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A study on the development of probiotic diabetic Kulfi Indian Ice cream

[1] Neha Nizam, [2] Sweata Rani Rai
[1] Student of M.Sc., Department of Food Science & Nutrition Management, JD. Birla Institute, Kolkata, West Bengal, India
[2] Assistant Professor, Department of Food Science & Nutrition Management, JD. Birla Institute, Kolkata, West Bengal, India

Abstract
Background: In the past, diets for people with diabetes were very restrictive and one has to cut down sugar in their diet or look for other sources which can impart sweetness to the food. However most of us enjoy the taste of sweet foods and use them as a source of pleasure in the good times and comfort in the bad. So, a diagnosis of diabetes, with its emphasis on sweet foods as occasional treats rather than staple foods, can feel harsh. Hence keeping in mind, the problems faced by diabetic people regarding desserts, particularly frozen desserts this product;i.e. a diabetic friendly kulfi was developed.
Method: A market survey was conducted to know the different types of diabetic frozen desserts available for people suffering from diabetic. After the survey it was clear about the types and varieties available, so a kulfi particularly for diabetic patients was developed. Effects of the ingredient incorporation on the nutritional composition and sensory qualities were evaluated. The kulfi with more consumer acceptability was analyzed for physical and chemical parameters like protein, fat, carbohydrate, meltdown rate, ash, moisture, calcium, total soluble solids.
Result & Discussion: By considering the nutritional and consumer acceptability the kulfi with 15gms oats and 9 drops of stevia was the best sample selected. The removal of khoa and sugar and addition of oats and stevia improved the nutritional composition of the kulfi and made it diabetic friendly.
Conclusion: The developed product was effective in terms of making it diabetic friendly and also in terms of nutritional quality, without compromising on the taste of the kulfi available locally.

Keywords: probiotics, diabetes, stevia, frozen desserts

Introduction
Diabetes is a group of metabolic diseases characterized by hyperglycaemia resulting from the defects in insulin secretion, insulin action or both [1]. Recently compiled data show that approximately 422 million people have diabetes mellitus worldwide, and that this number may well double by the year 2025. Much of this increase will occur in developing countries and will be due to population growth, ageing, unhealthy diets, obesity and sedentary lifestyles [2]. By 2025, while most people with diabetes in developed countries will be aged 65 years or more, in developing countries most will be in the 45-64 year age bracket and affected in their most productive years. Over 30 million have now been diagnosed with diabetes in India. The number of people with diabetes is increasing due to population growth, aging, urbanization and increasing prevalence of obesity and physical activity. Quantifying the prevalence of diabetes and the number of people affected by diabetes now and in the future, is important to allow rational planning and allocation of resources [3]. However having diabetes does not mean one cannot enjoy desserts anymore, locally available frozen desserts can be prepared in a different way with diabetic friendly ingredients without compromising much with the taste.
Kulfi, an Indian traditional frozen dairy product, has the composition almost similar to that of ice cream. Sugar and khoais an important ingredient of kulfi. Sugar is the most widely used sweetener in the food industry also khoa is an important ingredient in kulfi which helps in giving the smooth creamy taste as well as the desired consistency to the kulfi. But it cannot be used by people suffering from diabetes. Stevia, a natural sweetener obtained from the leaf of *Stevia rebaudiana* plant, is 130–300 times sweeter than sucrose. It is heat stable up to 200°C [4]. It contains different sweetening compounds like stevioside, a principal diterpene glycosides having sweetness of 250–300 times than that of sucrose. Rebaudioside-A is another sweet constituent, which is ~400 times sweeter than sugar. The other sweet constituents are rebaudioside-B, rebaudioside-C, rebaudioside-D, rebaudioside-E and dulcoside [5]. Besides its sweetness properties, stevia prevents diabetes, decreases weight, prevents tooth decay, increases digestion etc. Stevia has been introduced as a sweetener in number of countries i.e., Brazil, Argentina, Korea, Mexico, US, Indonesia, Tanzania and Canada [6]. Stevia had received government approval in over 20 countries. In Latin America, stevia has been used for centuries for its sweet taste and medicinal properties. The Japan Ministry of Health and Welfare and the Korean Ministry of Health approved stevia for food applications more than 30 years ago. In China, stevia has been approved as a 'Food additive' by the National Health Inspection Authority. In Australia, stevia has been listed under the Australian Register of the Therapeutic Goods (ARTG). In America, stevia has been approved as 'a dietary supplement' by the US Food and Drug Administration (USFDA) in 1994 [7].

Probiotics plays a major role in diabetes. The term probiotics derived from the Latin prefix pro which means for and the Greek noun βίος (bios) which means "life". Probiotics have been defined as "live microorganisms which, when administrated in adequate amounts, confer a health benefit on the host" [8]. The pathogenesis of diabetes mellitus is complex and some of the factors implemented in it are oxidative stress and inflammation. Some probiotics have been reported to decrease the oxidative stress and to suppress the effector functions of CD4+ T cells, Probiotics plays a major role in diabetes accompanied by reducing the pro-inflammatory molecules [9] thus having antioxidant, immune-modulatory effects and antidiabetic effects. Probiotic bacteria improve insulin sensitivity by attenuating systemic inflammation. The chronic low-grade inflammation with persistently elevated levels of circulation pro- inflammatory cytokines is considered a principal pathogenetic component of insulin resistance and T2D. Probiotics has immune- modulatory effects. Probiotic supplementation improves high-fat diet-induced insulin resistance and hepatic steatosis. In another study it was proved that strains *L. acidophilus La5 B. lactis Bb12* noticeably reduce blood glucose levels, glycated hemoglobin and remarkably improve antioxidant status and total serum antioxidant capacity with elevation of erythrocyte SOD (superoxide dismutase) and GPX (glutathione peroxidase) levels in patients with T2D [10].

Generally the diabetic people are overweight, so apart for restricting sugar, fat needs to be cut down also, hence skimmed milk are best for them. Hence also in the product developed skimmed milk has been used, as milk is the major ingredient of kulfi. Skimmed milk, or skim milk, is made when all the cream (also called milkfat) is removed from whole milk. Having Type 2 Diabetes increases the risk of heart disease but eating less fat in the diet can help reduce that risk. As well as eating less fat it is important to eat the right type of fat [11].

Diabetes has become a major health problem, control of blood glucose and insulin levels are essential in preventing many of the complications associated with diabetes. Eating oats can spread the rise in blood sugars over a longer time period. Oat beta-glucan slows the rise in blood glucose levels following a meal and delays its decline to pre-meal levels. As the beta-glucan in the soluble fibre of oats is digested, it forms a gel, which causes the viscosity of the contents of the stomach and small intestine to be increased. This in turn slows down digestion and prolongs the absorption of carbohydrates into the bloodstream. This means dramatic changes in blood sugar levels are avoided [12].

Spices used in day-to-day life as food, can also be used in the treatment of various human ailments. Spices also possess hypoglycemic effects besides their taste, flavor, colour and preservative property. This review is focused mainly on Cardamom, it Cardamom or Elaichi is a perennial herb indigenous to the Indian subcontinent, it is added in majority of the kulfis for the flavour it imparts, according to a research, cardamom showed 12.68% decrease in serum glucose indicating that the hypoglycaemic effect of this spice should not be neglected [13].

Thus keeping in mind all the benefits of the fortificants and the need for more number of diabetic frozen desserts in the market, a new frozen dessert, kulfi was prepared to target the people suffering from diabetes.

Materials &Methodology

Study Design

A market survey was conducted to know the different types of diabetic frozen desserts available for people suffering from diabetic. The leading markets like Spencer's, More, Metro Cash and Carry, Big Bazaar and many other were checked the availability of different types of frozen desserts available and the company's manufacturing it. After the survey it was clear about the types and varieties available, so a kulfi particularly for diabetic patients was prepared using skim milk, skim milk powder, oats and stevia to increase the therapeutic aspects. This study was conducted in the food and chemistry laboratories of J. D. Birla Institute, Kolkata. All the ingredients were collected from a departmental store in Kolkata and the probiotic tablet (Vizylac) was bought from a medical store. Each time the samples were collected from the same vendor and of the same brand.

Product Development

The kulfi was mixed, with varying proportions of 5gm, 10gms, 15gms, 20gms, 25gms of the oats and 3, 6, 9, 12 and 15 drops of stevia. These were blended with other ingredients (Table 1).Two sets of kulfi were prepared Standard kulfi and test kulfi and both were evaluated for sensory and nutritional parameters.

Standard Kulfi

The standard kulfi was prepared using Skim milk, skim milk powder, kesar, cardamom powder, khoa, sugar and probiotic tablets (vizylac) (Table 2). Firstly the milk was boiles with withkesar and elaichi powder. Then add the khoa and boil till milk slightly thickens. Add the sugar and skimmed milk powder and cook till it thickens. After the mixture cools down break the probiotic tablet and pour the contents and mix it nicely and pour it into the kulfi cups. Keep it in the freezer for at least 8 hours.

Table 1: Standard Recipe

Ingredients	Amount(gms)
Skim milk	250
Skim milk powder	30
Khoa	15
Sugar	50
Probiotic Tablets	3pc
Kesar	3-4 pc
Cardaom powder	2

Test Kulfi

The Test kulfi was prepared using Skim milk, skim milk powder, kesar, cardamom powder, oats, stevia and probiotic tablet (vizylac).For the preparation the milk was boiled with kesar and elaichi seed Then dry roast the oats in a pan and powder it in a mixer. Add stevia and skim milk powder, cook till it thickens. After the mixture has cooled down break open the tablets and mix the powder in the kulfi mixture. Pour them immediately in kulfi cups and refrigerate them.

Table 2: Variations of Kulfi

Variations Ingredients	1 (g)	2 (g)	3 (g)	4 (g)	5 (g)
Skim milk	250	250	250	250	250
Skim milk powder	30	30	30	30	30
Oats	5	10	15	30	40
Stevia	3 drops	9 drop	12 drops	15 drops	18 drops
Probiotic tablet	3pc	3pc	3pc	3pc	3pc
Kesar	3-4 pc	3-4 Pc	3-4 pc	3-4 Pc	3-4 pc
Cardomom Powder	2	2	2	2	2

Sensory evaluation

Sensory evaluation of both the samples were carried out by 25 panelists on a 9 point hedonic scale for different parameters such as colour, appearance, odour, taste, texture and overall acceptability as described by Joel, 2004.

Table 3

9-Point Hedonic Scale	
1	Dislike extremely
2	Dislike very much
3	Dislike Moderately
4	Dislike Slightly
5	Neither like nor dislike
6	Like slightly
7	Like moderately
8	Like very much
9	Like Extremely

Chemical and Nutrient analysis

The developed kulfi were used for the physical, chemical analysis. Various parameters like total soluble solids moisture, ash, meltdown rate, Calcium, Qualitative determination of, protein, fat, carbohydrate and crude-fibre, were determined. Moisture was determined by hot air oven method. Protein estimation was done using kjeldahl method; carbohydrate content was measured with the help of Anthrone assay, the calcium content was measured by complexometric titration using the well-known chelating agent ethylenediaminetetraacetic acid (EDTA), fat and meltdown rate was determined according to FSSAI lab manual and total soluble solids was determined using a pycnometer.

Results

The market survey revealed all the types of frozen desserts available for diabetic people, since kulfi is one of the most popular and widely consumed product by almost all age groups, thus keeping in mind all the benefits of the fortificants and the need for more number of diabetic frozen desserts in the market, a new frozen dessert, kulfi was prepared to target the people suffering from diabetes**.** The experimental results on various chemical and nutritional characteristics of standard and test kulfi are tabulated in table 3.The addition of oats and stevia greatly affected the physico-chemical quality of the fortified bread. There was also a significant improvement in the levels of fat.

Table 3: Nutritional analysis of the standard and fortified bread

Parameters	Standard Kulfi	TestKulfi
Protein	8.3 gm	6.2 gm
Fat	12.5 gm	3.2 gm
Carbohydrate	17.7 gm	18.2 gm
Ash	2.82 gm	6.2 gm
Total soluble solid	43 brix	23 brix
Calcium	257 mg	130 mg
Meltdown	0.68 ml/min	0.32 ml/min

Discussion

Table 4 shows the carbohydrate content of the standard and test kulfi which is, 17.7gm and 18.gm respectively. It can be noted that the standard sample has less amount of carbohydrate than the test which can be due to the presence of oats in the test sample. Oats contain complex carbohydrate which are loaded with fibre, fibre does not raise the blood sugar levels as they are not broken down by body, it also gives a high level of satiety [14]. On the other hand addition of oats instead of khoa has various health benefits for the diabetic patients. Soluble fiber from oats, when incorporated into a low-glycemic diet, can improve postprandial glycemic and insulinemic responses in both non-insulin dependent diabetes mellitus and healthy subject. Moreover the consumption of a high carbohydrate diet high in fiber may reduce insulin doses needed by diabetic patients.

Table 4 shows the amount of protein present in the standard and test kulfi. There was a substantial decrease in the protein content of the kulfi in the test sample because here the addition of khoa has been omitted completely. Protein is an essential macronutrient needed by the human body for growth and maintenance [15]. Dietary proteins have an important role in regulating protein metabolism in skeletal muscle. A high-protein diet lowers blood glucose postprandially in persons with type 2 diabetes and improves overall glucose control [16].To both the products skim milk and skimmed milk powder has been added which contributes to the protein content of the product. Khoa has a high content of protein it has 25.2 gm of protein/100gm, skimmed milk which has 3.3 gm of protein/100ml and skimmed milk powder which has 20gm of protein/100gm whereas the protein content is low in test sample because of the removal of khoa which is also high in fat.

In the figure 1, the fat content of the two products have been represented. The standard kulfi contains 12.5gm/100gm, whereas the test sample contains 3.2gm/100gm.The fat content of the product is due to the addition of khoa particularly, as khoa is an important ingredient in kulfi preparation and helps in giving the kulfi its desired consistency and mouth feel. However the test kulfi has been prepared without using khoa keeping in mind the diabetic customers and to get the desired consistency and mouth feel oats with various nutritional benefits for the diabetic people has been added. It can be noted from the figure no 4 that there

is a decrease in the fat content, which is due to the complete elimination of khoa in the test kulfi.

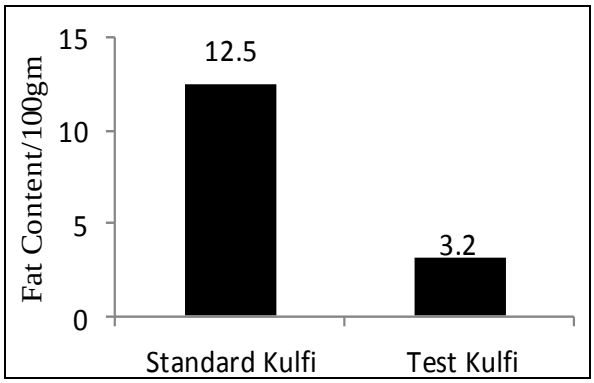

Fig 1: Comparative analysis of protein content

Khoa has been eliminated in the test sample because khoa is rich in fat and generally the diabetic people are overweight. Both the amount and quality of dietary fat may modify glucose tolerance and insulin sensitivity [17]. A high fat content in the diet may result in deterioration of glucose tolerance by several mechanisms including decreased binding of insulin to its receptors, impaired glucose transport, reduced proportion of glycogen synthase and accumulation of stored triglycerides in skeletal muscle. The fatty acid composition of the diet, in turn, affects tissue phospholipid composition, which may relate to insulin action by altering membrane fluidity and insulin signalling. Particularly for these reasons skimmed milk and skimmed milk powder has been reduced which helps in achieving a low fat product [18].

It can be seen from Table 2 that the melting rates are different and more stable (less) in the test kulfi because it contains stevia whereas the meltdown rate is more in the standard kulfi because it contains sugar. Melt down rate is one of the important manifestations of Kulfi. A low meltdown rate is desirable because meltdown is an important part of any consumers' perception of the product quality. On an average, melting rates were, 0.68 and 0.32 ml/min for standard and test respectively [19]. The existence of stevia slows down the behaviour of ice melting, especially at a high concentration of stevia this is an enhancement because lower melting rate relates to the sustainability of the kulfi's shape, which is typically evaluated as a good quality kulfi. Type and amount of sweetener affects the melting rate of ice cream. This is because the overrun and the nature of air-cell distribution in ice cream influence the rate of heat penetration into the ice cream, affecting the melting stability [20]. Several studies have reported that ice cream with a low overrun melted quicker than those with higher overrun [21]. This may be due to a higher amount ofair cells that decelerate of heat transfer across the ice cream, thus slowing the meltdown [22]. As in case of kulfi there is no incorporation of air so overrun is low, thus slowing down the melting rate, also the melting rate decreased due to reduction in sugar level and increased moisture content. So at higher levels of sugar replacement, increase in free moisture content and subsequent increase in large ice crystal formation might be the reason for decreased melting rate in the kulfi samples. Salama (2004) also reported that in ice cream mix, whenever levels of sugar replacement (20, 40 and 60%) increased by stevia addition, there was reduction in the melting rate.

Ash content was found to be more in the standard kulfi, the ash content present in the standard and test kulfi were 2.82 and 1.8gm/100 gm respectively. With the incorporation of khoa in the standard kulfi, the amount of ash content nearly doubled the amount present in the test kulfi as the test kulfi did not contain khoa but it contained oats which contributed to the high ash content. Ash refers to the inorganic residue remaining after either ignition or complete oxidation of organic matter in a foodstuff. Ash content represents the total mineral content in foods. Determining the ash content may be important because it is the part of proximate analysis for nutritional evaluation. [23]. The calcium content is more in the standard due to the inclusion of khoa. The standard kulfi contains 257mg/100 ml and the test kulfi has 130mg/100ml of calcium. Also in various studies it has been noted that, low calcium intake is consistently found to be inversely associated with incident type 2 diabetes [24]. From the above figure 8, it can be seen that the total soluble solids of standard is 43 Brix where as that of test kulfi is much lower i.e 26 Brix. Total soluble solids of the ice cream are contributed by the addition of sweetener into ice cream, besides that, sweetener also gives essential bulk, texture, and body to ice cream [25]. Several studies found that ice cream with lower total soluble solids may have proportionately more water to freeze due to overrun, thus contributing to more ice crystal formation, influencing the texture and body of ice cream. Thus, these texture differences will directly influence the consumers' judgment on the ice creams' quality. However since these is no aeration done in case of kulfi making so obviously there will be no ice crystal formation taking place [26].

Sensory Evaluation

The result of the sensory evaluation of the kulfi both standard and test are shown in figure 2.

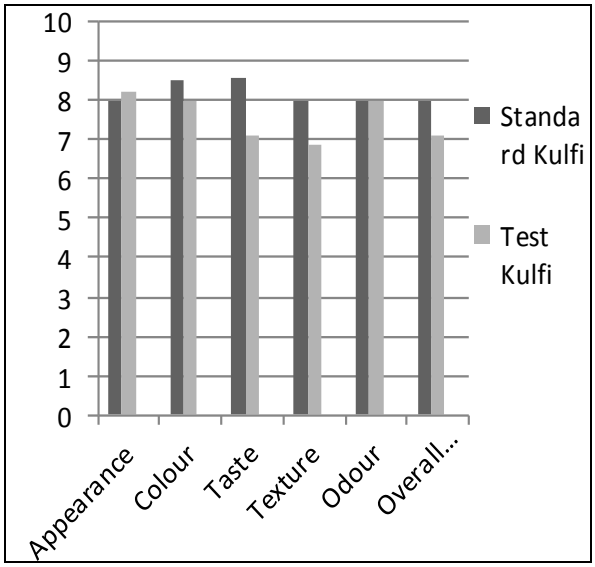

Fig 2

The result for the sensory evaluation of the kulfi samples, i.e standard and test kulfi were compared as shown in figure

1.The appearance, color and odour of both the standard and test kulfi did not vary much as the addition of stevia and oats did not effected the same. However in case of the texture there was a noticeable difference in the standard and test kulfi with the scores of 8 and 6.9 respectively. The difference in texture was mainly because of the addition of oats in the test sample which was giving a grainy mouthfeel. According to the panel members the test kulfi had an after taste which was due to the addition of stevia. However there was no considerable difference between both the products in case of acceptability.

Conclusion

The data from the analyses done says that the product is completely safe for the diabetic people as well as for the general masses, since there is a high demand for functional foods. The product developed contained ingredients that are diabetic friendly and also helps normalize the blood glucose level.

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