 1993).for color, sweetness, taste & flavor, texture & consistency and overall acceptability. Samples were served in coded numbers. Water was given between two samples to cleanse the mouth.

Microbiological analysis

The standard plate count of the product was determined as per the procedure described in IS 2802 1964 using pore plate method, potato dextrose agar was used to enumerate yeast and mould counts in the shrikhand sample as per the Indian Standards (IS2802 1964) and violet red bile agar was used to enumerate coliform counts in the shrikhand sample. The plates were incubated at 30°C for 48 hrs and counts were expressed as cfu/g of the product.

Statistical analysis

Data generated during selection of sugar and kiwi fruit pulp were analyzed by employing CRD & RSM technique. Whereas the level of sugar and kiwi fruit pulp was optimized using Stat-Ease Design Expert 7.0.0 package procured from stat ease Inc., USA (www.statease.com).

RESULTS AND DISCUSSION

Selection of kiwi fruit pulp and sugar level in goat milk shrikhand for RSM

The pulp extract from kiwi fruit was made in proper mixture to add up in goat milk shrikhand. The kiwi fruit pulp was added @ 1%(T_1), 3%(T_2), 5%(T_3), 7%(T_4) and 9%(T_5) per cent of goat milk shrikhand accordingly.

Table 1: Effect of kiwi fruit pulp level in chakka on sensory quality of shrikhand

Treatments	Scores for sensory attributes				
	Colour	**Sweetness**	**Taste & Flavour**	**Texture & Consistency**	**Overall acceptability**
T_1	6.78±0.04	6.73±0.02	6.87±0.03	7.0±0.05	6.87±0.03
T_2	7.25±0.04	7.52±0.03	7.0±0.03	7.0±0.06	7.21±0.02
T_3	7.87±0.04	7.94±0.02	8.1±0.04	7.83±0.03	7.93±0.01
T_4	8.20±0.06	8.08±0.05	8.13±0.07	8.21±0.05	8.13±0.06
T_5	6.94±0.04	7.69±0.06	7.65±0.03	7.95±0.0	7.55±0.01

Data expressed as mean ± standard deviation of triplicate experiments (n=3) (Kiwi pulp - T1-3%, T2- 3%, T3-5%, T4-7% and T5- 9%.)

The above samples of kiwi fruit pulp added with goat milk shrikhand were organoleptically analyzed by a semi-trained panel of judges from the staff of the department of technology, shivaji university, Kolhapur, by using 9- point Hedonic scale for color, sweetness, taste & flavor, texture & consistency and overall acceptability. The shrikhand having kiwi fruit pulp 3%, 5%, and 7% had good overall acceptability so from above sensory results, use of kiwi fruit pulp from 3 to 7 % can be used for optimization of shrikhand for RSM.

Selection of sugar level in goat milk chakka for RSM

The sugar level was added with chakka @ 35%(T1), 40%(T2), 45%(T3), 50%(T4). These levels of sugar with goat milk chakka was analysed by sensory panel with sensory quality of the different level of product.

Table 2: Effect of sugar level in goat milk chakka on sensory quality of shrikhand

Treatments	Scores for sensory attributes				
	Colour	**Sweetness**	**Taste & Flavour**	**Texture & Consistency**	**Overall acceptability**
T_1	7.11±0.02	7.54±0.05	6.89±0.06	7.23±0.04	7.19±0.07
T_2	8.35±0.05	7.88±0.04	8.12±0.05	7.88±0.07	8.0±0.05
T_3	7.89±0.03	7.99±0.09	6.92±0.03	7.29±0.01	7.52±0.03
T_4	7.79±0.02	7.89±0.13	7.55±0.1	6.99±0.03	7.55±0.02

Data expressed as mean ± standard deviation of triplicate experiments (n=3) (Sugar - T1-35%, T2- 40%, T3-45% and T4-50%)

The above samples of different sugar % added with goat milk shrikhand were organoleptically analyzed by a semi-trained panel of judges from the staff of the department of technology, shivaji university, Kolhapur by using 9- point Hedonic scale for color, sweetness, taste & flavor, texture & consistency and overall acceptability. The shrikhand having sugar 40%, 45%, and 50% had good overall acceptability so from above sensory results, use of sugar from 40% to 50% can be used for optimization of shrikhand for RSM.

Optimization of level of kiwi fruit pulp and sugar in goat milk shrikhand through response surface methodology

Response Surface Methodology experiment was conducted including two factors i.e. Kiwi fruit pulp was used at 3 to 7 per cent and sugar was used at 40 to 50 per cent from the sensory results from table 1 and 2. In total, 13 formulations were prepared using different levels of the ingredients as per Design Expert 7.0.0 version software. The level of ingredients of the design matrix for the experiment is presented in table below. The data generated were analyzed using Design-Expert Software and a generalized polynomial equation was obtained for each response. The response measured for the goat milk shrikhand was sensory scored.

Table 3: Experimental levels of Independent variables in RSM

Std	Run	Kiwi fruit pulp (%)	Sugar (%)
5	1	2.171	45
12	2	5	45
8	3	5	52.071
1	4	3	40
11	5	5	45
6	6	7.828	45
2	7	7	40
4	8	7	50
9	9	5	45
10	10	5	45
7	11	5	37.928
3	12	3	50
13	13	5	45

From the results obtained through sensory evaluation of goat milk shrikhand added kiwi fruit with different levels of kiwi fruit pulp and sugar, most desirable combination was optimized numerically by giving command of expected goal on basis of sensory parameters.

Effect of level of kiwi fruit pulp and sugar on sensory qualities of goat milk shrikhand

Sensory score of goat milk shrikhand added with kiwi fruit as affected by the product formulation is presented in Table 4 as below.

Table 4: Effect of ingredient levels on sensory attributes (score *) of goat milk shrikhand added with kiwi fruit

Ingredients				Sensory Score				
Run	Std	Kiwi pulp (%)	Sugar (%)	Colour	Sweetness	Taste & Flavour	Texture & Consistency	Overall Acceptability
1	5	2.171	45	7.40	7.40	7.30	7.50	7.40
2	12	5	45	7.80	7.70	7.70	7.70	7.72
3	8	5	52.071	7.90	7.90	7.80	7.80	7.85
4	1	3	40	7.50	7.50	7.50	7.60	7.52
5	11	5	45	7.70	7.60	7.80	7.80	7.72
6	6	7.828	45	8.10	8.0	7.90	7.90	7.97
7	2	7	40	8.0	7.90	7.90	8.0	7.95
8	4	7	50	8.0	7.90	8.0	7.90	7.94
9	9	5	45	7.70	7.80	7.70	7.80	7.75
10	10	5	45	7.80	7.70	7.80	7.70	7.75
11	7	5	37.928	7.80	7.60	7.60	7.60	7.65
12	3	3	50	7.60	7.60	7.50	7.70	7.60
13	13	5	45	7.70	7.70	7.60	7.70	7.67

Table 5: Coefficients of Quadratic polynomial model for coded sensory score attributes

	Sensory Score				
Factor	Colour	Flavour	Consistency	Sweetness	Overall acceptability
Intercept	7.74	7.72	7.74	7.70	7.72
Kiwi pulp(A)	0.2364	0.2186	0.1458	0.1937	0.1984
Sugar (B)	0.0302	0.0479	0.0354	0.0656	0.0454
AB	-0.0250	0.0250	-0.0500	-0.0250	-0.0200
A^2	-0.0011	-0.0411	0.0052	0.0001	-0.089
B^2	0.0486	0.0087	0.0049	0.0249	0.0233
R^2	0.9702	0.9050	0.8190	0.9046	0.9648
F-value	45.59	13.34	6.33	13.28	38.41
Mean	7.77	7.70	7.75	7.72	7.73
SD	0.0456	0.0790	0.0795	0.0717	0.0419
Adeq Precision	21.5739	12.1219	8.3011	11.2392	19.6852

Table 6: Constraints selected in the range for optimization of goat milk shrikhand added with kiwi fruit

Name	Goal	Lower Limit	Upper Limit
A: Kiwi Pulp (%)	Is in range	3	7
B: Sugar (%)	Is in range	40	50
Color	Is target = 8	7.4	8.1
Sweetness	Is target = 7.8	7.4	8
Taste & Flavor	Is target = 7.9	7.3	8
Consistency	Is target = 7.9	7.6	8
Overall Acceptability	Is target = 7.9	7.4	8

Table 7: Coefficients of Quadratic polynomial model for coded sensory score attributes

Factor	Sensory Score				
	Colour	**Flavour**	**Consistency**	**Sweetness**	**Overall acceptability**
Intercept	7.74	7.72	7.74	7.70	7.72
Kiwi pulp(A)	0.2364	0.2186	0.1458	0.1937	0.1984
Sugar (B)	0.0302	0.0479	0.0354	0.0656	0.0454
AB	-0.0250	0.0250	-0.0500	-0.0250	-0.0200
A^2	-0.0011	-0.0411	0.0052	0.0001	-0.089
B^2	0.0486	0.0087	0.0049	0.0249	0.0233
R^2	0.9702	0.9050	0.8190	0.9046	0.9648
F-value	45.59	13.34	6.33	13.28	38.41
Mean	7.77	7.70	7.75	7.72	7.73
SD	0.0456	0.0790	0.0795	0.0717	0.0419
Adeq Precision	21.5739	12.1219	8.3011	11.2392	19.6852

Table 8: Predicted and actual sensory score of suggested formulation by Design Expert 7.0.0 package

Sr. no	Ingredients (%)	Score	Sensory parameters				
			Colour & appearance	Flavour	Consistency	Sweetness	Overall acceptability
1	Kiwi fruit pulp (6.85)	Predicted	8.0	7.86	7.82	7.89	7.89
2	Sugar (40)	Actual	8.0±0.08	7.83±0.02	7.91±0.002	7.82±0.03	7.87±0.03

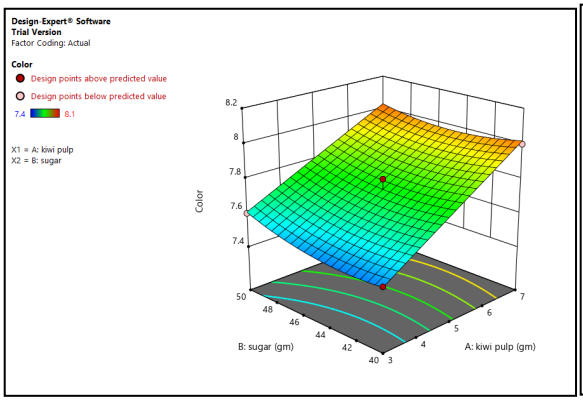

Figure 1: 3D Graph for the Colour and appearance score

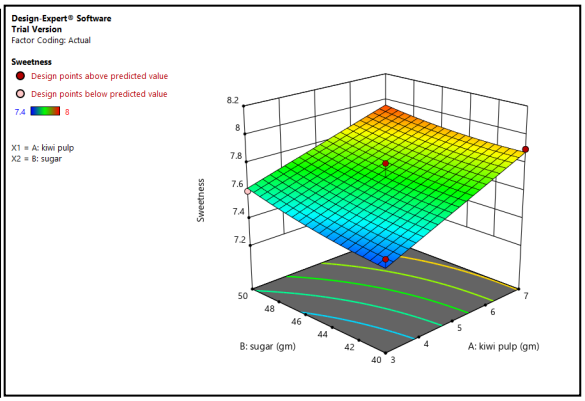

Figure 2: 3D Graph for the sweetness score

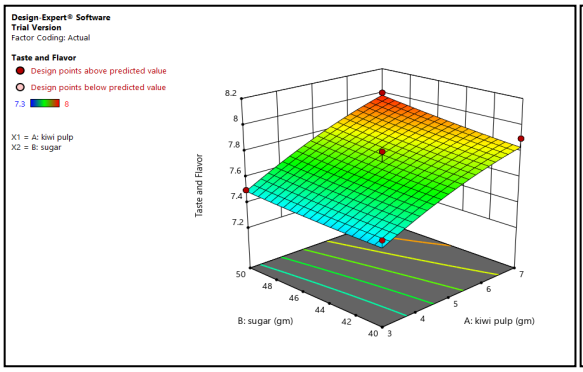

Figure 3: 3D Graph for the Taste & Flavour score

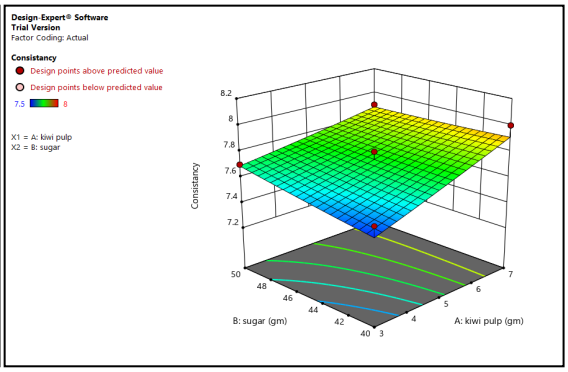

Figure 4: 3D Graph for Texture & Consistency score

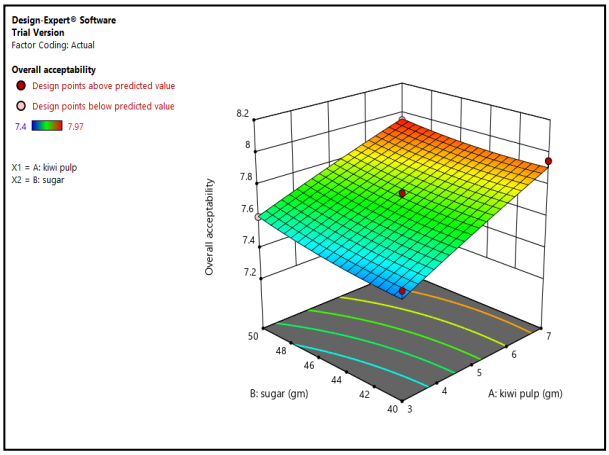

Figure 5: 3D Graph for Overall Acceptability

Table 9: Physiochemical Analysis of prepared goat milk shrikhand added with kiwi fruit

Chemical parameters	Values
Total Fat (g)	6.0±0.21
Protein (g)	11.05±0.1
Carbohydrate (g)	33.92±0.51
Total Energy (kcal)	239.76
Ash (%)	1.28±0.4
Moisture (%)	48.75±2.1
Sugar (g)	28.50
Total phenolic content (mg GAE/g)	7.63±0.12
Total Antioxidant Content (% RSA)	3.78±0.41
Vitamin C (mg/100g)	5.22
Ph	3.9
Crude Fibre (%)	0.38±0.55
Acidity	0.87±0.13

As shown in table 9 the chemical composition of the goat milk shrikhand added with kiwi fruit revealed that it contains of antioxidant (3.78 percent), Total phenolic content (7.63), vitamin C (5.22), protein (11.05g), and ash (1.28) percent at different level. Shrikhand can provide beneficial effects on health as it is a rich source of phytochemical compounds that includes ascorbic acid and antioxidants.

Table 10: Mineral content of goat milk shrikhand added with kiwi fruit

Parameters	Unit	Sample
Magnesium (Mg)	Mg/L	12.30
Zinc (Zn)	Mg/L	1.7222
Iron (Fe)	Mg/L	5.216
Calcium (Ca)	Mg/L	320
Potassium (K)	Mg/L	360
Phosphorous	Mg/L	260

The above table 10 reveals the mineral content of final product which has the highest amount of potassium 360Mg/l, magnesium content was about 12.30mg/l, iron was 5.216mg/l, also it was higgest in calcium and phosphorous i.e. 320mg/l, 260mg/l. The least mineral was found zinc about 1.7222mg/l.

Microbial and Sensorial changes during storage

The prepared and selected shrikhand sample were analysed on the basis of sensory and microbial changes during storage period at predetermined intervals at refrigeration temperature (5°C). The microbial changes include total plate count, yeast and mould count and coliform count. The microbial changes were recorded at interval of 7 days. Sensorial analysis of product during storage period includes organoleptic changes like colour, sweetness, taste & flavour, texture & consistency and overall acceptability were expressed by 9 point Hedonic scale sensory chart. Microbial changes occurred during storage period of shrikhand were estimated in terms of total plate count (TPC), yeast and mould count and coliform count.

Table 11: Sensorial Evaluation of prepared goat milk shrikhand added with kiwi fruit during storage period 5°C

Packaging Material	Polypropylene			
Sample	Shrikhand at 5°C			
Days	0	7	14	21
Colour	8.1	8.0	7.22	6.63
Sweetness	7.95	7.76	7.55	7.12
Taste & Flavour	7.99	7.9	6.88	6.28
Texture & Consistency	7.95	7.67	6.92	6.67
Overall Acceptability	7.9	7.8	7.1	6.6

The above table 11 shows the sensory evaluation of selected sample of shrikhand stored in polypropylene cups at 5°C temperature. From sensory score it was observed that as days were increasing sensory score was decreasing, this pattern was observed.

Table 12: Microbial analysis of prepared shrikhand at (5°C)

Packaging Material	Sample	Days	Total Plate Count (TPC) cfu X 10^3/g	Yeast and Mould Count (YMC) cfu X 10^3/g
Polypropylene cups	Shrikhand at 5°C	0	4.00	ND
		7	7 .88	ND
		14	12.40	ND
		21	21.66	3.8

The above table 12 shows the microbial analysis of selected shrikhand sample stored in polypropylene cups at refrigeration temperature (5°C). From the results, TPC count was observed on 0th day in selected shrikhand sample was 4.00 X 10^3per gm. Microbial load was observed in increasing pattern. Yeast and Mould count was observed on 21th day in selected sample was 3.8 X 10^3 per gm which does not exceed the count limit of shrikhand.

Coliform count**:** Shrikhand is not suitable for the growth of coliform because of low pH and acidity of the fermented milk which inhibits the growth of those microorganisms. The sample is free from coliform count which meets the prescribed BIS limits.

CONCLUSION

Use of kiwi fruit with goat milk chakka for preparation of goat milk shrikhand was having significant combination for fermented dairy products and the product was superior in sensory quality. The RSM gave the most desirable combination for optimisation of kiwi fruit pulp and sugar to prepare goat milk shrikhand under study but the most sensorial accepted quality of kiwi fruit pulp and sugar can be prepared by using 6.85% of kiwi fruit pulp and 40% of sugar. The optimized formulated (6.85 % kiwi pulp and 40 % sugar) product had 3.9 pH, 6.0, 11.05, 33.92, 239.76, 1.28, 48.75, 28.50, 7.63, 3.78 and 5.22 total fat, protein, carbohydrate, total energy, ash, moisture, sugar, total phelolic content and vitamin C.

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