EFFECT OF DIFFERENT LEVELS OF GOAT MILK, SOY MILK AND COW MILK ON CHEMICAL COMPOSITION OF RASOGOLLA

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Introduction

- *Chhana* **is a base material**

  - *sandesh, rasogolla, cham-cham, rajbhog, chhana murki, chhana podo* etc.

  - 4% milk is converted *chhana.*

- **Bengali sweets –** West Bengal & other Eastern parts

- *Rasogolla* **is most popular – indigenous milk sweets**

- *Rasogollas* **are marble white balls, spongy and chewy body and smooth texture –** served in sugar syrup

- **Cow milk is prefered**

Importance of goat milk

- **Increasing demand**

  - goat milk cheeses and yoghurt is increasing in developed countries

  - Increasing levels of disposable incomes

  - People with cow milk allergy & gastro-intestinal ailments

- **Goat milk is dominant - Capric, caprylic acids and MCT**

- **Beneficial for human health – cardiovascular conditions**

- **MCT – unique metabolic ability**

- **Goat milk exceeds cow milk in**

  - MCT   : 46%
  - MUFA   : 16%
  - PUFA   : 25%

Importance of soymilk

■ **Soymilk is inexpensive source of protein and calorie**

▶ WHO (1996) recommended soymilk as a supplement of bovine milk & nutritionally comparable with mother's milk

▶ Soy milk and its products do not contain cholesterol - major cause of coronary heart disease

▶ Free from lactose – lactose intolerance
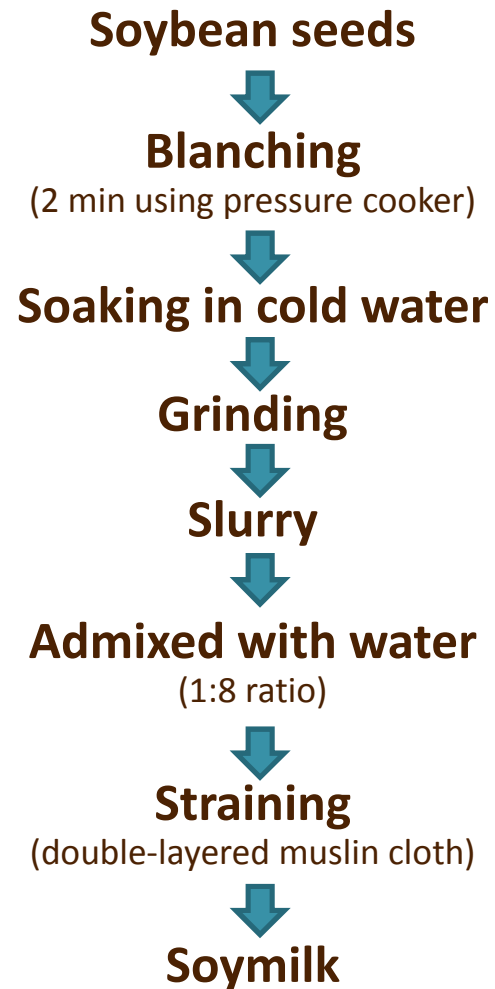
■ **Potential health benefits of soy foods**

▶ Cancer prevension, cardiovascular disease, osteoporosis and lowering cholesterol

Objectives

❑ Optimization of different levels of goat milk and soy milk on the basis of cow milk for preparation of *rasogolla* using RSM.

❑ Selection of best finished product on the basis of sensory evaluation for further studies.

❑ Chemical composition of *rasogolla* prepared from different levels of goat milk and soy milk on the basis of cow milk.

Materials and methods

Preparation of soymilk

Soybean seeds

⬇

Blanching
(2 min using pressure cooker)

⬇

Soaking in cold water

⬇

Grinding

⬇

Slurry

⬇

Admixed with water
(1:8 ratio)

⬇

Straining
(double-layered muslin cloth)

⬇

Soymilk

(Chauhan *et al,* 2003)

Preparation of *rasogolla*

Goat milk   Cow milk   Soy milk

Mixing

Heating (70°C)

Coagulation (1% calcium lactate solution at 70°C)

Straining ⟶ whey removal

Hanging of chant

Kneading (5% Maida)

Rolling (app. 6-10 g)

Cooking
(boiling in 60 per cent sugar syrup for 15-20 minutes)

Soaking (40 per cent sugar syrup at 60°C)
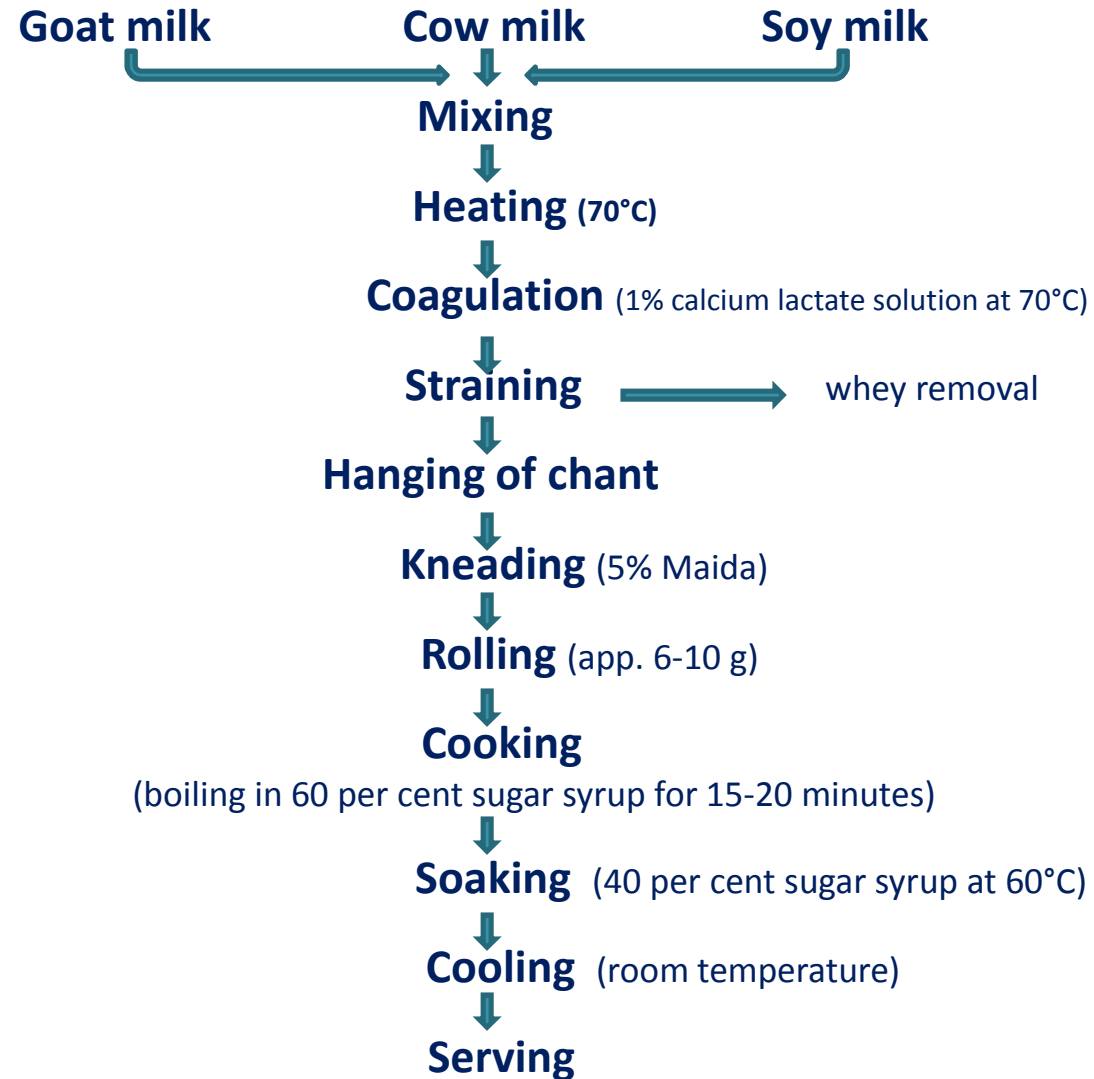
Cooling (room temperature)

Serving

Table 1. Average chemical composition of different milks used for preparation of *rasogolla*

Constituents (%)	Cow milk	Goat milk	Soy milk
Moisture	87.72	86.38	89.28
Total Solids	12.28	13.62	10.72
SNF	8.78	9.12	8.80
Fat	3.50	4.50	1.84
Total Protein	3.15	4.24	5.43
Total Carbohydrates	4.86	4.12	2.80
Ash	0.78	0.84	0.74

Response Surface Methodology

RSM was used to estimate the effect of goat milk & soy milk on the basis of cow milk on sensory attributes. STATE EASE Design Expert Software (version 8.0.4.1). Central Composite Rotatable Design, face centered with two factors & 5 center points was used.

Quadratic Model used to describe the response variables is as

$$Y = b_o + b_1 X_1 + b_2 X_2 + b_3 X_1^2 + b_4 X_2^2 + b_5 X_1 X_2$$

Y = response (dependent variable)

X_1 = level of goat milk (independent variable)

X_2 = level of soy milk (independent variable)

b_o, b_1, b_2, b_3, b_4 & b_5 = response model coeficient

Table 2. Experimental variables, their coded level and decoded (actual values)

	-1	0	+1
Goat milk- A	20	40	60
Soy milk- B	10	20	30

Standard order	Goat milk (%)	Soy milk (%)
1	20	10
2	60	10
3	20	30
4	60	30
5	11.71	20
6	68.28	20
7	40	5.85
8	40	34.14
9	40	20
10	40	20
11	40	20
12	40	20
13	40	20

Results

Table 3. Effect of goat milk and soymilk on sensory attributes of *rasogolla*

Standard order	Goat milk (%)	Soy milk (%)	Flavour	Body & Texture	Mouthfeel	Colour & Appearance	Overall Acceptability
1	20	10	8.0	8.0	8.0	8.0	8.0
2	60	10	8.0	9.0	8.0	8.0	8.0
3	20	30	6.5	6.0	6.0	7.0	6.5
4	60	30	7.0	7.0	6.5	7.0	7.0
5	11.71	20	6.0	6.0	7.0	7.5	6.5
6	68.28	20	7.5	7.0	7.5	8.0	7.5
7	40	5.85	8.0	8.5	8.0	8.0	8.0
8	40	34.14	6.0	6.0	6.0	6.5	6.0
9	40	20	8.5	9.0	8.5	8.0	8.5
10	40	20	9.0	8.5	8.0	7.5	8.0
11	40	20	9.0	8.5	8.0	8.0	8.0
12	40	20	8.5	9.0	8.5	7.5	8.5
13	40	20	8.5	9.0	8.0	8.0	8.5

Optimization of levels of variables using RSM

- Suitable levels of goat milk & soymilk – verification of sensory status
- Design Expert Software –Optimization command

Table 4. Goals for level of goat milk and soymilk on the basis of cow milk and sensory score targeted to predict the optimal combinations.

	Name	Goal set	Lower limit	Upper limit
Factor	Goat milk (%)	In range	20	60
	Soy milk (%)	In range	10	30
Response	Flavour	Maximize	6.0	9.0
	Body & Texture	Maximize	6.0	9.0
	Mouthfeel	Maximize	6.0	8.5
	Colour & Appearance	Maximize	6.5	8.0
	Overall Acceptability	Maximize	6.0	8.5

- Design Expert Software suggested formulation on the basis of sensory evaluation

- 42.52% goat milk & 14.54% soymilk

Predicted sensory score

Flavour	Body & text.	Mouthfeel	Colour & app.	Overall Accp.
8.66	8.51	8.35	8.01	8.41

Table 5. Verification of predicted sensory quality of optimized rosogolla

Parameter	Predicted score	Actual score*	Calculated 't' value
Flavour	8.66	8.82	1.38
Body and texture	8.51	8.71	1.12
Mouthfeel	8.35	8.55	1.12
Colour and appearance	8.01	8.23	1.90
Overall acceptability	8.41	8.99	1.66

*Average of triplicate experiments;
Table $t_{0.05}$ is 4.30

Table 6. Effect of goat milk and soymilk & cow milk on chemical composition of *rasogolla*

Standard order	Goat milk (%)	Soy milk (%)	Moisture (%)	T.S (%)	Fat (%)	Total Protein (%)	Total Carbohydrates (%)	Ash (%)
1	20	10	52.17	47.83	5.20	8.40	33.42	0.81
2	60	10	50.48	49.52	6.12	9.21	32.36	0.83
3	20	30	52.56	47.44	5.11	9.68	31.86	0.79
4	60	30	51.71	48.29	5.92	8.99	32.54	0.84
5	11.71	20	52.68	47.32	5.00	8.87	32.64	0.80
6	68.28	20	50.99	49.01	6.34	9.81	31.98	0.88
7	40	5.85	52.05	47.95	6.46	8.55	32.09	0.85
8	40	34.14	52.53	47.47	5.89	9.35	31.41	0.82
9	40	20	52.39	47.61	5.62	9.63	31.53	0.83
10	40	20	52.39	47.61	5.63	9.62	31.52	0.84
11	40	20	52.39	47.61	5.62	9.63	31.52	0.84
12	40	20	52.39	47.61	5.63	9.62	31.53	0.83
13	40	20	52.40	47.60	5.62	9.63	31.52	0.83

Table 7. Coefficient of full second order polynominal model for coded chemical composition to different levels of goat milk, soymilk & cow milk in *rasogolla*

Factor	Moisture (%)	T.S (%)	Fat (%)	Total Protein (%)	Total Carbohydrates (%)	Ash (%)
Intercept	52.39	47.60	5.62	9.62	31.52	0.83
A- Goat milk	-0.61**	0.61**	0.45**	0.18*	-0.16	0.02**
B- Soy milk	0.28**	-0.61**	-0.13	0.27**	-0.29*	-0.006
A^2	-0.36**	0.36**	-0.06	-0.16*	0.52**	-0.002
B^2	-0.13	0.13	0.19*	-0.35**	0.24	-0.004
AB	0.21	-0.21	-0.02	-0.37**	0.43*	0.007
R^2	0.93	0.93	0.88	0.92	0.86	0.79
Adeq Precision	12.16	12.16	11.51	11.89	8.38	7.80
Model 'F' value	20.23	20.23	11.27	17.27	8.92	5.35

**P< 0.01, *P < 0.05

Fig.3 Response surface relating to moisture as influenced by levels of goat milk, soymilk & cow milk for *rasogolla*
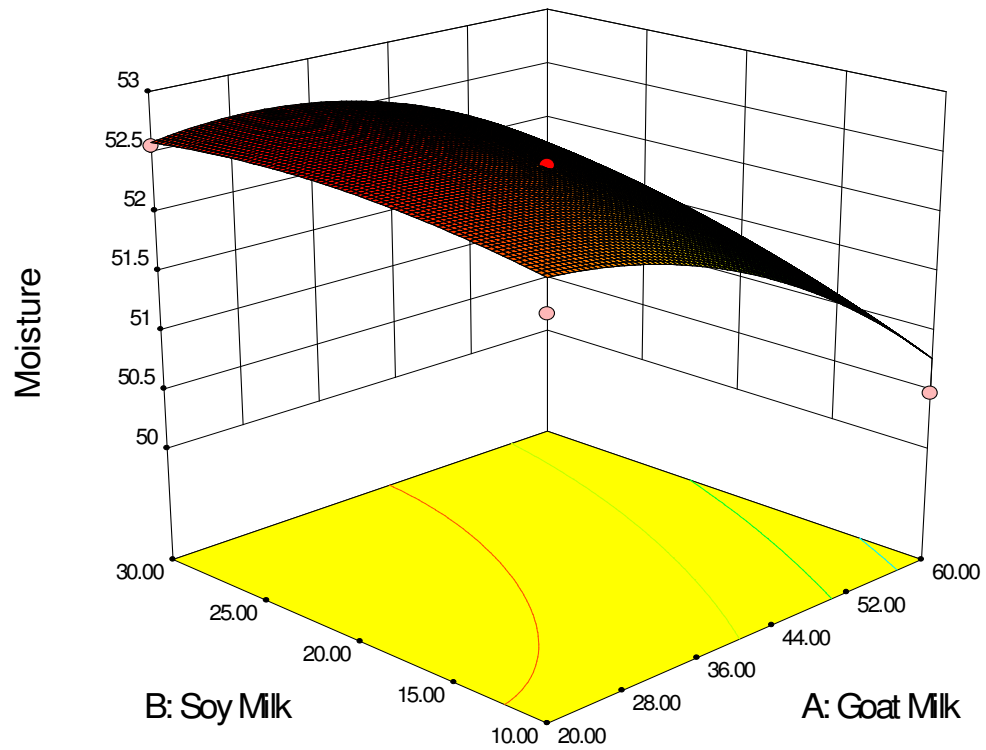
Fig.4 Response surface relating to total solids as influenced by levels of goat milk, soymilk & cow milk for *rasogolla*
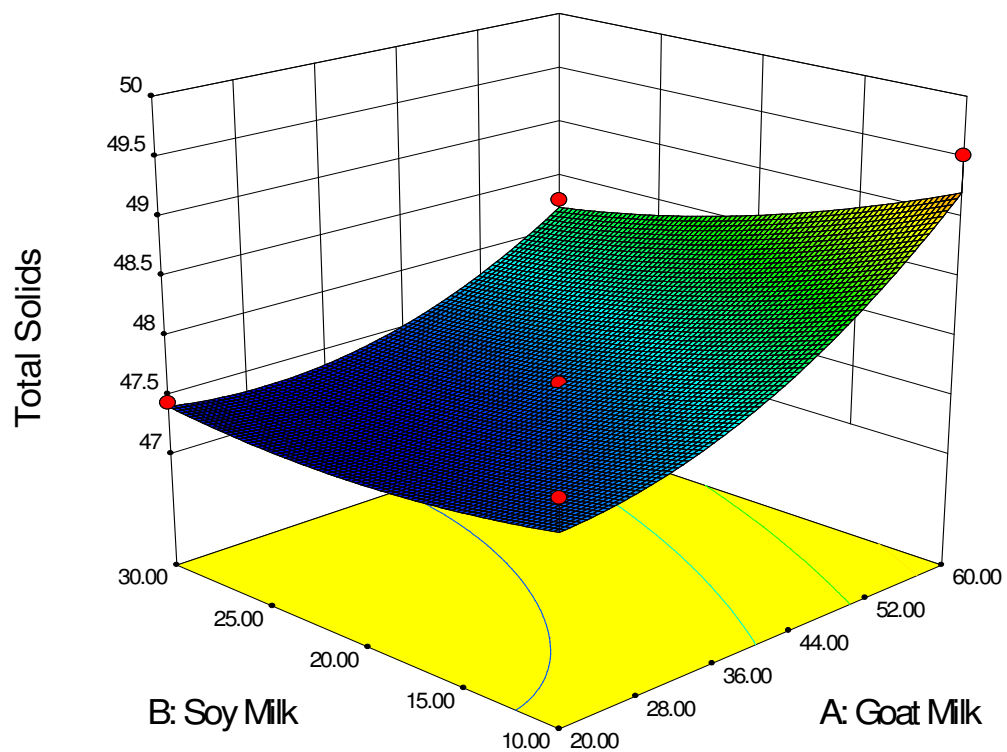
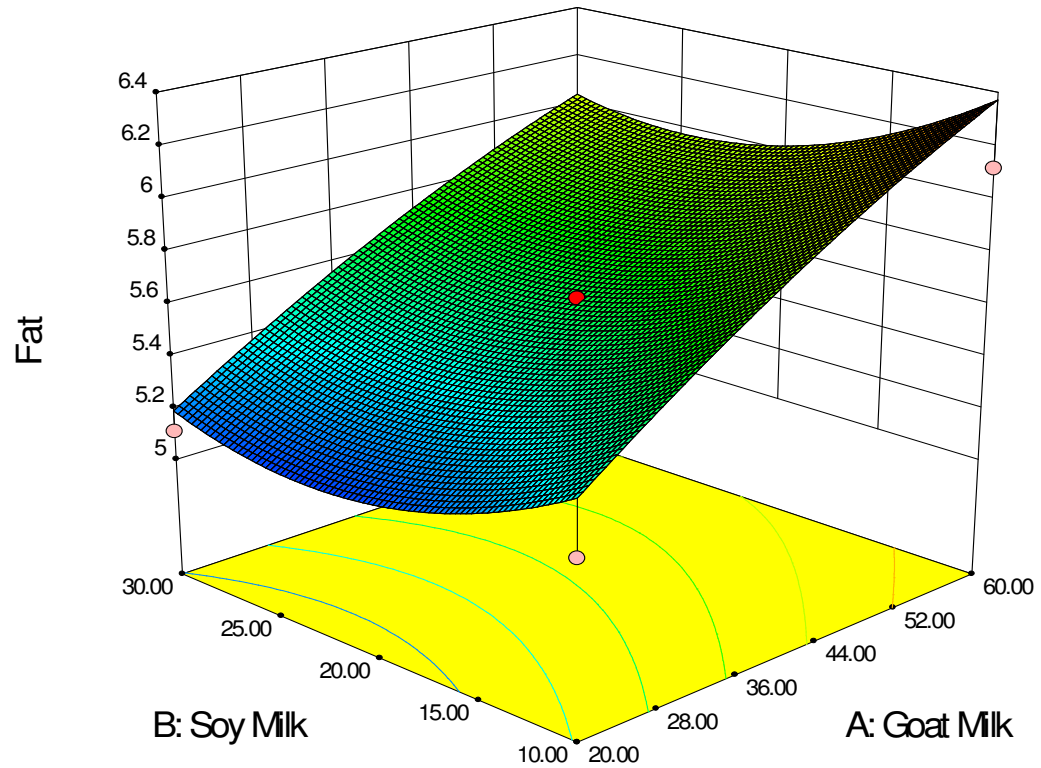# Fig.5 Response surface relating to fat as influenced by levels of goat milk, soymilk & cow milk for *rasogolla*

Design-Expert® Software
Factor Coding: Actual
Fat
● Design points above predicted value
○ Design points below predicted value
6.46

5

X1 = A: Goat Milk
X2 = B: Soy Milk

Fig. 6 Response surface relating to total protein as influenced by levels of goat milk, soymilk & cow milk for *rasogolla*
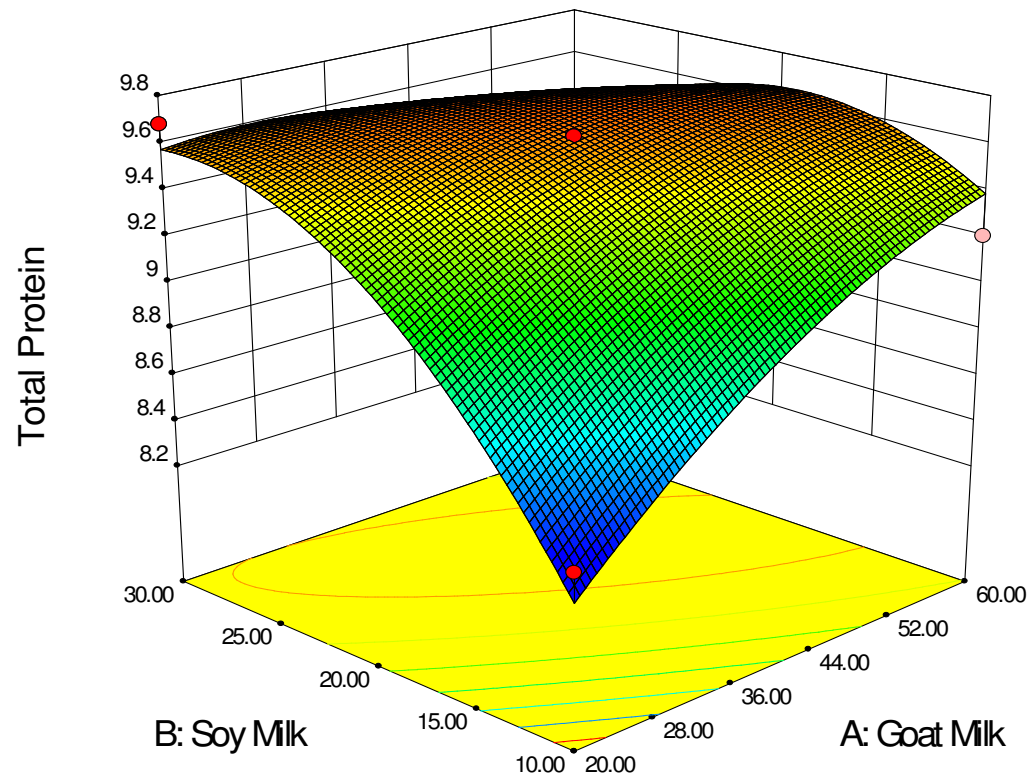
Fig. 7 Response surface relating to total carbobydrate as influenced by levels of goat milk, soymilk & cow milk for *rasogolla*

Design-Expert® Software
Factor Coding: Actual
Total Carbohydrates
● Design points above predicted value
○ Design points below predicted value
33.42

31.41

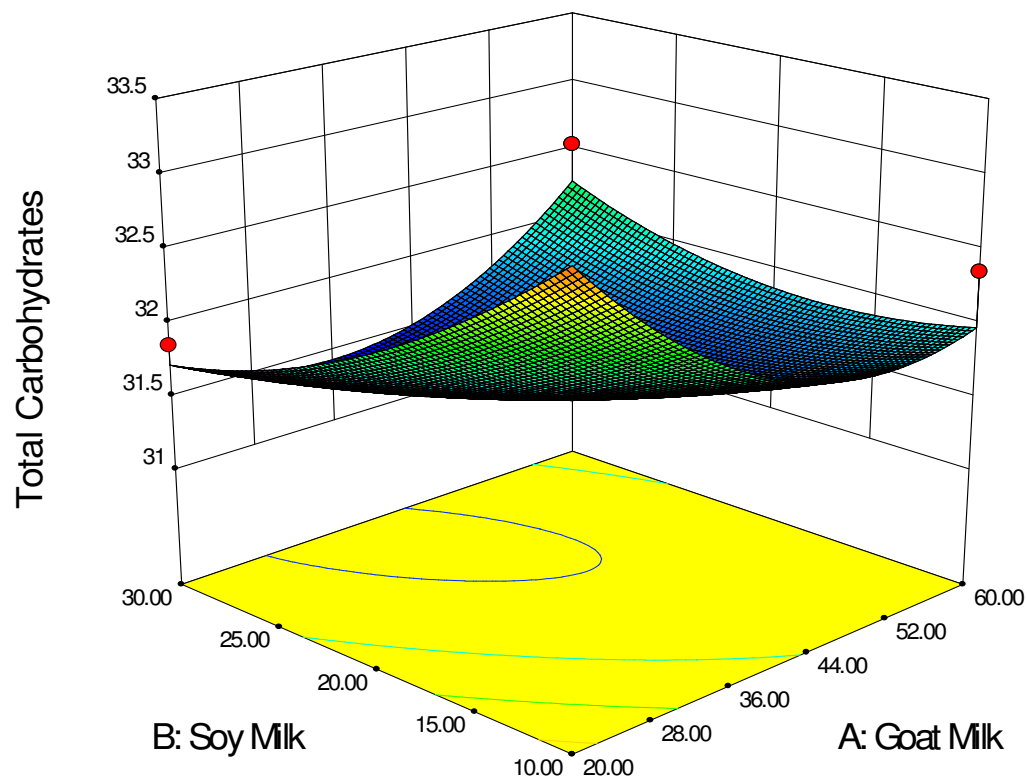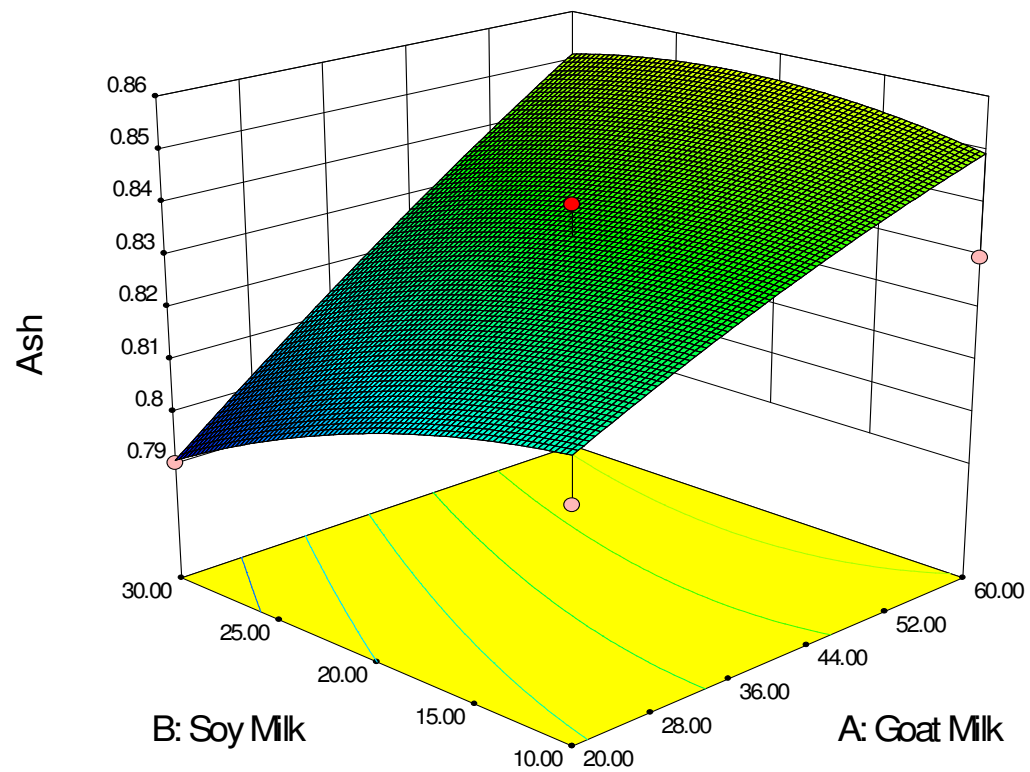X1 = A: Goat Milk
X2 = B: Soy Milk

Fig. 8 Response surface relating to ash as influenced by levels of goat milk, soymilk & cow milk for *rasogolla*

Response Surface Equation for Chemical Parameters

Moisture $= 52.39 - 0.61\ A + 0.28\ B + 0.21\ A\ B - 0.36\ A^2 + 0.13\ B^2$

Total Solids $= 47.60 + 0.61\ A - 0.28\ B - 0.21\ A\ B + 0.36\ A^2 + 0.13\ B^2$

Fat $= 5.62 + 0.45\ A - 0.13\ B - 0.027\ A\ B - 0.060\ A^2 + 0.19\ B^2$

Total Protein $= 9.62 + 0.18\ A + 0.27\ B - 0.37\ A\ B - 0.16\ A^2 - 0.35\ B^2$

Total Carbohydrates $= 31.52 - 0.16\ A - 0.29\ B + 0.43\ A\ B + 0.52\ A^2 + 0.24\ B^2$

Ash $= 0.83 + 0.022\ A - 0.0065\ B + 0.007\ A\ B - 0.002\ A^2 - 0.004\ B^2$

Chemical composition of *rasogolla* with optimized levels of goat milk, soy milk & cow milk on sensory basis

Final formulation on the basis of cow milk

Goat milk : 42.52 %
Soy milk   : 14.54 %

Table 8. Comparison of optimized *rasogolla* with cow milk *rasogolla*

Constituents (%)	Cow milk	Optimized
Moisture	51.10	52.43
Total Solids	48.90	47.54
Fat	5.78	5.65
Total Protein	5.04	9.59
Total Carbohydrate	37.09	31.49
Ash	0.90	0.84

Conclusion

- Incorporation of goat milk and soy milk in cow milk is feasible for preparation of good quality *rasogolla*

- Incorporation of 42.52 % goat milk and 14.54% soy milk is best on the basis of sensory evaluation.

- Incorporation of goat milk and soy milk increases the protein & yield of product.

- Reduces the cost of product.

- Value added health benefit product could be prepared using this combination.
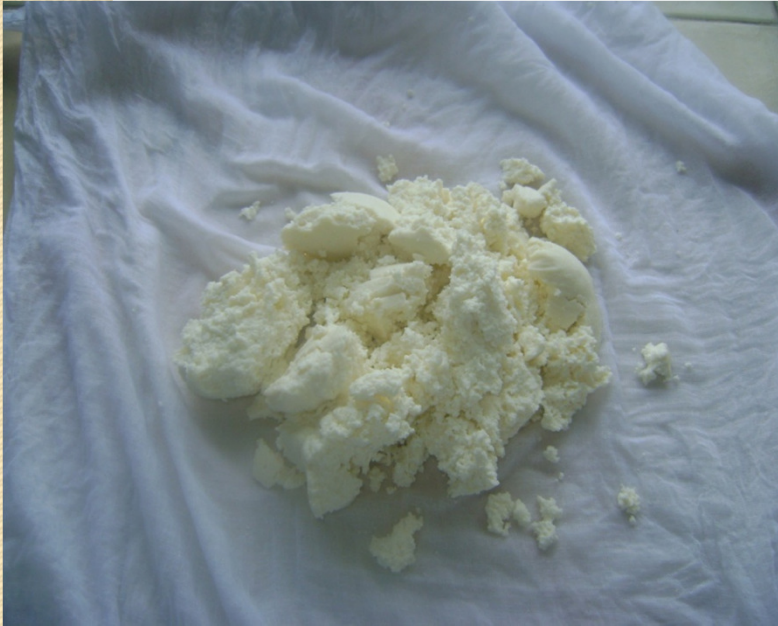
THANK YOU

Fatty acid profile of goat milk vs cow milk

	Goat milk	Cow milk	Difference (%) for goat milk
C4:0 butyric	0.13	0.11	
C6:0 caproic	0.09	0.06	
C8:0 caprylic	0.10	0.04	
C10:0 capric	0.26	0.08	
C12:0 lauric	0.12	0.09	
C14:0 myristic	0.32	0.34	
C16:0 palmitic	0.91	0.88	
C18:0 stearic	0.44	0.40	
C6-14 total MCT	**0.89**	**0.61**	**+46**
C4-18 total SAFA	**2.67**	**2.08**	**+28**
C16:1 palmitoleic	0.08	0.08	
C18:1 oleic	0.98	0.84	
C16:1-22:1 total MUFA	**1.11**	**0.96**	**+16**
C18:2 linoleic	0.11	0.08	
C18:3 linolenic	0.04	0.05	
C18:2-18:3 total PUFA	**0.15**	**0.12**	**+25**

[a] MCT: medium chain triglycerides; SAFA: saturated fatty acids;

MUFA: monounsaturated fatty acids; PUFA: polyunsaturated fatty acids.

Table 14. Cost structure of *rasogolla* prepared from cow milk and optimized *rasogolla* (cow milk + goat milk + soy milk)

Sr. No.	Particulars	Rate (Rs.)	Cow milk *rasogolla*		Optimized *rasogolla*	
			Quantity	Amount (Rs.)	Quantity	Amount (Rs.)
1	Cow milk (ml)	32.00/lit.	1000	32.00	1000	32.00
2	Goat milk (ml)	41.00/lit.	--	--	425	17.50
3	Soy milk (ml)	6.00/lit.	--	--	145	1.00
4	*Chhana* obtained (gm.)	--	200	--	320	--
5	Sugar (60% syrup) (gm.)	30.00/kg	300	9.00	360	10.80
6	Electric charges (Unit)	7.00/Unit	01	7.00	01	7.00
7	Labour (hr.)	15.00/hr.	--	3.20	--	3.20
8	Miscellaneous	--	--	1.00	--	1.00
9	*Rasogolla* obtained (gm.)	--	270	--	425	--
10	Total cost of *rasogolla*	--	--	52.00	--	62.50
11	Cost of drained weight *rasogolla*/kg.	--	--	192.60	--	147.05
12	Cost including packaging charges	5.00/Tin	--	197.60	--	152.05

Fig. 19 Cost structure of cow milk *rasogolla* with optimized *rasogolla*

Cow milk *Rasogolla*

Rs. 192.60/kg.

- 62%
- 17%
- 6%
- 13.46%
- 2.00%

Legend:
- Cow milk
- Sugar
- Labour
- Electric charges
- Miscellaneous

Optimized *Rasogolla*

Rs. 147.05/kg.

- 51%
- 28%
- 1.60%
- 17%
- 5%
- 11.20%
- 1.60%

Legend:
- Cow milk
- Goat milk
- Soymilk
- Sugar
- Labour
- Electric charges
- Miscellaneous