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Full Length Research Paper

Efficacy of defatted soy flour supplement in *Gulabjamun*

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Study was undertaken to determine the efficacy of defatted soyflour mix levels in *Gulabjamun* (sweet dessert comprised of fried milk balls dipped in sugar syrup) and its impact on the quality parameters. Soy flour was fortified in three levels (3.33, 6.66 and 9.99%) w/w to prepare different compositions of *Gulabjamuns* by replacing wheat-flour in control recipe. 10 g spherical shape balls were made using thoroughly mixed ingredients dough and these were deep -fried in oil before soaking in sugar syrup (50°Brix for 4 h) at 70°C. Standard methods were used to estimate protein and crude fat content in *Gulabjamun*. Significant effect of raw premixes, prior to sugar syrup dipping, was observed due to addition of defatted soy flour on protein and fat content. Protein content was decreased to 18.24% from 20.66% and fat content increased to 28.36 from 12.09% in deep-fried samples from raw premix. Hardness, cohesiveness, springiness/elasticity, gumminess and chewiness values were increased with the increase in the soy flour levels. Appearance, colour, texture, flavour and overall acceptability of the *Gulabjamuns* had improved with the addition of 3.33% soy flour and decreased there after.

Key words: Fat, fortification, *Gulabjamun*, protein, sensory attributes, soy flour, TPA.

INTRODUCTION

Recently, the food industry has seen expansive growth in what is known as “functional food”. Recent growth of funcional foods far outpaces that of conventional foods and supplements, and has attracted the interests of both consumers and food producers (van Poppel, 1998; Locklear, 2000). van Poppel (1998) defined functional foods as food that exerts a beneficial health effect beyond the recognized traditional nutritional value of such a food. Within the grouping of functional foods are two categories; 1) potential functional foods (those with the potential for use in human nutrition), and 2) established functional foods (those with proven benefits in human nutrition) (Heller, 2008).

Soybean is one of the nature’s wonderful nutritional gifts. Soybeans have served as a major source of dietary protein for many people throughout Asia for over 1,000 years (Wiseman, 1997). In other parts of the world, however, soybeans have been sought after mostly for their oil. Soybeans contain all the three-macro nutrients required for good nutrition, complete protein (40%), carbohydrate (18%), fat (18%) and moisture (9%) as well as vitamins and minerals (5%), including folic acid, calcium, potassium and iron (National Soybean Research Laboratory, 2008). Soybean protein provides all the nine essential amino acids in the amounts needed for human health. Fortification of cereals with soy will not only improve protein quantity but also improve the quality of food nutrients such as amino acid balance. Recent developments in processing technology and a need to meet demands of new soyfood consumers have brought on the development of a new class of soyfoods, known as “the second generation of soyfoods” (Liu, 1997). This “second generation of soyfoods” includes among others soy sausages, soy yogurt, and soy cheeses, and soy-based dairy analogs. These foods utilize protein ingredients derived from defatted soybean meal including soy protein concentrate, soy protein isolate, and texturized soy protein (Liu, 1997).

Consumption of soyfoods has been on the rise since the establishment of the October, 1998U.S.FDA-approv-

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ed soy health claim, which links the intake of products high in soy protein with positive health benefits such as lower risk for heart disease (Henkel, 2000; Federal Register, 1998). Soy- based dairy analogs such as soymilk, soy yogurt, and soy ice cream are available; however there are few soy-fortified dairy-based food products that might appeal to a more traditional dairy consumer (Berry, 2002). Drake et al. (2000 and 2001) evaluated soy protein fortification of dairy yogurts. Although physical and sensory properties were altered, consumer studies indicated an interest and a potential market for soy fortified dairy yogurts and other foods (Drake and Gerard, 2003).

In addition to soybeans supplying adequate protein to the diet, studies have shown that protein from soybeans may be beneficial to human health in other ways. Aside form soy protein being low in saturated fat and cholesterol free; there may be many more advantages to consumption of soy in the diet (Messina, 1995). Research shows that, blending of soy flour with wheat flour will increase the recommended amino acid availability from 40 to 80% (Khan et al., 2005). In addition to nutritional improvements, soy fortified wheat flour will improve the functional characteristics of the end products in terms of better moisture retention and less oil absorption. It has been recognized for some time now that consumption of plant proteins often results in significant lowering of low-density lipoproteins and total cholesterol levels, which are associated risk factors for cardiovascular disease (Friedman and Brandon, 2001; Krummel, 1996).

Effect of soybean flour lipoxygenase isozymes on wheat flour dough rheological and bread making properties were studied by Cumbee et al. (1997). Also, an appropriate household/small-scale technique for the production of soy- fortified fermented maize dough by comparing different treatments, processing methods and fortification levels were investigated (Plahar et al., 1997). Torres et al. (1998) studied the sensory characteristics of soymilk and tofu made from lipoxygenase-free and normal soybeans and found that there was no difference between lipoxygenase- free and normal soybeans for milky flavor, wheat flavor, thickness and chalkiness. Massey et al. (2001) observed that the consumption of soybeans and foods made from them are increasing because of their desirable nutritional value. Effects of high and low-isoflavone soy-protein foods on lipid and non-lipid risk factors for coronary artery disease were investigated. Saxena et al. (1996) studied the soy flour – *Gulabjamun* premixes and ready-to-serve soy flour - *Gulabjamun* prepared from mixture of soy flour and milk solids and found 40% soy flour substitution of whole milk powder prepared *Gulabjamuns* was best.

Gulabjamun is a popular and favorite sweet dish/ /desserts comprised of *khoya* rounds deep fried in ghee /fat and soaked in hot saffron/cardamom seeds/rosewater flavoured sugar syrup. The *khoya* or *mava* is made by reducing low fat milk and is slightly yellowish in colour and is also loose and sticky in consistency. Frying is done on sufficiently low flame that the *Gulabjamuns* get cooked till the inside with golden brown colour balls. They are served warm or at room temperature. Currently, there is limited literature encompassing the utilization of soy flour for preparations of soy flour fortified *Gulabjamuns*. Thus, the present study was undertaken to find out the effect of defatted soyflour addition levels (0, 3.33, 6.66 and 9.99%) w/w in *Gulabjamun* on protein, fat, sensory and textural quality parameters.

MATERIALS AND METHODS

Materials

The raw materials are such as *khoya*, paneer (Indian cheese), wheat flour, semolina, baking powder, refined oil and soy flour were obtained from local market of Ludhiana (Punjab, India). The experiment was conducted in the Department of Processing and Food Engineering, Punjab Agricultural University, Ludhiana, Punjab, India.

Preliminary studies

Based on the preliminary studies carried out for the preparation of *Gulabjamuns* using different levels (0, 3.33, 6.66, 9.99, 13.32, 16.65 and 19.98% w/w) of defatted soy flour in the recipe. Three levels of soy flour mixing, that is, 3.33, 6.66 and 9.99% w/w were considered for further studies based on sensory evaluation. Each experiment was replicated for five times.

Gulabjamun premix

Premix raw materials were procured from Ludhiana local market for making control *Gulabjamun*. The control premix consists of *khoya* (66.66%), *paneer* (16.6%), wheat flour (13.3%), semolina (2.66%), baking powder (0.16%) and refined oil (0.62%). Soy flour was fortified in three levels (3.33, 6.66 and 9.99% w/w) by replacing wheat flour in control recipe to prepare three different compositions of *Gulabjamuns*. All the ingredients like *khoya*, *paneer*, wheat flour, semolina, refined oil and baking powder were weighed and mixed thoroughly in small quantity of water to make dough and thereafter 10 g spherical/ round shape balls were prepared and these were deep fried in fat using the electrical fryer at 130°C temperature for 15 min to get a light brown coloured surface (Rangi et al., 1985).

Sugar syrup and soaking of *Gulabjamun*

Boiling 250 g of sugar in 300 ml of water for 5 min made sugar syrup of 50°Brix. The total solids of sugar syrup were determined by using an ERMA (Japan) make hand refractrometer having range 32 - 60°Brix. TSS value was recorded on scale at a temperature of 20°C. Deep fried *Gulabjamuns* were soaked in hot sugar syrup having 50°Brix TSS at 70°C for 4 h (Rangi et al., 1985).

Estimation of protein content

Protein content of *Gulabjamun* samples were estimated using Microkjeldahl distillation apparatus as per the method of AOAC (2002a).

$$\text{Nitrogen, } N_2\ (\%) = \frac{\text{Liter value} \times 0.0014 \times \text{volume made} \times 100}{\text{Aliquot taken} \times \text{weight of the sample (g)}}$$

Table 1. Protein content (%) in *Gulabjamuns* at different levels of soy flour mix.

Soy flour mix, % and stat. parameters	Protein content (%)		
	Raw mix	Fried balls	Fried balls soakedin syrup
0.00	16.08	15.02	14.05
3.33	17.37	15.68	14.81
6.66	22.75	20.60	18.01
9.99	26.46	21.68	19.56
Mean ± sd	20.66 ± 4.17	18.24 ± 3.80	16.60 ± 4.64
SE_M	2.08	1.90	2.32
CD at 5%	0.75	1.32	0.88
CV (%)	1.94	3.84	2.81

Note: SE_M is standard error of the mean, sd is standard deviation, CD is critical difference and CV is critical variance.

N_2 (%) = [(A) x 0.0014×250×100] / (5×1)
∴ Protein (%) = N_2 (%) × 6.25

Estimation of fat content

Crude fat content (triglycerides of fatty acid) of *Gulabjamun* samples were estimated as per the standard method of AOAC (2002b) using fat extraction tube of soxhlet apparatus.

Fat content, % = (Amount of ether extract (g) / weight of the sample) × 100

Sensory evaluation

Gulabjamuns were evaluated for overall acceptability of samples by a randomly selected panel consists of minimum 15 persons. The panel was asked to evaluate the a, b, c …. coded samples of *Gulabjamuns* for appearance, color, texture, flavour and overall acceptability as per 9 point Hedonic scale (Rangi et al., 1985). Samples were served as per standard of sensory evaluation.

Textural behaviour

Textural profile analysis (TPA) of *Gulabjamuns* was carried out using texture analyzer (Model No: TA-Hd*i*, Stable Micro Systems, UK) in the Engineering Properties Laboratory of the Department. The texture behaviour of whole *Gulabjamuns* was estimated in terms of the TPA curve. The parameters of the brittleness, hardness, cohesiveness, chewiness, springiness and gumminess were calculated from the plot of two cyclic compression tests. The following textural parameters were estimated as follows (Bourne, 1982):

Hardness: The maximum height of curve during the first compression.
Brittleness: Height of first significant break of multi peak shape of first chew.
Cohesiveness: Ratio of area under second peak to that of first peak, that is, A_2/ A_1.
Elasticity: Test speed × distance on × axis from start of second bite to its peak.
Chewiness: Hardness × cohesiveness× elasticity.
Gumminess: Hardness × cohesiveness.

Statistical analysis

The statistical analysis was carried using two-way ANOVA in General Linear Model (GLM) using Statistical Package for Social Sciences (SPSS) - version 7.5. Five replication means were computed and tested at 5% levels of significant to arrive at the best results of the treatments.

RESULTS AND DISCUSSION

Efficacy of soy flour mix level on protein content

In Table 1, it is clear that the protein content was higher in the raw mix as compared to the fried balls. The decreases in protein after frying of raw mix balls may be due to incorporation of oil and air in the fried balls. The protein content further decreased to some extent after soaking in sugar syrup. This may be due to the incorpo-ration of sugar syrup in the balls and increase in the weight of *Gulabjamun* that has helped to lower protein content percentage. It was observed that protein content of soy-fortified mix increase might be due to use of higher protein content of defatted soy flour, which was significant in case of 6.66 and 9.99% levels. Bongirwar et al. (1979) studied the development of high protein ready to eat foods from defatted groundnut and soybean blends and observed that defatted soy flour mixed products gave satisfactory structure, colour and appearance. Babje et al. (1992) blended soymilk with buffalo milk for obtaining good quality paneer which showed higher protein content.

There was significant effect of addition of all levels of defatted soy flour on protein content of raw premixes prior to soaking in sugar syrup. There was also a signifi-cant difference between the values of protein content for raw premix and fried samples of *Gulabjamuns* . Statistical analysis shows that critical difference (CD) at 5% in raw mix, fried balls and fried balls soaked in syrup were 0.7542, 1.3196 and 0.8803 respectively. Critical variance (CV) % was 1.94, 3.84 and 2.81 in raw mix, fried balls and fried balls dipped in syrup respectively. Pair wise comparisons of protein content for different stages of *Gulabjamuns* found significantly difference between the values of protein content for raw premix and fried samples without dipping in sugar syrup (Table 2). Mean diffe-

Table 2. Pair wise comparisons of protein content in *Gulabjamuns* at different levels of soy flour mix.

Premix I	Premix J	Mean difference (I - J)	Std. error	Sig.F	95% confidence interval	
					Lower bound	Upper bound
A	B	-0.975	1.157	0.461	-8.182	6.232
	C	-6.125*	1.157	0.013	-13.332	1.082
	D	-8.520*	1.157	0.005	-15.727	-1.313
B	C	-5.150*	1.157	0.021	-12.357	2.057
	D	-7.545*	1.157	0.007	-14.752	-0.338
	A	0.975	1.157	0.461	-6.232	8.182
C	B	5.150*	1.157	0.021	-2.057	12.357
	D	-2.395	1.157	0.130	-9.602	4.812
	A	6.125*	1.157	0.013	-1.082	13.332
D	B	7.545*	1.157	0.007	0.338	14.752
	C	2.395	1.157	0.130	-4.812	9.602
	A	8.520*	1.157	0.005	1.313	15.727

Based on estimated marginal means, *The mean difference is significant at the 0.05 level. Note: A- 0% soy flour; B- 3.33% soy flour; C- 6.66% soy flour; D- 9.99% soy flour

Table 3. Fat content in *Gulabjamun* at different levels of soyflour mix.

Soy flour Mix, % & Stat. Parameters	Fat content (%)		
	Raw Mix	Fried balls	Fried balls soaked in syrup
0.00	14.37	30.74	22.12
3.33	11.4	27.38	15.25
6.66	12.1	28.9	15.01
9.99	10.5	26.44	13.86
Mean ± sd	12.09 ± 1.43	28.36 ± 1.63	16.56 ± 3.25
SE_M	0.72	0.81	1.63
CD at 5%	1.05	1.66	0.62
CV (%)	4.54	3.12	2.02

Note: SE_M is standard error of the mean, sd is standard deviation, CD is critical difference and CV is critical variance.

rence with standard error between both were found to be 2.42 ± 0.81.

Efficacy of levels of soy flour on fat content

Fat content increased to 28.36 from 12.09% in deep- fried samples as compared to the raw premix. It is clear that the fat content of *Gulabjamun* decreased with the increase in defatted soy flour level (Table 3). The fat content of raw mix having 3.33, 6.66 and 9.99% levels of defatted soy flour were significantly different from each other. The decrease could be due to a very low fat conent of defatted soy flour. Fried *Gulabjamun* soaked in sugar syrup having 0% soy flour (control) had an average fat content of 22.12%. The fat content decrease may be due to diffusion of sugar syrup in fried balls. It was found that there was significant effect of addition of defatted soy flour at all levels on fat content of raw premixes and without sugar syrup soaked samples. Bookwalter et al. (1971) reported that full-fat soy flours prepared by the extrusion process have good nutritive value, flavor and stability. From Tables 4, it is clear that pair wise comparisons of fat content has significant difference between the values of fat content of raw premix and without dipping in sugar syrup.

Textural profile analysis of *Gulabjamuns*

Textural characteristics of fresh, soy-fortified *Gulabjamuns* are given in Table 5. Hardness of *Gulabjamuns* increased with the increase in the levels of soy flour. This increase might be due to the decrease in fat content, increase in protein content and reduction in moisture content (Gulhati et al., 1992). *Gulabjamun* cohesiveness, springiness/elasticity, gumminess, and chewing value were 0.45 g, 3.9 mm, 91.4 and 356.45 g respectively. Cohesiveness, springiness/elasticity, gumminess, and chewing energy values increased with the increase in soy flour level in *Gulabjamun*. Gumminess value increase with the increase of soy flour levels may be due to higher level of hardness in the *Gulabjamuns*. It was found that

Table 4. Pair wise comparison of fat content of *Gulabjamuns* at different levels of soy flour mix.

Premix I	Premix J	Mean difference (I-J)	Std. error	Sig. F	95% confidence interval	
					Lower bound	Upper bound
A	B	2.055*	0.284	0.005	0.285	3.825
	C	3.165*	0.284	0.002	1.395	4.935
	D	4.085*	0.284	0.001	2.315	5.855
B	C	1.110*	0.284	0.030	-0.660	2.880
	D	2.030*	0.284	0.006	0.260	3.800
	A	-2.055*	0.284	0.005	-3.825	-0.285
C	B	-1.110*	0.284	0.030	-2.880	0.660
	D	0.920*	0.284	0.048	-0.850	2.690
	A	-3.165*	0.284	0.002	-4.935	-1.395
D	B	-2.030*	0.284	0.006	-3.800	-0.260
	C	-0.920*	0.284	0.048	-2.690	0.850
	A	-4.085*	0.284	0.001	-5.855	-2.315

Based on estimated marginal means, *The mean difference is significant at the 0.05 levels.
Note: A- 0% soy flour; B- 3.33% soy flour; C- 6.66% soy flour; D- 9.99% soy flour.

Table 5. Effects of soy flour levels on the textural properties of fresh *Gulabjamuns*.

Soy flour mix (%)	Hardness (g)	Cohesiveness (g)	Elasticity(mm)	Chewiness (g)	Gumminess (g)
0.00	203.13	0.45	3.9	356.50	91.40
3.33	296.15	0.51	3.8	573.93	151.04
6.66	364.01	0.53	3.6	694.53	192.92
9.99	492.62	0.67	3.5	1155.19	330.05
Mean ± sd	338.97 ± 105.49	0.54 ± 0.08	3.7 ± 0.15	695.03 ± 291.98	191.35 ± 87.82
SE_M	52.75	0.041	0.079	145.99	43.92

Note: SE_M is standard error of the mean, sd is standard deviation.

energy required during mastication also increased with the increase in soy flour levels of *Gulabjamuns*.

Sensory evaluation of *Gulabjamuns*

The average values of appearance, colour, texture, flavor and overall acceptability of freshly prepared *Gulabjamuns* at different levels of soy flour have been given in Table 6. Addition of 3.33% soy flour had improved the appearance and colour of the *Gulabjamuns* and there after it has decreased for both the levels, that is, 6.66 and 9.99% soy flour with little variation. Among the three levels of replacements of soy flour, 3.33% mix had the best appearance and colour become darker with the increase in soy flour level. Flavour was also improved with the addition of 3.33 and 6.66% levels of soy flour but score decreased at 9.99%. However best flavour was obtained in 6.66% soy flour mixed *Gulabjamuns* . Overall acceptability was the average of appearance colour, ($p<0.05$) between different types of premixes. Overall acceptability was the highest in 6.66% soy flour mix. *Gulabj*It decreased with increase in soy flour level (9.99%) and remained same as control in 3.33% soy flour mix Gulab-*jamun* samples. Similar results were also reported by Biswas et al. (2002) and Jenkins et al. (2002). Beneficial effects for health associated consumption of soy products include menopausal symptoms, specifically hot flushes. It was concluded that soy products warrant a greater role in the Western diet on the basis of their potential health benefits accompanied by no apparent disadvantages of their consumption, and that dietitians could help consumers identify suitable soy products to act as replacements for other foods in their diet (Messina, 2003).

Conclusion

It has been concluded that there was significant effect of addition of defatted soy flour at all four levels on protein and fat content of raw premixes as well as fried samples texture and flavour. There was significant difference of *Gulabjamuns*. It was observed from TPA that the hardness, cohesiveness, springiness or elasticity, gumminess and chewiness value of *Gulabjamuns* were increased with the increase in the soy flour levels mix in *Gulab-jamun*. Appearance, colour, texture, flavour and overall

Table 6. Sensory evaluations of fresh *Gulabjamuns* of different levels of soy flour.

Soy flour mix, %	Appearance	Colour	Texture	Flavour	Overall acceptability
0.00	8.8	8.7	8.7	8.8	8.75
3.33	9.0	9.0	8.7	8.5	8.80
6.66	8.9	8.8	8.8	9.0	8.90
9.99	8.8	8.7	8.7	8.8	8.75
Mean ± sd	8.875 ± 0.08	8.8 ± 0.12	8.725 ± 0.04	8.775 ± 0.18	8.8 ± 0.06
SE_M	0.04	0.06	0.02	0.09	0.03

Note: SE_M is standard error of the mean, sd is standard deviation.

acceptability of the *Gulabjamuns* had improved with the addition of soy flour.

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