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Process optimization, microbiology and cost analysis of low calorie fiber enriched herbal *Gulabjamun*

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Abstract

Research was conducted to optimize the process for the manufacturing of low calorie fiber enriched herbal *Gulabjamun*. The objective of the present research was to develop improved herbal based *Gulabjamun* with health benefits beyond those of traditionally formulated *Gulabjamun*. The product was manufactured by different ratio of Sorbitol (2%, 4% and 6%), Oat flour (10%, 15% and 20%) and *Tulsi* extract (10%, 15% and 20%). The mean score of overall acceptability were evaluated to optimize the product. The results revealed that the combination A₃B₃C₃ i.e. of 6% Sorbitol, 20% Oat flour and sugar syrup containing 20% *Tulsi* extract was the best. The Coliform count of functional *Gulabjamun* is nil. The Y/M count of functional *Gulabjamun* is very low, indicating good keeping quality of the functional *Gulabjamun*. The developed low calorie, fiber enriched herbal *Gulabjamun* was costlier than normal *Gulabjamun* that can be justified by low calorie, fiber enriched and possessing antioxidant activities.

Keywords: *Gulabjamun*, *Tulsi*, Sorbitol, Oat flour, Coliform

1. Introduction

Foods which promote health beyond providing basic nutrition are termed as —functional foods. It refers to a food that has been modified or value-added. Significant strategy in the development of functional foods evolves increasing the levels of specific nutraceuticals that are known as health benefits. This can be through enhancement of levels of the desired component that is inherent in the food by fortification of food products with functional ingredients, such as dietary fibres, antioxidants, natural isoflavones, plant sterols/stanols, other phytochemicals or phytonutrients, bioactive peptides, w-3, -6 PUFA, probiotics, prebiotics, minerals and vitamins etc.

Gulabjamun is a popular *Khoa* based sweet. Originally it was made with *Khoa* and *maida*. As it looks like monsoon fruit —*Jamun* and is flavoured with —rose water. It got the name of *Gulabjamun*.

Gulabjamun in India is characterized by an unorganized nature of business. There is no denying the fact that indigenous products have come to stay as a vital fiber in the fabric of the country's dairy industry. Obviously, the indigenous products have a big potential of becoming the main stay of the emerging dairy industry under the organized sector and technological developments in their production will have far-reaching implication on it.

There are an increasing interest in low calorie food and beverages. Most of the population in the world is being aware up to the impact of sugar on health. Today's health conscious consumer is looking for the low sugar or sugar free traditional dairy products. With the changing life style and dietary pattern, non-communicable diseases like obesity, diabetes, cardio-vascular diseases and cancer have become major health problem worldwide (Ramchandran, 2004) [6].

According to the most recent report of WHO (Ramchandran *et al.*, 2010) [7], India now has done dubious distinction of being the diabetic capital of the world with over 50.8 million people affected by it, whereas the figure is close 285 million for the rest of the world and expected to touch 438 million by 2030. This statistics indicates the graveness of the situation and need attention.

As per the ICMR (Indian Council of Medical Research) 2001 report, 49 percent of women and 36 percent of men in urban areas is obese, this is due to physiological disorder and increase the Body Mass Index (BMI) values as well as increase the risk of Cardio Vascular Diseases (CVD), diabetes, hypertension, cancer etc. To maintain ideal body weight, negative energy balance is needed. Excessive fat intake in food increases blood cholesterol and risk of CVDs. According to WHO (2003) [10] it is estimated that 15 per cent death in India is due to CVDs

and may grow to 40 percent by 2015.

Diabetes mellitus, a condition characterized by hyperglycemia resulting from the body’s inability to use blood glucose for energy, this condition affecting every organ of the system. India is having 50.8 million diabetic populations in 2010, affected by this condition and it is estimated that by the year 2030, nearly 87.0 million populations will be diabetic.

2. Materials and Methods

The experiment “Process Optimization, microbiology and cost analysis of Low Calorie Fiber enriched Herbal *Gulabjamun*” was conducted in the Laboratory of Animal Husbandry & Dairying and Centre of Food Science and Technology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. The experimental techniques were

employed as under.

Cow milk was procured from Dairy farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh. Milk was standardized to 3 percent fat and 9 percent SNF. High quality bulking agents Sorbitol were purchased from the local market of Varanasi, Uttar Pradesh. High quality oat was purchased from the local market of Varanasi, Uttar Pradesh. Plastic Cup and Aluminum Foil were purchased from Varanasi market. Fresh *tulsi* leaves were procured from faculty of Ayurveda Banaras Hindu University.

2.1 Manufacturing Method

The low calorie and fiber enriched Herbal *Gulabjamun* has been manufactured by using following flow chart as shown in fig 1.

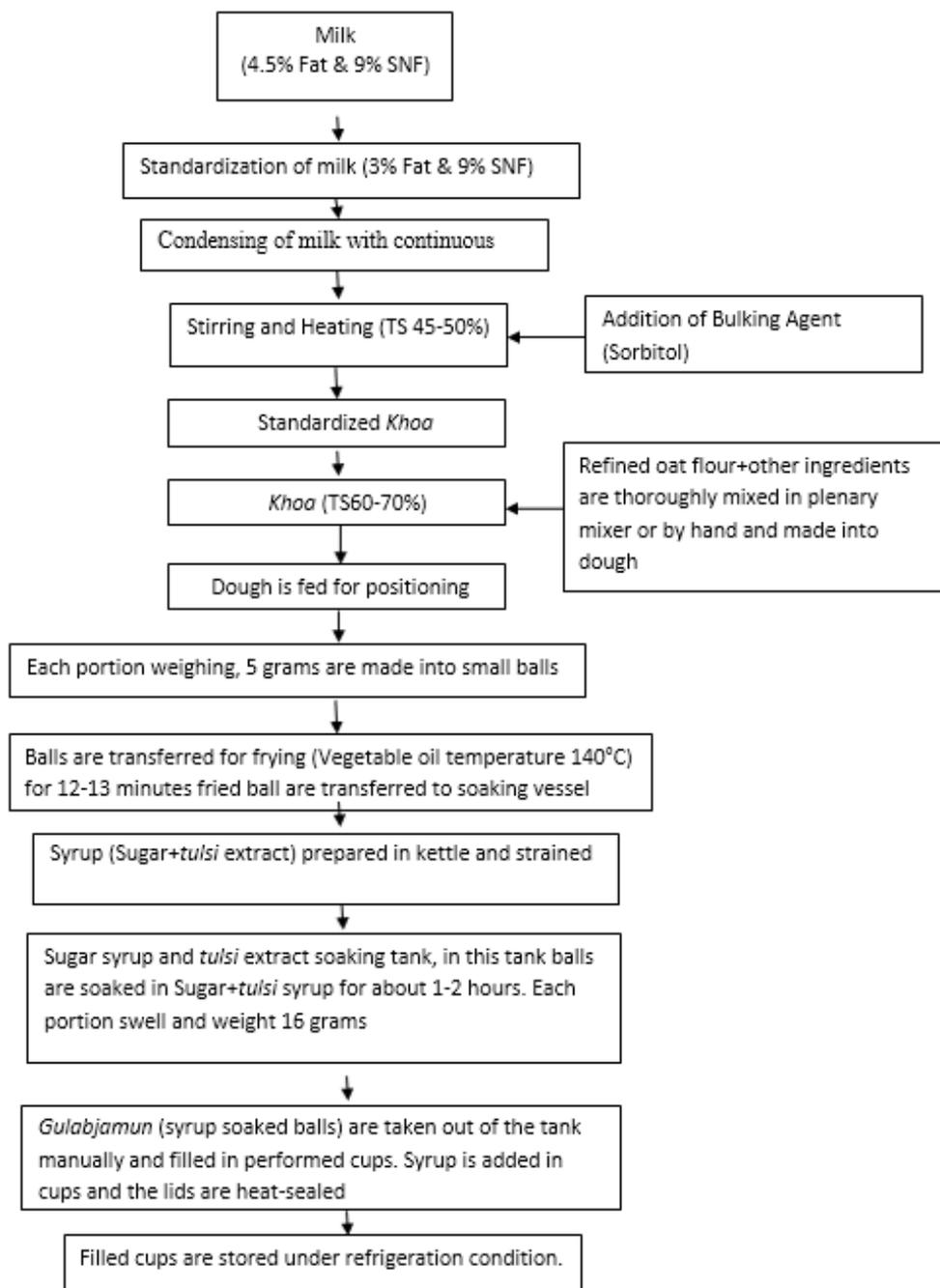


Fig 1: Flow diagram for manufacturing of low calorie and fiber enriched Herbal *Gulabjamun*

2.2 Preparation of Sugar Syrup

Sugar of 250 g was put in 300 ml of boiling water for 5 minutes and stir to make sugar syrup of 50 °Brix concentration. Sugar syrup was filtered through muslin cloth to remove the impurities present in it. In this prepared syrup solution appropriate amount of *tulsi* extract (10%, 15% and 20%) has been added. The total solid of sugar syrup was determined by using an ERMA (Japan) make hand refractrometer having range 60 °Brix.

2.3 Dipping Gulabjamuns in Syrup

The fried *Gulabjamun* balls were dipped in sugar syrup containing tulsi extract of approximately 60 °Brix TSS for 4 hours at 70 °C temperature (Rangi *et al.*, 1985; Singh *et al.*, 2009) [8, 9] and samples were taken out from the syrup before packing.

2.4 Packaging and storage of Gulabjamun under refrigeration

The *Gulabjamun* samples were packed in Plastic cup wrapped with aluminium foil.

2.5 Microbial analysis

The lipolysis and proteolysis of the samples due to the microbial activity result in the deterioration of colour, flavour and texture, which ultimately affect the shelf life of the product. All the samples of *Gulabjamun* were subjected to microbiological analysis for total plate count (TPC), yeast and mold count (YMC) and coliform count. The TPC was determined by surface spreading, the homogenate spread with appropriate dilutions (10^{-2}) on plate count agar (PCA) plates and were incubated at 37 °C for 24-48 h. For mold and yeast detection, appropriate dilutions (10^{-2}) of sample were spread on potato dextrose agar (PDA) plates and incubated at 25 °C for 24-48 h. Coliform in the samples were estimated by plating appropriate dilutions (10^{-2}) on Violet Red Bile Agar (VRBA) before being incubated at 37 °C for 24-48 h. The standard method described in Manual of Dairy Bacteriology (ICAR, 1982) was used for microbiological analysis of *Gulabjamun*.

2.6 Cost Analysis of the product

The yield of low calorie fiber enriched herbal *Gulabjamun* was noted by weighing the low calorie fiber enriched herbal *Gulabjamun* on the physical balance and the cost of the prepared product was calculated at the prevailing prices of raw materials purchased from the local market of Varanasi.

3. Results and Discussions

The data collected on different aspects, as per plan were tabulated and analyzed statistically on the basis of C.R.D. factorial. The findings are also illustrated diagrammatically. The results obtained from the analysis during the course of investigation are presented in this chapter and discussed in detail.

3.1 Treatment Combinations

Twenty seven different combinations of low calorie fiber enriched herbal *Gulabjamun* has been manufactured by different ratio of Sorbitol, Oat flour and *Tulsi* extract. The details of the prepared combinations were as follows:

A₁B₁C₁: Prepared by the combination of 2% Sorbitol, 10% Oat flour and sugar syrup containing 10% *Tulsi* extract possesses 6.33 as the mean score of overall acceptability in

sensory evaluation.

A₁B₁C₂: Prepared by the combination of 2% Sorbitol, 10% Oat flour and sugar syrup containing 15% *Tulsi* extract possesses 6.33 as the mean score of overall acceptability in sensory evaluation.

A₁B₁C₃: Prepared by the combination of 2% Sorbitol, 10% Oat flour and sugar syrup containing 20% *Tulsi* extract possesses 5.66 as the mean score of overall acceptability in sensory evaluation.

A₁B₂C₁: Prepared by the combination of 2% Sorbitol, 15% Oat flour and sugar syrup containing 10% *Tulsi* extract possesses 6.66 as the mean score of overall acceptability in sensory evaluation.

A₁B₂C₂: Prepared by the combination of 2% Sorbitol, 15% Oat flour and sugar syrup containing 15% *Tulsi* extract possesses 6.33 as the mean score of overall acceptability in sensory evaluation.

A₁B₂C₃: Prepared by the combination of 2% Sorbitol, 15% Oat flour and sugar syrup containing 20% *Tulsi* extract possesses 5.66 as the mean score of overall acceptability in sensory evaluation.

A₁B₃C₁: Prepared by the combination of 2% Sorbitol, 20% Oat flour and sugar syrup containing 10% *Tulsi* extract possesses 6.00 as the mean score of overall acceptability in sensory evaluation.

A₁B₃C₂: Prepared by the combination of 2% Sorbitol, 20% Oat flour and sugar syrup containing 15% *Tulsi* extract possesses 6.66 as the mean score of overall acceptability in sensory evaluation.

A₁B₃C₃: Prepared by the combination of 2% Sorbitol, 20% Oat flour and sugar syrup containing 20% *Tulsi* extract possesses 6.00 as the mean score of overall acceptability in sensory evaluation.

A₂B₁C₁: Prepared by the combination of 4% Sorbitol, 10% Oat flour and sugar syrup containing 10% *Tulsi* extract possesses 7.66 as the mean score of overall acceptability in sensory evaluation.

A₂B₁C₂: Prepared by the combination of 4% Sorbitol, 10% Oat flour and sugar syrup containing 15% *Tulsi* extract possesses 5.66 as the mean score of overall acceptability in sensory evaluation.

A₂B₁C₃: Prepared by the combination of 4% Sorbitol, 10% Oat flour and sugar syrup containing 20% *Tulsi* extract possesses 7.00 as the mean score of overall acceptability in sensory evaluation.

A₂B₂C₁: Prepared by the combination of 4% Sorbitol, 15% Oat flour and sugar syrup containing 10% *Tulsi* extract possesses 7.00 as the mean score of overall acceptability in sensory evaluation.

A₂B₂C₂: Prepared by the combination of 4% Sorbitol, 15% Oat flour and sugar syrup containing 15% *Tulsi* extract possesses 6.66 as the mean score of overall acceptability in sensory evaluation.

A₂B₂C₃: Prepared by the combination of 4% Sorbitol, 15% Oat flour and sugar syrup containing 20% *Tulsi* extract possesses 6.33 as the mean score of overall acceptability in sensory evaluation.

A₂B₃C₁: Prepared by the combination of 4% Sorbitol, 20% Oat flour and sugar syrup containing 10% *Tulsi* extract possesses 7.66 as the mean score of overall acceptability in sensory evaluation.

A₂B₃C₂: Prepared by the combination of 4% Sorbitol, 20% Oat flour and sugar syrup containing 15% *Tulsi* extract possesses 7.33 as the mean score of overall acceptability in

sensory evaluation.

A₂B₃C₃: Prepared by the combination of 4% Sorbitol, 20% Oat flour and sugar syrup containing 20% *Tulsi* extract possesses 5.66 as the mean score of overall acceptability in sensory evaluation.

A₃B₁C₁: Prepared by the combination of 6% Sorbitol, 10% Oat flour and sugar syrup containing 10% *Tulsi* extract possesses 7.00 as the mean score of overall acceptability in sensory evaluation.

A₃B₁C₂: Prepared by the combination of 6% Sorbitol, 10% Oat flour and sugar syrup containing 15% *Tulsi* extract possesses 7.00 as the mean score of overall acceptability in sensory evaluation.

A₃B₁C₃: Prepared by the combination of 6% Sorbitol, 10% Oat flour and sugar syrup containing 20% *Tulsi* extract possesses 7.00 as the mean score of overall acceptability in sensory evaluation.

A₃B₂C₁: Prepared by the combination of 6% Sorbitol, 15% Oat flour and sugar syrup containing 10% *Tulsi* extract possesses 6.66 as the mean score of overall acceptability in sensory evaluation.

A₃B₂C₂: Prepared by the combination of 6% Sorbitol, 15% Oat flour and sugar syrup containing 15% *Tulsi* extract possesses 6.00 as the mean score of overall acceptability in

sensory evaluation.

A₃B₂C₃: Prepared by the combination of 6% Sorbitol, 15% Oat flour and sugar syrup containing 20% *Tulsi* extract possesses 7.33 as the mean score of overall acceptability in sensory evaluation.

A₃B₃C₁: Prepared by the combination of 6% Sorbitol, 20% Oat flour and sugar syrup containing 10% *Tulsi* extract possesses 6.66 as the mean score of overall acceptability in sensory evaluation.

A₃B₃C₂: Prepared by the combination of 6% Sorbitol, 20% Oat flour and sugar syrup containing 15% *Tulsi* extract possesses 7.33 as the mean score of overall acceptability in sensory evaluation.

A₃B₃C₃: Prepared by the combination of 6% Sorbitol, 20% Oat flour and sugar syrup containing 20% *Tulsi* extract possesses 8.66 as the mean score of overall acceptability in sensory evaluation.

3.2 Yeast and mould content in low calorie fiber enriched herbal *Gulabjamun*

It can be seen from table 1 that the average yeast and mould count for low calorie fiber enriched herbal *Gulabjamun* samples respectively.

Table 1: Average Y/M count for low calorie fiber enriched herbal *Gulabjamun*

Treatment combination/ Replication	A ₃ ×B ₃ ×C ₃	Total	Range
R1 (DAY 1)	10	66	10-12
R2	11		
R3	12		
R4	10		
R5	12		
R6	11		
R1 (DAY 5)	13	81	12-14
R2	14		
R3	13		
R4	13		
R5	14		
R6	14		
R1 (DAY 10)	14	88	14-16
R2	15		
R3	15		
R4	15		
R5	15		
R6	14		
R1 (DAY 15)	15	93	16-17
R2	16		
R3	15		
R4	15		
R5	16		
R6	17		
Total		328	10-17

3.3 Coliform content in low calorie fiber enriched herbal *Gulabjamun*

It can be seen from table 2 that the average Coliform count for low calorie fiber enriched herbal *Gulabjamun* samples respectively.

Table 2: Average Coliform count for low calorie fiber enriched herbal *Gulabjamun*

Treatment combination/ Replication	A ₃ ×B ₃ ×C ₃
R1 (DAY 1) R2 R3 R4 R5 R6	Negative
R1 (DAY 5) R2 R3 R4 R5 R6	Negative
R1 (DAY 10) R2 R3 R4 R5 R6	Negative
R1 (DAY 15) R2 R3 R4 R5 R6	Negative

Aqueous extract of *Tulsi* leaves were subjected to *in vitro* antibacterial assay against human pathogenic organisms *Escherichia coli*, *Salmonella typhi*, *Salmonella paratyphi*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* employing cup diffusion method. *Tulsi* leaves extract was found to be the most effective against *S. typhi*. The extract were effective against *E. coli*. (Joshi *et. al.*, 2011). Modern research has revealed that *Tulsi* has anti-bacterial, anti-viral and anti-fungal activity (Vasudevan *et. al.*, 1999) that includes activity against many pathogens responsible for human infections.

3.4 Cost analysis of low calorie, fiber enriched herbal *Gulabjamun*

The cost of the ingredient is very important factor besides other factors in determining the cost of production. It is considered as a basis for price fixation and determining the profit. The price of a product is dependent on the cost of production. The cost of experimental low calorie fiber enriched herbal *Gulabjamun* was calculated considering the fixed cost and labour cost equal in all cases, which was calculated as given in the table no 3:

Table 3: Cost analysis table of low calorie, fiber enriched herbal *Gulabjamun*

Ingredient	Rate (Rs)	G0		A ₃ ×B ₃ ×C ₃	
		Quantity	Cost (Rs)	Quantity	Cost (Rs)
Whole milk (Cow)	40/lit	2 Liter	80	1.25 Liter	50
Skim Milk powder	370/kg	-	-	0.75 Liter	24.97
Sorbitol	488/lit	-	-	120 ml	58.56
Wheat Flour	40/kg	72gm	2.88	57.6gm	2.30
Oat flour	173/kg	-	-	14.4gm	2.49
Baking Powder	230/kg	1.8gm	0.41	1.8gm	0.41
Cardamom	2720/kg	1gm	2.72	1gm	2.72
Fortune Oil	105/lit	500 ml	52.5	500 ml	52.5
Sugar	44/kg	500 g	22	420 gm	18.48
<i>Tulsi</i> Extract	298/lit	-	-	80ml	23.84
Fuel (LPG)	607/14.2 kg	0.22 Kg gas/Kg <i>Gulabjamun</i> (0.33 kg gas)	14.10	0.22 Kg gas/Kg <i>Gulabjamun</i> (0.33 kg gas)	14.10
Plastic Cup	40/100 Cups	22	8.8	22	8.8
Aluminium Foil	105/50g	50g	105	50g	105
Labour Charge	300/8h	2h	75	2h	75
Misc.			20		20
Total Cast /Kg			383.33		459.17

4. Conclusions

Preliminary studies were carried out for process optimization for the manufacturing of low calorie fiber enriched herbal *Gulabjamun*. First of all Cow milk is standardized at 3% fat and 9% SNF by pearson square method by altering the levels of water and skim milk powder. In the second phase 27 different trails and different combinations were manufactured for optimizing the level of fat replacer Sorbitol, Oat flour and *Tulsi* extract for manufacturing of low calorie, fiber enriched herbal *Gulabjamun* by comparing these combination on the basis of sensory and chemical properties 6% fat replacer (Sorbitol), 20% oat flour, 20 % *Tulsi* extract was found most suitable and posses maximum overall acceptability.

4.1 Coliform count in functional *Gulabjamun*

The Coliform count of functional *Gulabjamun* is nil.

4.2 Yeast and Mould counts in functional *Gulabjamun*

The Y/M count of functional *Gulabjamun* is very low, indicating good keeping quality of the functional *Gulabjamun*.

The microbiology analysis of low calorie fiber enriched herbal *Gulabjamun* indicates that the keeping quality is near about 16 days without any sign of microbial growth.

4.3 Cost of production of Low Calorie Fiber Enriched Herbal *Gulabjamun*

The production cost is the one of the important considerations for establishing the project. The production cost of developed *Gulabjamun* was worked out by taking cost of ingredients from current market rates. However newly developed product constituents oat as fiber source, fat replacer as Sorbitol as well as *Tulsi* extract. So it is beneficial for peoples suffering from

obesity, diabetes, heart related problems and constipation. The total cost of production of low calorie fiber enriched herbal *Gulabjamun*. was estimated as Rs. 459.17/Kg. whereas the cost of normal *Gulabjamun* was Rs. 383.33/Kg. The developed *Gulabjamun* was costlier than normal *Gulabjamun* by Rs. 75.84/Kg. The cost of production of developed *Gulabjamun* is quite higher as compared to normal *Gulabjamun*. So it is clear from analysis that the cost of production of low calorie, fiber enriched herbal *Gulabjamun* is very quite expensive as compared to normal *Gulabjamun*. However newly developed *Gulabjamun* constitutes of oat as a fiber source, fat replacer as Sorbitol as well as *Tulsi* extract is beneficial for the peoples suffering from diabetes, heart related problem, constipation and obesity. The increased price is justified since the product is low calorie, fiber enriched and possessing antioxidant activities.

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