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Development and evaluation of soy based rasgulla blended with dairy milk

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Abstract
Rasgulla, the popular Indian dairy-based dessert, was blended by using soymilk to improve its nutritional and different physical parameters like color, texture and sensory attributes. Soymilk was blended with dairy milk in the ratio 100:0, 80:20, 60:40 and 40:60 (v/v) and were analyzed for physico-chemical, sensory and microbiological attributes. As such the rasgulla made from pure soy milk shows higher content of phenolics, flavanoids contents as well as antioxidant potential. Blending with dairy milk improve the color of the product in terms of CIE L*, a* and b* values. Hardness of the product also improved with increase in the dairy milk. Sensory score where also found to increase with increase in the level of dairy milk. The products showed shelf life of 60 days on the basis of physico-chemical, microbiological and sensory attributes.

Keywords: Physico-chemical, sensory attributes, microbiological, shelf life

Introduction
Soy foods are traditional foods made from soybeans in Asia, and now become popular in Western Countries. Soy foods have high plant protein content and contain polyphenol components, such as isoflavones. Thus, soy foods are classified as a functional food. In addition, soy foods may decrease the risk of coronary heart disease and have anti-cancer and anti-inflammation properties (Yang and others 2009; Peng and others 2009) [39, 31], and increase the Calcium absorption for women (Charoenphun and others 2013; Bao and others 2008) [7, 28] provide positive effects for Type 1 or Type 2 diabetes (Zimmermann and others 2012) [41], and maintain or even relieve dementia symptoms for patients who suffer from Alzheimer's disease (Duffy and others 2003) [11].

Soybean production in India is estimated to be around 10.450 million metric tonsin the year 2020-2021 accounting for 2.87 percentage of total world production. In 2020-2021, world production of soybeans was over 364.066 million metric tons. Brazil, USA and Argentina are the three major soybean producing countries which dominate global production, accounting for 81.45% of the world's soybean.

Soymilk, are considered a good substitution for dairy products for individuals who have milk intolerance. Soybeans are an excellent source of high quality protein, and soy milk has been used as a milk alternative. Soy milk contains high amounts of protein, iron, unsaturated fatty acids, and niacin, but low amounts of fat, carbohydrates, and calcium compared with cow's milk (Liu, 1997) [27]. Various soy products are made in many countries and have attracted much attention (Li *et al*., 2013) [26]. The primary focus has been on making rasgulla from mixtures of cow's milk and soy milk; however, its quality is decreased proportionally with increasing levels of soy milk (Rani and Verma, 1995) [33].

Rasgulla is a popular sweet prepared generally from dairy milk and it is a good source of milk proteins. It is prepared from *channa*, an intermediate product obtained from heat and acid coagulation of milk Milk is first boiled and curdled, usually by adding an adequate quantity of lemon salt. It is then filtered by filtering into a mull bag and the 'channa` collected and cooled by immersing the mull bag in cold water. Rasgulla is generally made from cow milk (Rao *et al*., 1989) [34] and there are very few reports regarding the manufacture of rasgulla from buffalo milk (Kanwal *et al*., 1980) [17]. This dairy product is easily digested and has high food value due to its fairly high protein content, calcium, phosphorus, vitamin A and D content (Tarafdar *et al*., 2002) [37]. Rasgulla are highly consumed due to its good nutritional and health beneficial property (Chavan *et al*., 2011; Sahu and Das, 2009) [8, 35]. Due to ongoing trends of vegetarianism, milk cholesterol, saturated milk fat and lactose intolerance production of non-dairy food products has emerged as popular alternative to traditional dairy products.

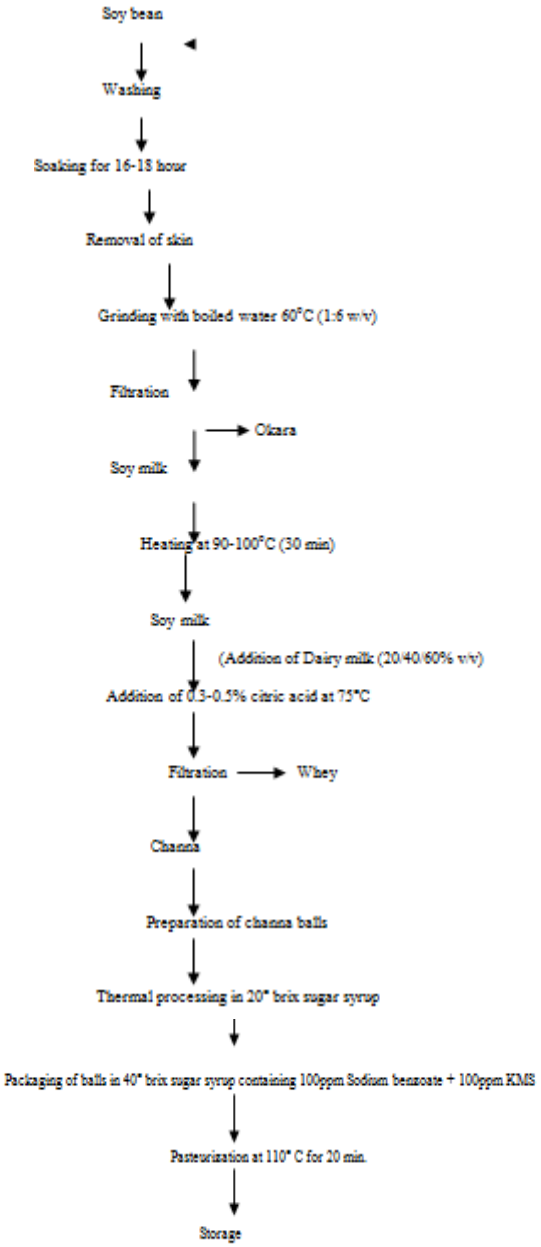
In the present study milk rasgulla prepared from dairy milk was partially substituted with soy milk to give the product the health benefits of soybeans by optimizing the levels of soymilk in dairy milk for the development of rasgulla and to study the effects of blending soymilk with dairy milk as the physio-chemical attributes of rasgulla.

Materials and Methods

Raw materials

Soy bean was purchased from Mysore local market, Karnataka. Nandini dairy milk was purchased from Mysore local market, Karnataka. Chemicals used were of AR (Analytical Reagent) grade and were procured from reputed companies.

Processing of soy Rasgulla



Determination of nutritional compositions

All proximate composition of rasgulla sample was analyzed according to AOAC (2005) method.

Determination of total phenolics

Total phenolics as milli gram acid equivalent per 100 ml was estimated calorimetrically in methanolic extract using Folin-Ciocalteu reagent as per the method described by Singleton and Rosi (1965) [36].

Determination of total flavanoids

Total flavanoids in sample was estimated using method of Zhishen et.al. (1999) [40].

Determination of pH

The pH of the sample was determined using a digital EUTECH Instruments pH Tutor (pH/ ºC meter).

Determination of titrable acidity

Titrable acidity was determined by the method given in Ranganna (1999) [32].

Determination of total soluble solids

Total soluble solids were determined by using hand refractometer. The method was given in Ranganna (1999) [32]. (Ref: Manual of Analysis of Fruit and Vegetable Products S. Rangana, 1999)

Determination of water activity

Water activity was determined by using DuPont equipment, Aqualab, Decagon Devices Inc., Pullman, WA, US.

Determination of moisture

The moisture content of the fresh as well as the stored sample was determined using the standard AOAC Procedure (1948 procedures).

Determination of texture

Texture analysis was carried out using a texture analyzer (TAHDi, stable Microsystems, UK) equipped with 100 kg load cell. Firmness evaluation was carried out by breaking the rasgulla using a knife edge.

Determination of reducing sugars

Reducing sugars were estimated by dinitrosalicylic acid (DNS) method.

Determination of total sugars

Total sugars were estimated by phenol-sulphuric acid method of Dubois *et al*. (1956) using glucose as standard.

Determination of antioxidant

Antioxidant were estimated by Ferric Reducing Antioxidant Power Assay (FRAP method). Given by Benzie IFF and Strain JJ 1999 (Methods in Enzymology)

Determination of CIE color co-ordinates

CIE color co-ordinates (L*, a*, b*, c* and h*) was measured using D-65 illuminant and 10 degree observers. The equipment (Minis can XE plus, model 45/0-S,HunterLab,Hunter Associates Laboratory Inc, Reston, VA, USA) was calibrated using a white and black ceramic tile and the readings were recorded with inbuilt software Easy match QC (Hunter Lab, Hunter Associates Laboratory Inc, Reston, VA, USA). Color measurements of the samples were carried out in triplicate.

Sensory evaluation of the developed product

Sensory evaluation provides an idea about overall acceptability of the developed food product. The overall

acceptability depends on the appearance, flavor, taste, texture and aftertaste of the food product. In the present study, the developed products were judged by 10 semi trained panel members. For sensory evaluation of value added products nine point rating scale was used. In nine point rating scale each product characteristics (color, aroma, taste, texture and overall acceptability) were rated separately on hedonic scale of 1 to9. Scores were defined as follows, 1 for extremely poor, 2 for very poor, 3 for poor, 4 for fair above poor, 5 for fair, 6 for good above fair, 7 for good, 8 for very good and 9 for excellent.

Determination of shelf life

Microbiological Analysis – Total Plate Count Method (AOAC, 2005) [2] Microbiological analysis was done for rasgulla samples which were kept at room temperature and low temperature in air tight Cans for about more than 60 days as well as after every 15 days bacterial and fungal count was estimated of these samples.

Statistical analysis

The data generated during the study was processed using various statistical tests.

Data characteristics and Analysis of Variance:

The data characteristics such as Mean and Standard deviation were determined. Data were subjected to analysis of variance (ANOVA) using completely randomized design (CRD) and least significant difference (LSD) at $p \leq 0.05$ (or equivalently, 5%) by keeping in view the consequences of such an error, using Statistica 7.1 software (Stat Soft, Tulsa, OK, USA) expressed as means ± standard deviation

Results and Discussion

Proximate composition of soy rasgulla

The compositions of soy rasgulla were analyzed using standard analytical methods and the results are summarized in Table 1. The initial studies showed that rasgulla contains about 62.70% to 60.66% of moisture, 3.56 to 3.50% of fat, 6.01 to 6.07% of protein, 0.63 to 0.42% of crude fibre, 0.80 to 0.74% of ash and 29.18 to 26.36% of carbohydrates. 100% soy rasgulla contains high level of moisture (62.70±0.07%) as compared to 80, 60 and 40% compositions (61.90±0.04, 60.00±0.14 and 60.66±0.10) in agreement with those reported by Sahu and Jha (2009). Milk enriched sample (40:60 S:M) contains low level of protein (6.01±0.02%) as compared to pure sample fig 1. (6.07±0.21%, 100:0S:M). The average fat content of soy rasgulla made from 100:0, 80:20, 60:40 and 40:60 S:M was 3.50, 3.52, 3.54 and 3.56% respectively whereas same rasgulla samples had 6.07±0.21, 6.05±0.13, 6.04±0.03 and 6.01±0.02 % protein content. An increasing trend in fat content and decrease in protein content was observed with the increasing fat content of milk used for making channa. The results obtained forthe experimental samples are in full agreement for good acceptability with those reported values of fat as 4.2-4.6% by Gangopadhay *et al*. (2005) [14] and Bandyopadhay *et al*. (2008) [4] but in contradiction with those reported by Desai *et al*. (1993) [10]. Ash content of 100:0, 80:20, 60:40 and 40:60 S:M were analyzed and the values were found to be in decreasing order (0.80±0.04, 0.79±0.30, 0.76±0.09 and 0.74±0.04%) respectively. These values are comparable to Onuorah*et al* (2007) [30] findings. Higher ash content in all the samples are in full agreement with those reported by Desai *et al*. (1993) [10] and Haque *et al*. (2003) [15]. Crude fibre content trends to decrease with increasing levels of dairy milk for making channa (0.63±0.21, 0.55±0.32, 0.45±0.12 and 0.42±0.03). Carbohydrate content trends to increase with increasing level of dairy milk (26.36± 0.03, 27.20± 0.04, 29.18± 0.07 and 28.57± 0.11.

Table 1: Proximate composition of soy Rasgulla**5**

Sample	Moisture (%)	Fat (%)	Protein (%)	Crude fibre (%)	Ash (%)	CHO (%)
Soy:Milk::100:0	62.70± 0.07^a	3.50± 0.02^a	6.07± 0.21^a	0.63± 0.21^a	0.80± 0.04 ^{a}	26.36± 0.03^a
Soy:Milk::80:20	61.90± 0.04^b	3.52± 0.25^a	6.05± 0.13^a	0.55± 0.32^a	0.79± 0.30^a	27.20± 0.04^b
Soy:Milk::60:40	60.00± 0.14^c	3.54± 0.43^a	6.04± 0.03^a	0.45± 0.12^a	0.76± 0.09^a	29.18± 0.07^d
Soy:Milk::40:60	60.66± 0.10^d	3.56± 0.15^a	6.01± 0.02^a	0.42± 0.03^a	0.74± 0.04^a	28.57± 0.11^c

Values are expressed as mean ± SD

The values with different superscripts in a column differ significantly ($p<0.05$)

Changes in physico-chemical properties of rasgulla

Table 2 shows total phenolic content varied from 2.71±0.20 to 2.03±0.21 mg gallic acid Eq./100g. It trends to decrease with increasing amount of dairy milk as soy milk contains more amounts of phenolics than milk. Total flavanoids content varied from 2.49±0.21 to 2.13±0.45 mg/ catechin Eq./100g showing less than 5% significant difference. Similar results were found by Kumar *et al*. (2010) [21] and Yamabe *et al*. (2007) [38]. It trends to decrease with increasing amount of dairy milk as soy milk contains more amounts of flavanoids as compared to milk. It was found to be in agreement with Franke *et al*. (1999). Total sugars and reducing sugars showed no significant variation for different soy rasgulla combinations. It tends to be equal in all samples as 40° brix sugar syrup was maintained. The antioxidant power was determined as FRAP showing less than 5% significant difference in all samples. It was found to be in the range of 95.35 to 89.86 µ mol/ml FRAP.

Table 2: Physico-chemical attributes of soy Rasgulla

Sample	Total Flavanoids (mg/ catechin Eq./100g)	Total Phenolics (mg gallic acid Eq./100g)	Total sugar (%)	Reducing sugar (%)	Antioxidant (µ mol/ml, FRAP)
Soy:Milk::100:0	2.71±0.21^a	2.49±0.21^a	38.30±0.03^a	10.32± 0.21 ^{a}	95.35±0.02^a
Soy:Milk::80:20	2.38±0.41^b	2.32±0.05^a	38.59±0.04^a	10.46± 0.07^a	89.86±0.09^d
Soy:Milk::60:40	2.13±0.45^c	2.31±0.06^a	38.76±0.45^a	10.50± 0.02^a	91.54±0.07^c
Soy:Milk::40:60	2.03±0.07^d	2.13±0.45^a	38.54±0.24^a	10.48± 0.09^a	92.88±0.05^b

Values are expressed as mean ± SD

The values with different superscripts in a column differ significantly ($p<0.05$)

Changes in acidity, pH, total soluble solids and water activity of soy rasgulla

pH is an important criterion to be maintained for the quality and stability of health beneficial compound. The pH, acidity, TSS and water activity of soy rasgullas were analyzed and the results were discussed in Table 3 The physico-chemical analysis of soy rasgulla showed pH, acidity, TSS and water activity were (6.45-6.56), (0.32-0.30), (40° brix) and (0.997-0.995) respectively. The titrable acidity of 100% soy rasgulla and pH of 40% soy rasgulla was found to be more than that of 80 and 60% soy rasgulla samples. Low concentration of acidity in soy rasgulla is due to the fact that it does not contain any lactose Lee *et al* (1990) [24]. TSS was found to be same with no significant difference in all the samples as 40° brix sugar syrup was maintained. The water activity parameters of rasgulla samples were analyzed and compared. It was found to be almost equal in all the samples. Water activity is a critical factor that determines shelf life.

Table 3: Physico-chemical attributes of soy Rasgulla

Sample	pH	Acidity (% citric acid)	TSS ° brix	Water activity (24.4°C)
Soy:Milk::100:0	6.56± 0.01^a	0.30± 0.21^a	40± 0.36^a	0.996± 0.01^a
Soy:Milk::80:20	6.56±0.01^a	0.30±0.25^a	40± 0.41^a	0.998± 0.01^a
Soy:Milk::60:40	6.54±0.04^a	0.32±0.09^a	40± 0.31^a	0.995± 0.03^a
Soy:Milk::40:60	6.45±0.03^a	0.32±0.01^a	40± 0.21^a	0.997± 0.03^a

Values are expressed as mean ± SD

The values with different superscripts in a column differ significantly ($p<0.05$)

CIE color coordinates and texture profile

CIE L*, a*, b* values of fresh soy rasgulla are presented in Table 4. There was no visual differences detected between the different combinations but significant differences were observed by instrumental analysis. The results showed that the lightness denoted by L* values was increased, significantly affected by addition of dairy milk. L* values was observed highest (73.09±0.04) in case of 40:60 S:M and lowest in case of 100:0 S:M (70.79±0.07). Raffinose present in soybean contributes to the yellowness of the soy milk (Akoh and Swanson 1987). The CIE a* values indicates the redness/greenness component of the color, decreased in case of 40:60 S:M (0.54±0.13). The instrumental b* values indicates the yellowness/blueness component of the color. The b* values were significantly higher (15.46±0.71) in case of 40:60 S:M and others having nearly same b* values. The addition of milk caused an increase in the lightness L* and decrease in the redness a* of the 100% soy rasgulla when compared to other combinations. This effect is due to pigment present in the dairy milk (lactose) that causes scattering of light rays making it lighter in color. The quality of a product is monitored not only by the sensory properties but also by their textural profile. The value of force was affected by the addition of dairy milk concentration by volume (Table 4). A decreasing trend in force (14.26±0.31 N to 10.23±0.41 N) with increase in fat content of milk used for channa making process was observed (Table 4).

The energy for sample 100:0 S:M was significantly lower than all the experimental rasgulla samples which varied from 84.15±0.05 to 123.20±0.09 N.s (Table 4). Type of channa had a significant effect while a decreasing trend was observed with the increasing fat content of milk used for channa making process (Table 4). The results are in agreement with Cheng *et al*. (1990) [9] who prepared three yoghurt samples using soymilk. Similar results were also given by Adhikhari *et al*. (1992) [1] and Karunanithy *et al*. (2006) [19].

Table 4: Color and texture profile of soy Rasgulla

Sample	L*	a*	b*	Force(N)	Energy (N.s)
Soy:Milk::100:0	70.79±0.07^a	0.54±0.13^a	13.33± 0.21^a	14.26± 0.31^a	123.20±0.09^a
Soy:Milk::80:20	71.57±0.08^b	0.50±0.17^b	14.92± 0.05^b	12.69± 0.45^b	119.20±0.06^b
Soy:Milk::60:40	71.79±0.31^b	0.21±0.03^b	14.98± 0.41^b	10.74± 0.27^c	86.58± 0.03^c
Soy:Milk::40:60	73.09±0.04^c	0.14±0.09^c	15.46± 0.71^c	10.23± 0.41^c	84.15± 0.05^d

Values are expressed as mean ± SD

The values with different superscripts in a column differ significantly ($p<0.05$)

4.5 Sensory evaluation of soy rasgulla

The experimental soy rasgulla were prepared and subjected to sensory evaluation. The mean sensory scores were obtained for the soy rasgulla are shown in Table 5. The sensory evaluation was carried out for selecting the best composition of flavors on 9 point hedonic scale with 10 semi trained panelists. Color, aroma, taste, texture and overall acceptability were the parameters evaluated periodically in 15 days interval. From Table 5 it can be concluded that all soy rasgulla had comparatively similar overall acceptability but product with high % of dairy milk was slightly more liked than others. The overall acceptability was decreased after 2 month of storage at room temperature due to physico-chemical changes. Similar results were reported by Desai *et al*. (1993) [10] and Patil (2002) [13].

Soymilk when subjected to severe heating acquires a brown color and cooked flavor (Kwok *et al*., 2000 [23] cited in Egbo, 2012). Kwok and Niranjan (1995 cited in Egbo, 2012) [22] have demonstrated the effects of thermal processing on the quality of soymilk and concluded that the main chemical reaction that gives rise to heat-induced color and flavor changes is the maillard reaction. Most work done on soybean products made reference to future research to be done to improve color, taste and aroma of soybean products either through flavour additives and heat treatments (Farinde *et al*., 2008; Ikpeme *et al*, 2009) [12, 16].

Table 5: Sensory profile of soy Rasgulla

Sample	Color	Aroma	Taste	Texture	OAA
Soy:Milk::100:0	6.0±0.04[a]	6.0±0.04[a]	7.0±0.29[a]	7.0±0.13[a]	7.0±0.39[a]
Soy:Milk::80:20	7.5±0.12[b]	7.0±0.05[b]	7.5±0.09[b]	7.5±0.25[b]	7.5±0.17[b]
Soy:Milk::60:40	7.5±0.09[b]	8.0±0.07[c]	8.0±0.18[c]	8.0±0.31[c]	8.0±0.05[c]
Soy:Milk::40:60	8.0±1.07[c]	8.5±0.01[d]	8.5±1.01[d]	8.0±0.41[c]	8.5±0.29[d]

Values are expressed as mean ± SD
The values with different superscripts in a column differ significantly ($p<0.05$)

(1 for extremely poor, 2 for very poor, 3 for poor, 4 for fair above poor, 5 for fair, 6 for good above fair, 7 for good, 8 for very good and 9 for excellent)

Sensory evaluation of rehydrated soy rasgulla

Sugar syrup with 40° brix was prepared and rehydration was done in hot condition. A significant effect on rasgulla was observed due to the treatment given as observed in Table 6. The dehydrated rasgulla samples when rehydrated were found to be influenced significantly by dehydration treatment as it causes a significant effect on all the sensory properties. Soymilk when subjected to severe heating acquires a brown color and cooked flavor (Kwok *et al*., 2000 cited in Egbo, 2012). Kwok and Niranjan (1995 cited in Egbo, 2012) have demonstrated the effects of thermal processing on the quality of soymilk and concluded that the main chemical reaction that gives rise to heat-induced color and flavor changes is the maillard reaction. Most work done on soybean products made reference to future research to be done to improve colour, taste and aroma of soybean products either through flavour additives and heat treatments (Farinde *et al*., 2008; Ikpeme *et al*, 2009) [12, 16].

Table 6: Sensory profile of rehydrated soy Rasgulla

Sample	Color	Aroma	Taste	Texture	OAA
Soy:Milk::100:0	7.0±0.31[a]	6.0±0.03[a]	7.0±0.31[a]	6.5±0.17[a]	6.5±0.16[a]
Soy:Milk::80:20	7.0±0.59[a]	7.0±0.05[b]	7.5±0.33[b]	7.0±0.07[b]	7.0±0.07[b]
Soy:Milk::60:40	7.5±1.31[b]	8.0±0.19[d]	8.0±0.57[c]	8.0±0.05[d]	8.0±0.15[d]
Soy:Milk::40:60	7.5±0.93[b]	8.0±0.01[d]	8.5±0.30[d]	8.5±0.15[e]	8.5±0.61[e]

Values are expressed as mean ± SD
The values with different superscripts in a column differ significantly ($p<0.05$)

(1 for extremely poor, 2 for very poor, 3 for poor, 4 for fair above poor, 5 for fair, 6 for good above fair, 7 for good, 8 for very good and 9 for excellent)

Changes in physico-chemical parameter during storage of soy rasgulla

Fig 1 and 2 shows the chemical analysis i.e. pH and titrable acidity during storage. It was observed that the pH was slightly decreased and acidity was slightly increased.

On storage pH of 100% soy rasgulla was decreased from 6.56 to 6.50. The acidity of 100% soy rasgulla was increased from 0.30 to 0.37%. Lee *et al*. (1990) [24] stated that soybean derived sugars, raffinose and stachyose, may have an inhibitory effect on the production of acid. The total soluble solids are slightly decreased during storage with a non significant difference of 5% (Fig 3). The total sugars shows decrease in their value (Fig 4) ranging from 38.30 to 34.27% for 100:0 S:M, 38.59 to 34.61% for 80:20 S:M, 38.76 to 34.04% for 60:40 S:M and 39.54 to 34.01% for 40:60 S:M.The reducing sugars showed an increase in their value on storage up to 2 months (Fig 5).

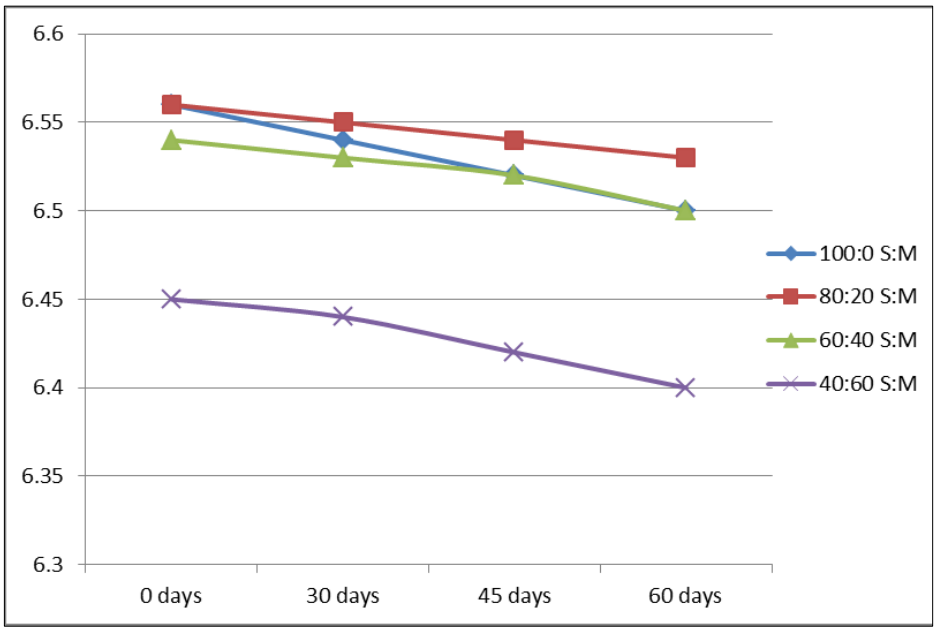


Fig 1: Changes in pH during storage study of soy rasgulla at room temperature (25±32^{0}C)

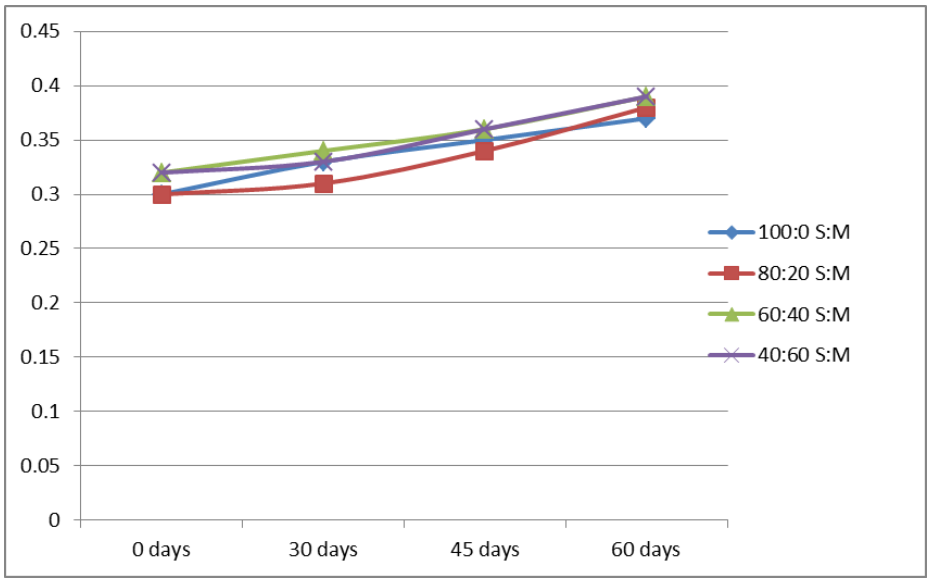


Fig 2: Changes in acidity during storage study of soy rasgulla at room temperature (25±32^{0}C)

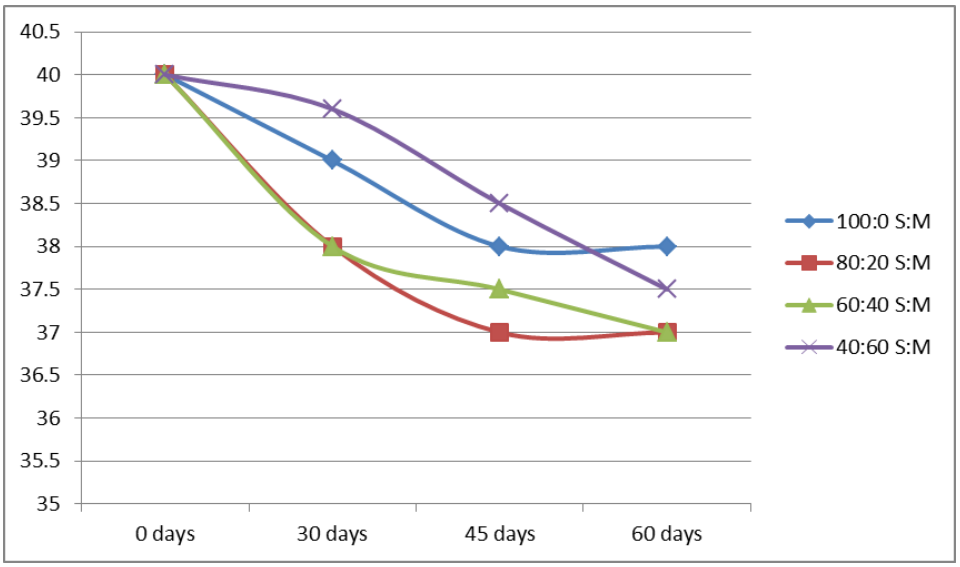


Fig 3: Changes in TSS during storage study of soy rasgulla at room temperature (25±32^{0}C)

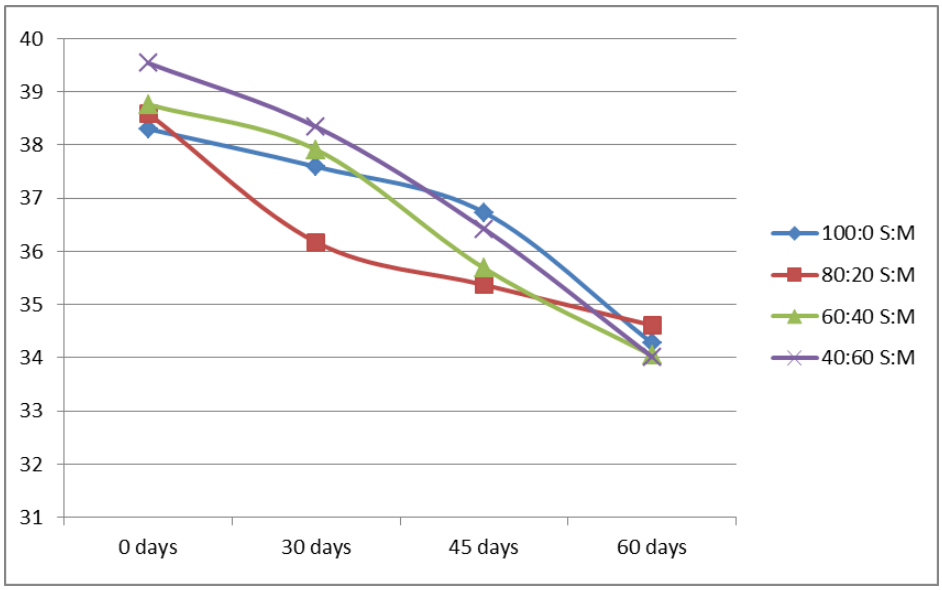


Fig 4: Changes in total sugars during storage study of soy rasgulla at room temperature (25±32^{0}C)

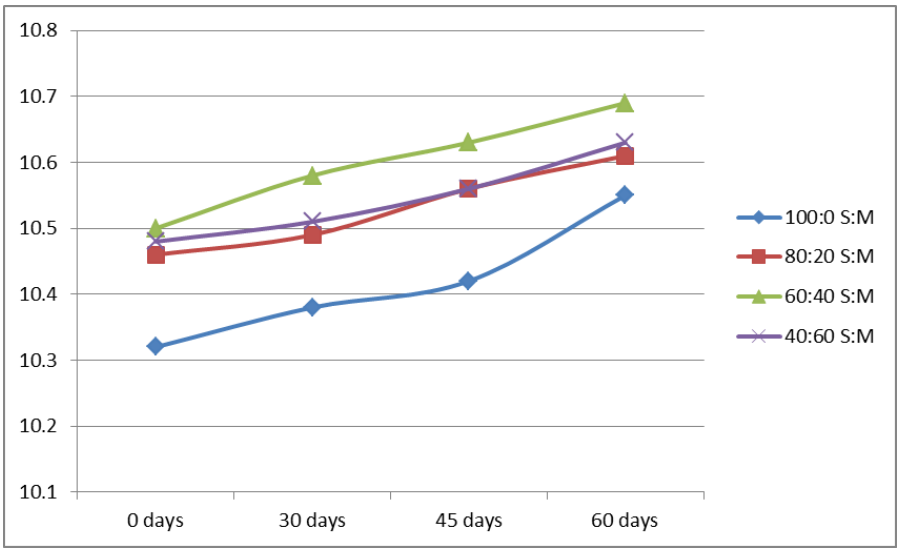


Fig 5: Changes in reducing sugar during storage study of soy rasgulla at room temperature (25±32^{0}C)

Changes in CIE color coordinates during storage of soy rasgulla

The CIE L* values indicate lightness, a* values indicates the redness/greenness and b* values indicates yellowness/blueness component of the color. The color parameters are well related to color changes in stored samples, as browning occurs. It causes decrease in L* and b* values and increase in a* values during storage Fig 6, Fig 7, and Fig 8. The increase in redness was clear and seemed to be result of browning reaction during storage. The decrease in lightness and yellowness was significant by 5%. Raffinose present in soybean contributes to the yellowness of the soy milk (Akoh and Swanson 1987). Soymilk when subjected to severe heating acquires a brown color and cooked flavor (Kwok *et al*., 2000 cited in Egbo, 2012). Kwok and Niranjan (1995 cited in Egbo, 2012) have demonstrated the effects of thermal processing on the quality of soymilk and concluded that the main chemical reaction that gives rise to heat-induced color and flavor changes is the maillard reaction. Most work done on soybean products made reference to future research to be done to improve colour, taste and aroma of soybean products either through flavour additives and heat treatments (Farinde *et al*., 2008; Ikpeme *et al*, 2009).

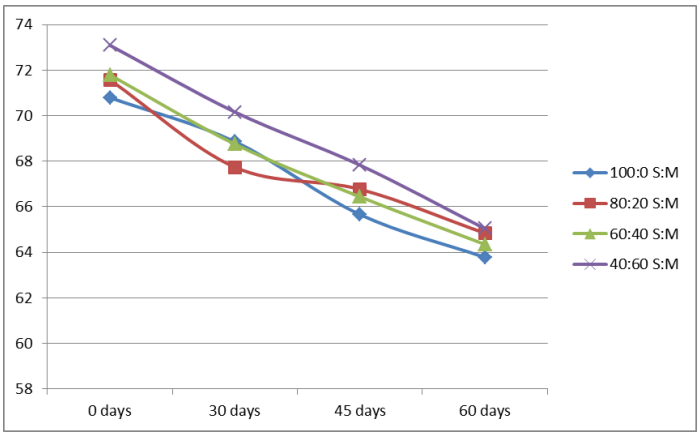


Fig 6: Changes in L* value during storage study of soy rasgulla at room temperature (25±32^{0}C)

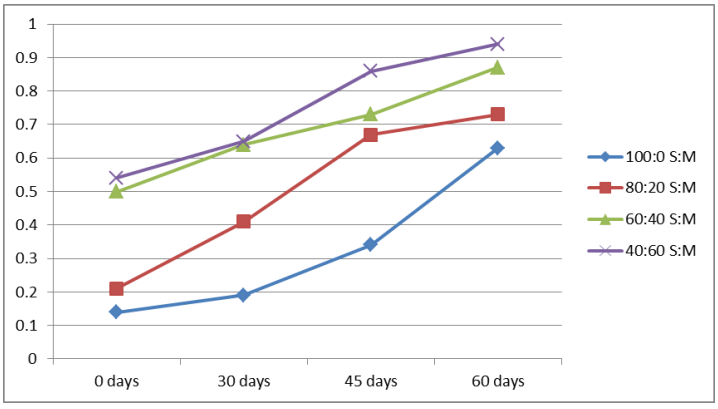


Fig 7: Changes in a* value during storage study of soy rasgulla at room temperature (25±32^{0}C)

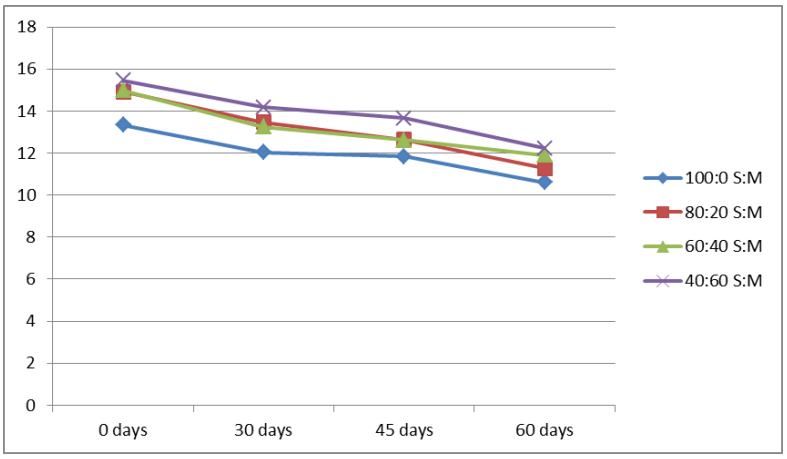


Fig 8: Changes in b* value during storage study of soy rasgulla at room temperature (25±32^{0}C)

Microbial profile of soy rasgulla stored at room temperature

Three microbial tests were done viz. total plate count, yeast and moulds and, coliforms count. The microbiological analysis results showed that there was no microbial growth during 1 month of storage. Table 7 showed the microbial profile of the soy rasgulla during storage. The coliforms and, yeasts and moulds count was found to be absent in all the samples throughout the storage. It notifies that handling of the product was satisfactory. Thus the microbial stability of soy rasgulla is proven and the product was stable for 2 months at room temperature. The total plate count at room temperature was found to increase with the increase in storage period (Table 7).

Table 7: Microbiological profile of soy rasgulla during storage at RT (25±32^{0}C)

Storage (days)	100:0::S:M TPC (cfu/g)	80:20::S:M TPC (cfu/g)	60:40::S:M TPC (cfu/g)	40:60::S:M TPC (cfu/g)
0	Absent	Absent	Absent	Absent
15	$1.0*10^1$	$1.0*10^1$	Absent	Absent
30	$2.0*10^1$	$1.0*10^1$	$1.0*10^1$	$1.0*10^1$
45	$2.0*10^1$	$2.0*10^1$	$2.0*10^1$	$3.0*10^1$
60	$3.0*10^1$	$3.0*10^3$	$3.0*10^1$	$4.0*10^1$

Effect of storage on sensory attributes of soy rasgulla

The color, aroma, taste, texture and OAA trends to decrease during storage of soy rasgulla showing a significant difference of more than 5% (Fig 9, Fig 10, Fig 11, Fig 12 and Fig 13). The color showed 100:0 S:M rasgulla samples were below rejection point after 60 days of storage whereas 40:60 S:M were slightly acceptable. During storage, rasgulla undergoes various physico-chemicals and microbial changes which trends to affect the taste and aroma of the product. The taste and aroma scores were decreased during storage. The textural scores of rasgulla declined with the advancement of storage period. The overall acceptability score decreased with the increase in storage time. The results were found similar to Desai *et al.* (1993) and Patil (2002), Bandyopadhyay *et al.* (2005, 2008), and Karunanaithy *et al.* (2006) [13, 3, 4].

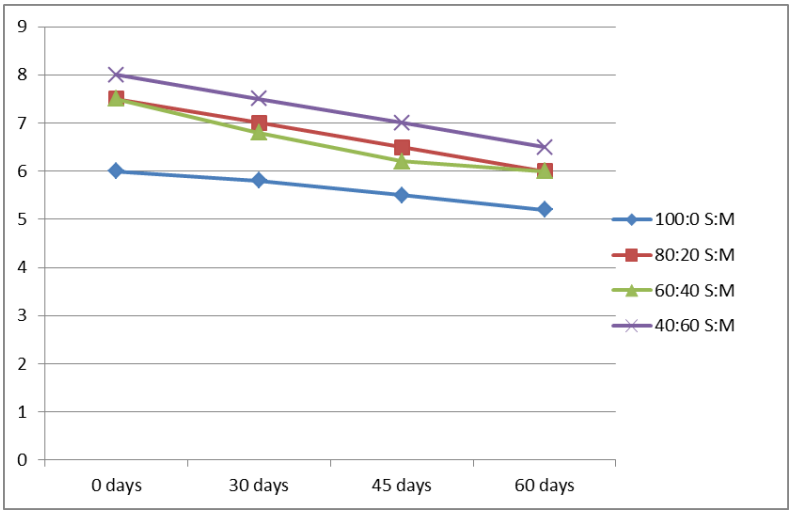


Fig 9: Changes in sensory color during storage study of soy rasgulla at RT (25±32^{0}C)

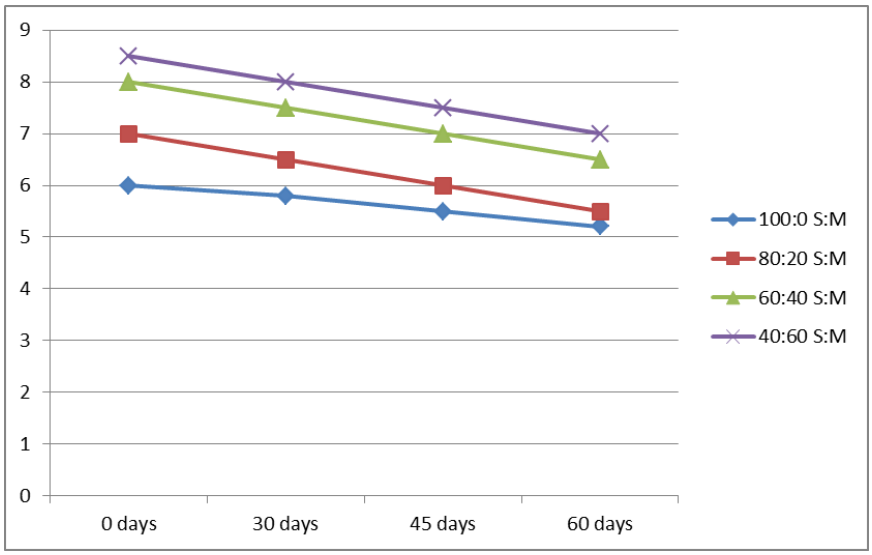


Fig 10: Changes in sensory aroma during storage study of soy rasgulla at RT (25±32^{0}C)

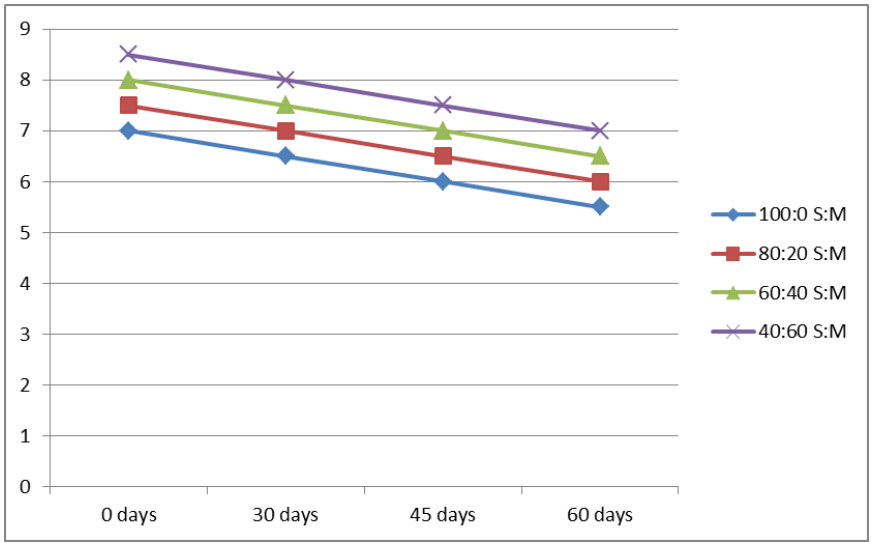


Fig 11: Changes in taste during storage study of soy rasgulla at RT (25±32^{0}C)

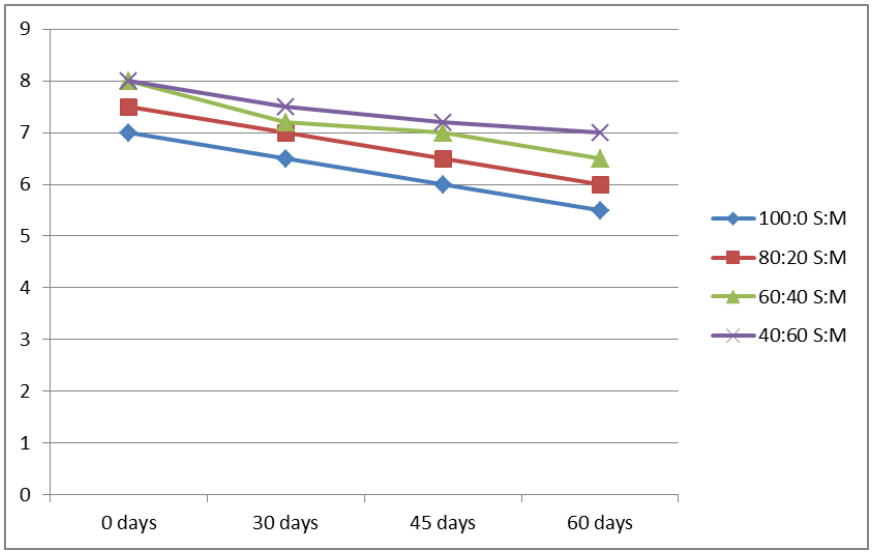


Fig 12: Changes in texture during storage study of soy rasgulla at RT (25±32^{0}C)

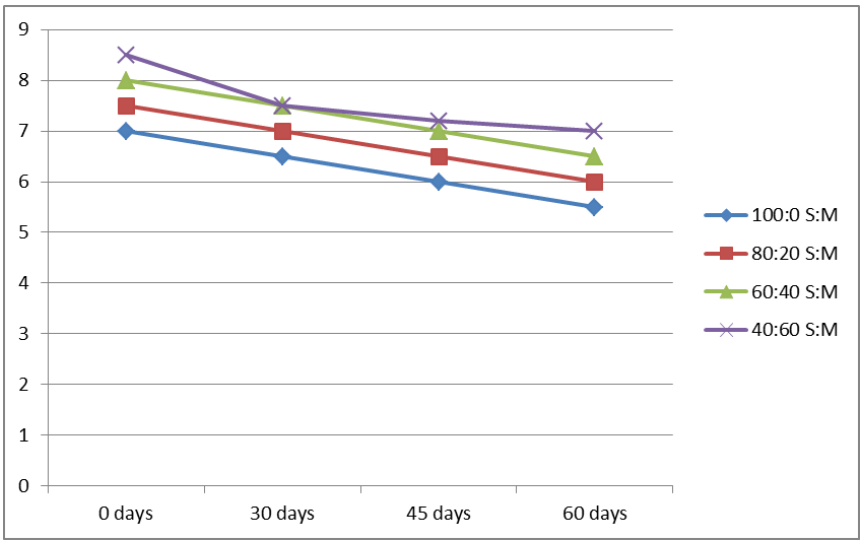


Fig 13: Changes in OAA during storage study of soy rasgulla at RT (25±32^{0}C)

Conclusion

Four variants of soy rasgulla were developed using blends of soy milk and dairy milk in the ratio of 100:0 S:M, 80:20 S:M, 60:40 S:M and 40:60 S:M. The products were evaluated for physico-chemical, sensory and microbiological attributes during ambient storage. As such the rasgulla made from pure soy milk(100:0 S:M) are high in protein contain as compared to milk enriched sample. Total phenolics and total flavanoids content decreased with increase in the level of dairy milk whereas antioxidant remains constant with a significant variation of 5%.The pH was found to decrease with increase in the level of dairy milk whereas acidity increased. The L* and b* values increased with increase in the level of dairy milk whereas a* values decreased. Fat content increases with increase in the level of dairy milk. Crude fibre content trends to decrease with increasing levels of dairy milk for making channa. The sensory score increases with increase in the level of dairy milk. A shelf life of 60 days was observed under ambient storage condition at room temperature. Value of pH and total sugars decreased whereas acidity and reducing sugars increased while TSS remains constant during storage of 60 days. CIE values also showed varied results, L* and b* values decrease while a* values increased during storage of 60 days. The acceptability of soy rasgulla increased with increase in the level of dairy milk. However, a blend of 40:60 (S: M) was found optimum with a overall sensory acceptability of 8.5 on hedonic scale.

References

1. Adhikari AK, Mathur ON, Patil GR. Texture and microstructure of Channa and rasgulla from cow's milk. Journal of Dairy Research. 1992;59:413-423.
2. AOAC. Official Methods of Analysis of the Association of Official Analytical Chemists, eighteenth ed. Association of Official Analytical Chemists; Arlington, VA, USA. 2005.
3. Bandhyopadhyay M, Chakraborty R, Raychaudhari U. The effect of coagulants on the texture of channa. International Journal of Food Science and Technology. 2005;40:799-810.
4. Bandyopadhyay, Mahuya, Runu Chakraborty, and Utpal Raychaudhuri. "Effect of carrot on quality improvement of sweet syrupy cheese ball (Rasgulla)." International journal of dairy technology. 2008;61(3):290-299.
5. Benzie IFF, Strain JJ. The Ferric Reducing Ability of Plasma (FRAP) as a Measure of Antioxidant Power: The FRAP Assay, Analytic Biochemistry. 1996;239:70-76.
6. Chang CC, Yang MH, Wen HM, Chern JC. Estimation of total flavonoid content in propolis by two complementary colorimetric methods. Journal of Food and Drug Analysis. 2002;10:178-182.
7. Charoenphun, Narin, et al. "Calcium-binding peptides derived from tilapia (Oreochromis niloticus) protein hydrolysate." European Food Research and Technology. 2013;236(1):57-63.
8. Chavan RS, Prajapati PS, Chavan SR. Low-fat sweet syrup cheese ball (Rosogolla) manufacturing and effect of lowering fat on quality. Journal of Food Science. 2013;57:45-53.
9. Cheng, Hefa. "Volatile flavor compounds in yogurt: a review." Critical reviews in food science and nutrition. 2010:50(10):938-950.
10. Desai HK. "Texture of rasogolla: effect of composition and variety in market samples." Indian Journal of Dairy Science. 1993;46:123-123.
11. Duffy, Rosanna, Helen Wiseman, Sandra E. File. "Improved cognitive function in postmenopausal women after 12 weeks of consumption of a soya extract containing isoflavones." Pharmacology Biochemistry and Behavior. 2003:75(3):721-729.
12. Farinde EO *et al*. "Use of alternative raw materials for yoghurt production." African Journal of Biotechnology, 2008, 7(18).
13. GR Patil. Present status of traditional dairy products. Indian Dairyman, 54, 35-46
14. Gangopadhyay D, *et al*. "Quality of rasogolla marketed in the state of Bihar and Jharkhand." The Indian Journal of Nutrition and Dietetics. 2005;42(11):522-527.
15. Haque A, *et al*. "Comparison of rasogolla made from fresh cow milk, fresh buffalo milk and mixture of cow and buffalo.
16. Ikpeme-Emmanuel CA, J Okoi, NC Osuchukwu. "Functional, anti-nutritional and sensory acceptability of taro and soybean based weaning food." African Journal of Food Science. 2009;3(11):372-377.
17. Kanwal S, AK Bandyopadhyay, NC Ganguli. "Manufacture of rasogolla from buffalo milk." Indian J. Dairy Sci. 1980;33:357-365.

18. Karunanaithy C, Varadharaju N and Kaillapan R. Studies on the development of the kneader and ball former for channa in rasgulla production: Part III Quality parameters of rasgulla. Journal of Food Engineering. 2007;80:966-971.
19. Karunanithy CN, Varadharaju, K Thangavel. "A comparative study on quality and textural parameters of commercial and machine prepared rasogolla." Journal of food science and technology-Mysore. 2006;43(5):493-495.
20. Kaur C, Kapoor HC. Antioxidant in fruits and vegetables-the Millennium's health, International Journal of Food Science and Technology. 2001;36:703-25.
21. Kumar V, Rani A, Dixit AK, Pratap D, Bhatnagar D. A comparative assessment of total phenolic content, ferric reducing-anti-oxidative power, free radical-scavenging activity, vitamin C and isoflavones content in soybean with varying seed coat colour,Food Research International. 2010;43:323-328.
22. KWOK, KIN-CHOR, Keshavan Niranjan. "Effect of thermal processing on soymilk." International journal of food science & technology. 1995;30(3):263-295.
23. Kwok, Kin-Chor, Dov Basker, Keshavan Niranjan. "Kinetics of sensory quality changes in soymilk during thermal processing, by parametric and non-parametric data analyses." Journal of the Science of Food and Agriculture. 2000;80(5):595-600.
24. Lee SY, CV Morr, A Seo. "Comparison of milk-based and soymilk-based yogurt." Journal of Food Science. 1990;55(2):532-536.
25. Lee, Sang Hwa, David B. Min. "Effects, quenching mechanisms, and kinetics of carotenoids in chlorophyll-sensitized photooxidation of soybean oil." Journal of Agricultural and Food Chemistry. 1990;38(8):1630-1634.
26. Li, Shuhong, *et al*. "Soybean curd residue: composition, utilization, and related limiting factors." International Scholarly Research Notices, 2013.
27. Liu K. Soybeans: Chemistry, Technology and Utilization. Chapter 4. I: Soymilk & II: Tofu. New York: Chapman and Hall. 1997, p. 138-197.
28. Lv, Ying, *et al*. "Identification and characteristics of iron-chelating peptides from soybean protein hydrolysates using IMAC-Fe3+." Journal of agricultural and food chemistry. 2009;57(11):4593-4597.
29. M Dubois, KA Gilles, JK Hamilton, PA Rebers, F Smith. Colorimetric method for determination of sugars and related substances, Anal. Chem. 1956;28:350-356.
30. Onuorah CE, AO Adejare, NS Uhiara. "Comparative physico-chemical evaluation of soymilk and soya cake produced by three different methods," 2007.
31. Peng Claudia Yu-Chen, *et al*. "Dietary soy protein selectively reduces renal prostanoids and cyclooxygenases in polycystic kidney disease." Experimental biology and medicine. 2009;234(7):737-743.
32. Ranganna S. Handbook of analysis and quality control for fruit and vegetable products and Ed., Tata Mc-Graw Hill publishing company Ltd, New Delhi. 1999.
33. Rani Meenakshi, NS Verma. "Changes in organoleptic quality during ripening of cheese made from cows and soya milk blends, using microbial rennet." Food chemistry. 1995;54(4):369-375.
34. Rao MS, *et al*. "Studies on preparation of chhana from buffalo milk and its suitability for rasogolla manufacture." Indian Journal of Dairy Science. 1989;42(4):810-816.
35. Sahu JK, Das H. A continuous heat-acid coagulation unit for continuous production of chhana. Assam Univ J Sci Technol Phys Sci Technol. 2009;4:40–45.
36. Singleton, Vernon L, Joseph A Rossi. "Colorimetry of total phenolics with phosphomolybdic-phosphotungstic acid reagents." American journal of Enology and Viticulture. 1965;16(3):144-158.
37. Tarafdar, Sharif Uddin, *et al*. "A comparative study on the quality of Rasogolla made in laboratory and collected from local markets of Mymensingh, Bangladesh." Pakistan Journal of Nutrition. 2002;1(3): 156-160.
38. Yamabe Shigeo, *et al*. "Effect of soybean varieties on the content and composition of isoflavone in rice-koji miso." Food Chemistry. 2007;100(1):369-374.
39. Franke, Adrian A, *et al*. "Isoflavone levels in soy foods consumed by multiethnic populations in Singapore and Hawaii." Journal of agricultural and food chemistry. 1999, 977-986.
40. Yang Gong, *et al*. "Prospective cohort study of soy food intake and colorectal cancer risk in women." The American journal of clinical nutrition. 2009;89(2):577-583.
41. Zhishen Jia, Tang Mengcheng, Wu Jianming. "The determination of flavonoid contents in mulberry and their scavenging effects on superoxide radicals." Food chemistry. 1999;64(4):555-559.
42. Zimmermann Céline, *et al*. "Prevention of diabetes in db/db mice by dietary soy is independent of isoflavone levels." Endocrinology. 2012;153(11):5200-5211.