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Chemical and organoleptic characteristics of functional gulabjamun along with food energy value

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Abstract
The functional gulabjamun, a dairy product was developed by using soy fortified milk to enhance the functional properties. The chemical composition, energy value and sensory attributes are important parameters for commercial acceptability of any food product and thus, the present study was aimed to explore the product formulation and its functional characterisation. Five different ratios of buffalo milk and soya milk i.e. 1:0 (T_0), 1:1 (T_1), 1:2 (T_2), 1:3 (T_3) and 1:4 (T_4) and three different levels of maida i.e. 30% (M_1), 33%(M_2) and 35% (M_3), respectively were taken for the mix formulation. These treatment combination (T_0, T_1M_1, T_1M_2, T_1M_3, T_2M_1, T_2M_2, T_2M_3, T_3M_1, T_3M_2, T_3M_3, T_4M_1, T_4M_2 and T_4M_3) used in the study were replicated six times. Sensory evaluation of the prepared functional gulabjamun was carried out by using nine point Hedonic scale. The Highest overall acceptability of gulabjamun was found for sample T_0M (8.35) and soya fortified milk T_1M_1 (8.49). Among the different treatment combinations, the highest flavour and taste score was found in T_0M (8.25) followed by T_1M_1 (8.37). The treatment combination $T_1M_1$was most acceptable in terms of body and texture as it has the highest score of 8.47. For colour and appearance, the treatment combination T_0M (8.35) was recorded be the most acceptable followed by T_1M_1 (8.64). The highest energy value of gulabjamun (T_4M_3) was (340.82 kcal/100 gm).

Keywords: Buffalo Milk; Soya Milk; Khoa; Maida; Sugar; Energy value

Introduction
Milk has been an essential part of our diet from times immemorial. India has emerged as the largest milk producing country of the World. As per the data published by Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, Govt. of India. India ranks first in milk production, accounting 18.5% of world production, with an annual production of 155.5 million tonnes during 2015-16 as compared to 146.3 million tonnes during 2014-15. Forty seven percent of total milk produced in India is converted into Indigenous dairy products viz. ghee, khoa, chhana, paneer, butter and varieties of sweets (Gupta 2007; Kumar. *et al* 2017; Prabhakar. *et al.* 2015) [14, 21, 19]. It is well recognized that, Indigenous dairy products stored at ambient temperature have longer shelf life than liquid milk and the conversion of milk into milk products is more profitable than the sale of liquid milk. Though the quality of milk and the compositions affects nutritional properties of dairy products must be ensured by analytical or sensing means based method (Kant.*et al*. 2017) [22]. The indigenous dairy product attracts consumers on the large scale due to vast varieties. The manufacturing processes of these products involves: heat and acid coagulation, heat desiccation, separation, fermentation etc.

Functional foods can be considered to be those whole, fortified, enriched or enhanced foods that provide health benefits beyond the provision of essential nutrients to the human (Head *et al.*, 1996). Increasing the levels of neutraceuticals and bio-active compounds in a product may be a significant approach while developing a functional food. This may be achieved through fortification of food products with one or more functional ingredients, such as dietary fibres, antioxidants, natural isoflavones, plant sterols/stanols, phytochemicals or phytonutrientvs, bio-active peptides, w-3, -6 Polly Unsaturated Fatty Acid, probiotics, prebiotics, minerals and vitamins etc. (Heasman *et al.*, 2001) [13].

Gulabjamun is one of the popular khoa based sweet consumed on large scale during the festive season and generally made with khoa, maida and sugar syrup. The name "Gulabjamun" comes from its appearance like a monsoon fruit "Jamun" and is flavoured with "rose water" (Kant, R. (2015) [20]. The Thesis.) is generally prepared from Dhap Khoa having 40-45 per cent moisture (Badami *et al.,* 2006) [4]. Gulabjamun is largely produce on small scale, due to which large variation in the sensory quality of gulabjamun is reported in terms of size, shape, colour and texture. However, the most acceptable product should have brown colour, smooth and spherical shape, soft and slightly spongy body free from lumps and hard central core, uniform granular texture, mildly cooked and oily flavour, free from doughy feel and fully succulent with sugar syrup. The overall chemical composition of gulabjamun is widely depends on the numerous factors, such as composition and quality of khoa, proportion of ingredients (maida and khoa), frying time, frying temperature and sugar syrup concentration, etc. As per Minhas *et al.,* (1985) [15], the composition of gulabjamun varies in the following range: Moisture: 25–35%, Fat 8.5–10.5%, Protein 6–7.6%, Ash: 0.9–1.0% and total carbohydrates: 43–48% on the drained weight basis. In gulabjamun manufacturing, dipping/soaking the balls in sugar syrup is a key unit operation which provides a characteristic sweetness and a typical texture. The characteristic sweetness is only due to the diffusion of sugar syrup into fried gulabjamun balls (Naikwadi *et al.* 2010) [16].

Fat consumption in higher amount increases the risk of heart attack because of high proportions of saturated fats available in the diet (Hu *et al.,* 2001) [11]. If the fat intake in a diet may reduced to be less than 30 per cent of the calories with fats and oil, then dietary fat would not be risk factor at all in heart disease.

Soyabean is often called the "golden miracle bean and is the world's foremost provider of protein and generally used for health food, feed sources and industrial products. It contains about 20% oil and 40% high quality protein (as against 7.0% in rice, 12% in wheat, 10% in maize and 20-25% in other pulses) (Deshpande *et al.,* 2008) [9]. Soya products are becoming popular especially amongst health conscious people and many value-added products are made from it like milk, sauce, paneer etc. Soya bean is rich in proteins and have protective properties against breast cancer, prostate, colon and lung cancers because of the isoflavones content (Clarke and Wiseman, 2000) [6]. Woodside *et al*., (2016) [26] mentioned that the Soya milk is rich in isoflavones while Cow's milk does not contain isoflavones. The isoflavones have many health benefits including reduction of cholesterol, easing of menopause symptoms, prevention of osteoporosis and reduction of risk for certain cancers (prostate cancer and breast cancer). Incidents of these cancers are very low in countries with high intake of soya products, including soya milk. Isoflavones are also antioxidants which protect our cells and DNA against oxidation. The presence of isoflavones is the most important and unique benefit of soya milk, (Alekel *et al.,* 2000) [1]. Other than the whole seed, many processed soy products are available in the market viz., soya milk, soya flour, soya curd and tofu (soya paneer). Soya protein is a complete protein, containing all of the indispensable amino acids required by the body in the correct proportions and amounts to meet human needs for growth, maintenance and repair of living tissues (Davies *et al.,* 1990) [8]. Soya protein is the only complete plant based protein which is available to those maintaining a vegetarian lifestyle and is equal in protein quality to milk, meat and egg proteins. Muscles need protein to repair, rebuild and grow. In accordance with the guidelines given by WHO/FAO/UNU, used of soy protein as a whole source of protein in the daily diet will support normal muscle formation and maintain nitrogen balance in both children and adults. Keeping these unique properties of soya milk, an attempt has been made to enhance the functionality of gulabjamun by fortification of soya milk.

Materials and Methods

The preparation of functional gulabjamun using khoa from soya fortified milk was carried out in the Student's Training Dairy and Food Research Laboratory of Warner college of Food and Dairy Technology, Sam Higginbottom University of Agricultural Technology and Sciences, Allahabad, U.P. India during Ph.D. Research work of first author.

Raw material collection and sample preparation

The raw materials such as Soyabean, maida flour, sugar and vegetable oil for the preparation of functional gulabjamun were procured from the local market of Naini, Allahabad while the buffalo milk was collected from Student's Training Dairy, Sam Higginbottom University of Agricultural Technology and Sciences, Allahabad, U.P. Soya milk was prepared from soybeans as per the process flow chart reported by Wang and Murphy (1996) [27] (Fig. 1).

Weigh 50 g (Soyabean)
↓
Pre-blanching
↓
Release pressure after blanching
↓
Cooling and soaking of pre blanched Soyabean
↓
Grinding of soaked soybean with hot water (1:8)
↓
Filtration of soymilk through double layer muslin cloth
↓
Soymilk

Fig 1: Process flow chart for extracting soymilk.

Formulations and treatment combinations

Four different ratios of Soya milk and Buffalo milk i.e. 50:50, 60:40, 70:30 & 80:20 were used for making Khoa. Three treatments of maida viz., M_1, M_2 and M_3 i.e. 30%, 33% and 35% with respect of obtained khoa (weight) were used for the preparation. The method of gulabjamun preparation was same as the method followed by De (1980).

Mixed milk (Buffalo milk and Soya milk) (6% fat and 9% SNF)
↓
Heat desiccation
↓
Khoa
↓
Kneading of khoa with maida and baking powder
↓
Preparation of balls
↓
Frying in vegetable oil
↓
Soaking in 62.5% sugar syrup for 2-3 hours
↓
Functional Gulabjamun (ready to serve)

Fig 2: Flow diagram for control and experimental Functional Gulabjamun.

Chemical composition

Proximate analysis for moisture, ash, protein, fat, total carbohydrate was carried out by standard method of AOAC (2002). These parameters are considered to be important for nutritional information for any food.

Organoleptic properties and energy value

The samples of functional gulabjamun were evaluated for flavor, body & texture, color & appearance, sweetness and overall acceptability on a 9-point hedonic scale by a sensory panel consisting of 8 judges as reported by Srilakshmi, (2002). Energy value was determined on the basis of nutritional composition. The Atwater method of energy calculation prescribed by FDA was used to calculate energy from protein, fat and carbohydrate, as adapted by (Schakel *et al*., 1997). The energy calculation equation using general Atwater factors is the following:

Energy (kcal) = (4 kcal/g protein x g protein) + (9 kcal/g fat x g fat) + (4 kcal/g carbohydrate x g carbohydrate)

Statistical analysis

Analysis of variance (ANOVA) was used to study the significant differences among the treatment combinations and their interaction. This was also used to find out the effect of quantity of maida in the mix on the quality of functional gulabjamun. A total five replications were taken for experiments and the energy value of all samples has been represented as mean value. Also, the average value of sensory score of different sample of functional gulabjamun was used to select the best composition mix.

Results and Discussions

Chemical composition

The chemical composition of soya fortified milk based gulabjamun are prepared in fig no. 3. A highly significance difference between the proximate composition of control (T_0) and soya milk based products was observed in the form of moisture, protein, fat, carbohydrate and ash. The moisture content of gulabjamun is basically depends on the initial composition of khoa, also the moisture retention in gulabjamun is largely affected by the addition of additives. Both 30% and 33% proportion of maida with respect to khoa obtained was found to be good for the developed functional gulabjamun. It has been found that the sample T_2M_1 and sample T_4M_2 consists of more fat and protein respectively compared to other samples. Based on the analysis, the percent carbohydrate in gulabjamun sample T_3M_3 was higher than other samples respectively. De (1982) stated that carbohydrate or total sugar percentage was influenced by total solid content in a product. As the moisture content decreases due to the evaporation of milk for the conversion into khoa, the total solid increases and the total sugar content increases. There is a significant difference in carbohydrate content in the product because of the addition of different levels of additives in the final product. The percent ash in functional gulabjamun sample T_3M_3 was higher than other samples also; there is a significant difference in ash content in the product mainly because of the differences in total solids content of the product. This may be because of the addition of different levels of additives in the final product. Biswas and Chaudhary (2002) also examined the possibility of blending cow milk with soy milk for getting milk product analogues.

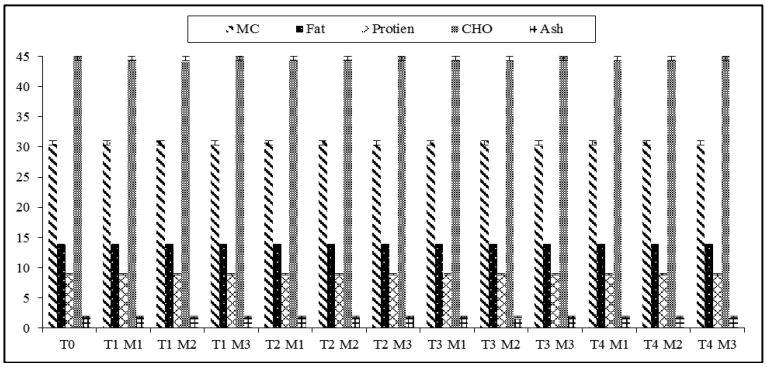

Fig 3: Chemical composition (%) of different combinations of functional gulabjamun.

Flavour and taste score of functional gulabjamun

The average flavour and taste score of functional gulabjamun samples were graphically presented in Fig. 4. It has been observed that the average flavour and taste score of sample T_1M_1 (Buffalo milk: Soya milk as 50:50 with Maida 30% on the basis of khoa obtained from mixed milk) was higher than other samples. The ANOVA (Table 1) showed that the calculated F values were less than tabulated values at 5 per cent probability levels for sources of variations M, T and interaction terms (MxT). It revealed that there was no significant difference between levels of maida, between treatments as well as interaction between them.

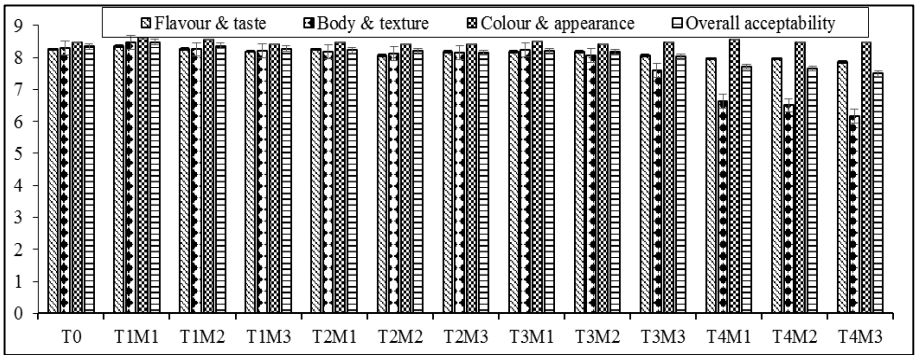

Fig 4: Sensory scores of different combinations of functional gulabjamun.

Body and texture score of functional gulabjamun

The average body and texture score of different samples of functional gulabjamun were presented in Fig. 4. It can be observed that the average body and texture score of functional gulabjamun sample T_1M_1 was higher than other samples. Data for average body and texture score of functional gulabjamun were statistically analysed to find out significant difference between treatments with regard to body and texture score of functional gulabjamun samples. The analysis of variance showed that the calculated values of F were greater than their tabulated F values at 5 per cent with at 1 per cent probability levels for level of Maida as well as treatment (Table 1). However, the interaction between level of maida (M) and treatments (T) i.e. MxT were not significant at $P<0.05$ as well as $P<0.01$. Therefore, it can be concluded from the experimental data that there are significant difference between levels of maida and between treatments over body and texture score.

Table 1: ANOVA for different sensory parameters of functional gulabjamun

Flavour and taste score						
Sources of variation	**d. f.**	**S. S**	**M.S.S.**	**F_{cal}**	**F_{tab} (5%)**	**Result**
Replication	5	1.984	0.3968	7.39		
Level of maida (M)	2	0.14	0.07	1.29	3.13	NS
Treatment (T)	4	0.53	0.1325	2.45	2.5	NS
Interaction (M x T)	8	0.073	0.00912	0.17	2.07	NS
Error	70	3.764	0.054			
Total	89	6.491				
Body and texture score						
Replication	5	0. 355	0. 071	1. 61		
Level of maida (M)	2	1. 01	0. 505	11. 48**	3. 13	4. 92
Treatment (T)	4	42. 41	10. 60	240. 91**	2. 5	3. 6
Interaction (M x T)	8	0. 528	0. 07	1. 6NS	2. 07	2. 77
Error	70	3. 057	0. 044			
Total	89	47. 36				
Colour and appearance score						
Replication	5	0. 12	0. 024	0. 24		
Level of maida (M)	2	0. 172	0. 086	0. 87	3. 13	NS
Treatment (T)	4	0. 28	0. 07	0. 71	2. 5	NS
Interaction (M x T)	8	0. 19	0. 024	0. 24	2. 07	NS
Error	70	6. 92	0. 099			
Total	89	7. 68				
Overall acceptability score						
Replication	5	0. 066	0. 0132	0. 825		
Level of maida (M)	2	0. 706	0. 0353	22. 06**	3.13	4.92
Treatment (T)	4	7. 34	1. 835	111.68**	2.5	3.6
Interaction (M x T)	8	0. 274	0. 034	2.125	2.07^{NS}	2.77^{*}
Error	70	1. 124	0. 016			
Total	89	9. 51				

NS = Non Significant, ** HS at $P<0.01$ and $P<0.05$, NS: Non significant at $P<0.05$, * significant at $P<0.01$, ** HS at $P<0.01$ and $P<0.05$, NS: Non significant at $P<0.05$, * significant at $P<0.01$.

Table 2: Comparison of different sensory scores of functional gulabjamun against critical difference (for maida).

Level of maida	Sensory scores	M_3	M_2	M_1
Body and texture score				
M_1	8.46	0.26^{**}	0.12^{**}	
M_2	8.11	0.14^{**}		
M_3	6.17			
Overall acceptability				
M_1	8.48	0.21^{*}	0.06	
M_2	8.20	0.15^{*}		
M_3	8.02			

** Significant for CD at 5% =0.11, * Significant for CD at 5% = 0.066,

The data were further analysed using critical difference and the results are presented in the table 2 and 3. On comparing the average body and texture scores for different levels of maida against the critical difference, the significant difference was observed between the mean values of (M_1, M_3), (M_1, M_2) and (M_2, M_3). On comparing the average body and texture scores showed in table 3 for different treatments against the critical difference, the significant difference was observed between the mean values of T_0, T_1M_1, T_1M_2, T_1M_3, T_2M_1, T_2M_2, T_2M_3, T_3M_1, T_3M_2, T_3M_3, T_4M_1, T_4M_2 and T_4M_3. Whereas non-significant difference was observed between the mean values of T_0 and T_1. The differences in body and texture scores in the product were probably attributed to differences in physical properties of milk fat and different levels of binder i.e. maida used in this experiment. It was also due to the variation in the moisture retention in the product. With the increase in the retention of moisture, the body and texture of the product was improved.

Table 3: Comparison of average body and texture score of functional gulabjamun against critical difference. (For treatment)

Treatments	Sensory scores	T_4	T_3	T_2	T_1	T_0
Average value of body and texture						
T_0	8.28	1. 85*	0. 42*	0. 23*	$0. 04^{NS}$	
T_1	8.46	1. 81*	0. 38*	0. 19*		
T_2	8.11	1. 62*	0. 19*			
T_3	8.15	1. 43*				
T_4	6.62					
Overall acceptability						
T_0	8.40	0. 77*	0. 34*	0. 2*	$0. 02^{NS}$	
T_1	8.38	0. 75*	0. 32*	0. 18*		
T_2	8.20	0. 57*	0. 14*			
T_3	8.06	0. 43*				
T_4	7.63					

CD at 5% = 0.139 * Significant, CD at 5% = 0.084 * Significant, NS: Non significant

Colour and appearance score of functional gulabjamun

Colour and appearance scores are presented in Table 1 and it can be observed that the average colour and appearance score of functional gulabjamun sample T_1M_1 was higher than other samples. Data for average colour and appearance score of functional gulabjamun were statistically analysed to find out significant difference between treatments with regard to the colour and appearance score of functional gulabjamun samples. That the calculated values of F were less than their tabulated F values at 5 per cent probability levels for M, T and MxT. Therefore, it can be concluded from the experimental data that there were no significant difference between levels of maida, between treatments as well as interaction between them over colour and appearance of functional gulabjamun.

Overall acceptability score of functional gulabjamun

It can be observed from Table1 that the average overall acceptability score of functional gulabjamun samples T_0 and T_1M_1 were higher than other samples. Data for average overall acceptability score of gulabjamun were statistically analysed to find out significant difference between treatments with regard to the overall acceptability score of functional gulabjamun samples. That the calculated values of F due to levels of maida and due to treatments are greater than their respective F values at 5 per cent as well as at 1 per cent probability levels. Therefore, it can be concluded from the experimental data that there are high significant difference between levels of maida and between treatments. Whereas,

the calculated value of F due to interaction between maida and treatment is less than its tabulated value F values at 1 per cent and at 5 per cent probability levels, the calculated value is slightly higher than tabulated value. Therefore, it can be concluded from the experimental data that there is non significant difference due to interaction between maida and treatment at $P<0.05$ but slightly significant at $P<0.01$.

The data were further analysed using critical difference and on comparing the average overall acceptability scores for different levels of maida against the critical difference, the significant difference was observed between the mean values of (M_1, M_3) and (M_2, M_3). Whereas, non-significant difference was observed between the mean values of (M_1, M_2). On comparing the average overall acceptability scores for different treatments against the critical difference, the significant difference was observed between the mean values of (T_0, T_4), (T_0, T_3), (T_0, T_2), (T_1, T_4), (T_1, T_3), (T_1, T_2), (T_2, T_4), (T_2, T_3) and (T_3, T_4).Whereas, non-significant difference was observed between the mean values of (T_0, T_1).The differences in overall acceptability scores of the product were attributed due to the sensory and physical characteristics.

Energy Value of Functional Gulabjamun

It is exhibited from Fig 5 that the average energy value of functional gulabjamun samples T_0, T_1M_1, T_1M_2, T_1M_3, T_2M_1, T_2M_2, T_2M_3, T_3M_1, T_3M_2, T_3M_3, T_4M_1, T_4M_2 and T_4M_3 were 339.31, 338.60, 337.87, 340.14, 339.31, 337.96, 340.37, 338.83, 338.25, 340.41, 338.90, 339.07 and 340.81 kCal/100g. The high energy value of these samples were due to their energy rich ingredients like milk fat, vegetable oil, sugar and refined wheat flour.

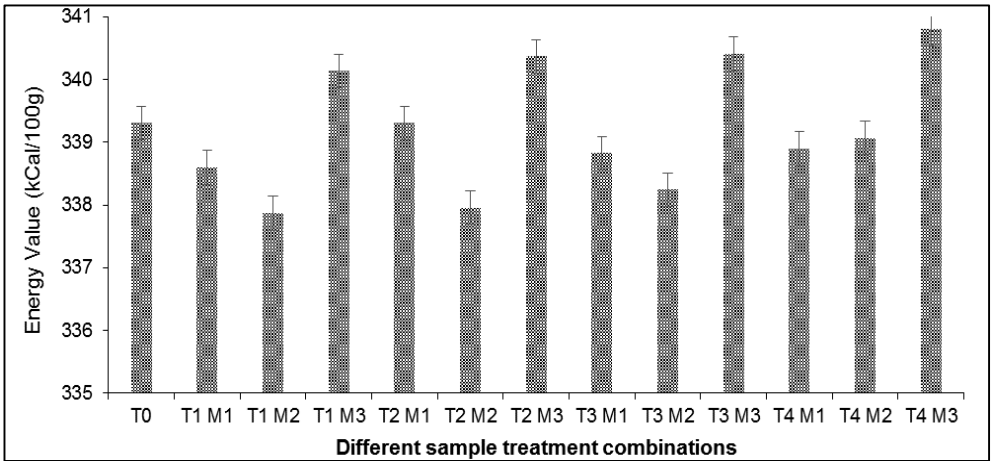

Fig 5: Energy value of functional gulabjamun samples

Conclusion

The effects of treatments (T) and Maida (M) on overall acceptability and sensory attributes reflected to have T_1M_1 combination. The scores of overall acceptability, flavour & taste, body & texture and colour & appearance were 8.48, 8.36, 8.46 and 8.47 respectively, which were closer to control sample. Therefore, the mixed milk of 6% fat and 9% SNF prepared by mixing buffalo milk with soya milk in the ratio of 50 : 50 is found to be best for preparation of khoa to be used in functional gulabjamun. The maida variation was found to be best as 30% of Khoa on weight basis to be used as binder in preparation of gulabjamun. The standard method of De (1980) was followed to prepare the functional gulabjamun. The maximum Energy value of gulabjamun sample 340.82 kCal/100gm was recorded in T_4M_3 treatment combination. In light of present finding, the use of soya milk is highly recommended for the development of milk based dessert for protein malnourished people with variable proportion. Though, the soy milk has been also be recommended as substitute for dairy milk in muffin and popovers (Swanson *et al*. 2012; Yadav *et al*. 2017) [23, 2]. If may be used for all the valuable group, CVD patient and protein energy deficiency disseats

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