***Review Article***

**A Comprehensive Review of Ice Cream’s Role in Bangladesh’s Diet and Industry: Nutritional Composition, Functional Potential, and Public Health Perspectives**

**Abstract**

Ice cream is a beloved frozen dessert that holds a special place in the diet and culture of Bangladeshi people. With the rapid growth of the ice cream industry in Bangladesh, its consumption has significantly increased across all age groups. This review explores the multifaceted role of ice cream in the Bangladeshi diet by examining its ingredients, manufacturing process, types, nutritional composition, functional benefits, and health implications.

The paper begins with an overview of the composition of ice cream, detailing the essential ingredients such as milk, sweeteners, emulsifiers, stabilizers, and flavoring agents. The manufacturing process, from pasteurization and homogenization to freezing and hardening, is discussed to highlight the technological advancements in ice cream production. The diverse range of ice cream varieties available in Bangladesh, including traditional dairy-based ice creams, low-fat alternatives, sugar-free options, and probiotic-enriched formulations, is also explored. Beyond its indulgent appeal, ice cream contributes to the nutritional intake of Bangladeshi consumers by providing essential macronutrients, vitamins, and minerals. The incorporation of probiotics into ice cream has gained attention for its potential to deliver health benefits, including improved gut health and enhanced immunity. However, excessive consumption of ice cream, particularly those high in sugar and fat, raises concerns about its impact on health, contributing to issues such as obesity, diabetes, and cardiovascular diseases.

Despite these concerns, ice cream remains an integral part of the Bangladeshi food landscape, driven by evolving consumer preferences and industry innovations. The paper concludes by discussing the future trends in the ice cream industry, emphasizing the need for healthier formulations and functional ice creams that align with modern dietary concerns. By providing a comprehensive understanding of the role of ice cream in the Bangladeshi diet, this review offers valuable insights into its nutritional, cultural, and economic significance.

**Keywords**: Ice cream, Probiotics, Consumers, Health impacts.

**Introduction**

Ice cream is a widely cherished frozen dessert enjoyed by people of all ages and genders across the globe. It is produced by blending key ingredients such as milk, fats, sweeteners, stabilizers, emulsifiers, and various additives. The texture and overall sensory attributes of ice cream are largely influenced by its composition, formulation techniques, and processing methods. Frozen dairy products like ice cream provide a unique opportunity to incorporate additional nutritional and functional benefits due to their ability to maintain ingredient stability at low temperatures. As a result, there is a growing research focus on developing healthier and high-value ice cream formulations to meet the evolving demands of health-conscious consumers (*Seong et al., 2023*).

It is classified as a sweetened frozen dairy product, typically consumed as a snack or dessert. It primarily consists of milk and milk derivatives, often complemented by the addition of fresh or dried fruits, as well as essential ingredients such as flavors and colorants. The sweetening agents used in ice cream include both traditional sugars and sugar substitutes. Flavor enhancers and colorants are commonly blended with stabilizers and emulsifiers to achieve the desired consistency and aesthetic appeal. The definition of ice cream varies across different countries due to regional regulations and variations in composition. Some definitions describe ice cream as a liquid mixture that transitions into a semi-solid paste through a combination of cooling and continuous agitation. The complex mixture that ultimately forms ice cream consists of multiple components, including sugars, fats, dairy ingredients, stabilizers, and water, among others (*Legassa, 2020*).

Beyond its indulgent appeal, ice cream holds potential as a functional food due to its high consumer acceptability. It serves as an effective medium for delivering health-enhancing bioactive compounds, such as peptides and isoflavones, while also facilitating the long-term preservation of probiotics—beneficial microorganisms known for their positive impact on gut health. The ability to integrate these functional ingredients into ice cream makes it an appealing choice for consumers seeking both taste and health benefits (*Aboulfazli et al., 2015*).

From a structural perspective, ice cream is a complex colloidal system composed of fat globules, air bubbles, and ice crystals, all dispersed within a concentrated matrix of proteins, salts, polysaccharides, and sugars. These elements interact to create the unique texture and consistency associated with ice cream. Advances in food technology have greatly contributed to the refinement of ice cream production, transforming it into a thriving industry characterized by continuous innovation and profitability (*Goff et al., 1999; Turgut & Cakmakci, 2009*).

It is structured as a three-phase network consisting of solid, liquid, and gaseous components. The liquid phase acts as a suspension medium, embedding ice crystals while allowing air cells to remain evenly dispersed. Additionally, milk proteins, soluble and insoluble salts, fat molecules, stabilizers, and sweeteners are incorporated into this phase, contributing to the physicochemical properties that define ice cream's smoothness, stability, and sensory characteristics (*Abbas Syed, 2018*).

The ice cream industry in Bangladesh started in the 1950s and has grown significantly over the years (*Humayun, 2018*). Today, the industry is valued at more than BDT 65 million (*Laskar, 2017*). The leading brand in Bangladesh is Igloo, followed by other popular names like Polar, Kwality, Bellissimo, Savoy, Lovello, Mi Amore, and Za ‘n Zee. The competition in the market is increasing due to factors like rising consumer demand, a growing middle class, changes in food preferences, better electricity availability, and longer summer seasons. These factors have contributed to the increasing popularity of ice cream across the country (*Begum et al., 2020*).

The first branded ice cream in Bangladesh, Igloo, was launched in 1964. After the country’s independence, it was nationalized. However, in the early 1980s, it was privatized and taken over by Abdul Monem Ltd. Around this time, another brand, Polar, entered the market, creating a strong rivalry. By the 1990s, Igloo had become the market leader through effective promotional campaigns and a well-established distribution network. Over the years, it has remained the most dominant brand, competing with both local and international ice cream companies. As demand for ice cream continues to rise, new companies are entering the industry. For example, Kazi Farms, a well-known poultry company, has recently introduced its own ice cream brand. Similarly, Golden Harvest has announced plans to launch its own ice cream products, encouraged by the increasing purchasing power of consumers and the growing demand for frozen desserts. The continuous growth of Bangladesh’s ice cream industry indicates a promising future, with companies focusing on innovation, product variety, and improved quality to attract a wider customer base (*Begum et al., 2020*).

The objective of this review paper is to explore the role of ice cream in the diet of Bangladeshi people by analyzing its ingredients, manufacturing process, and various types available in the market. It aims to assess the nutritional composition of ice cream, with a special focus on its potential as a carrier of probiotics and other functional ingredients. Additionally, the paper highlights the significance of ice cream in Bangladesh’s food culture and economy while discussing its potential health impacts on consumers. Through this review, a better understanding of ice cream’s contribution to dietary patterns and public health in Bangladesh will be established.

**Methodology**

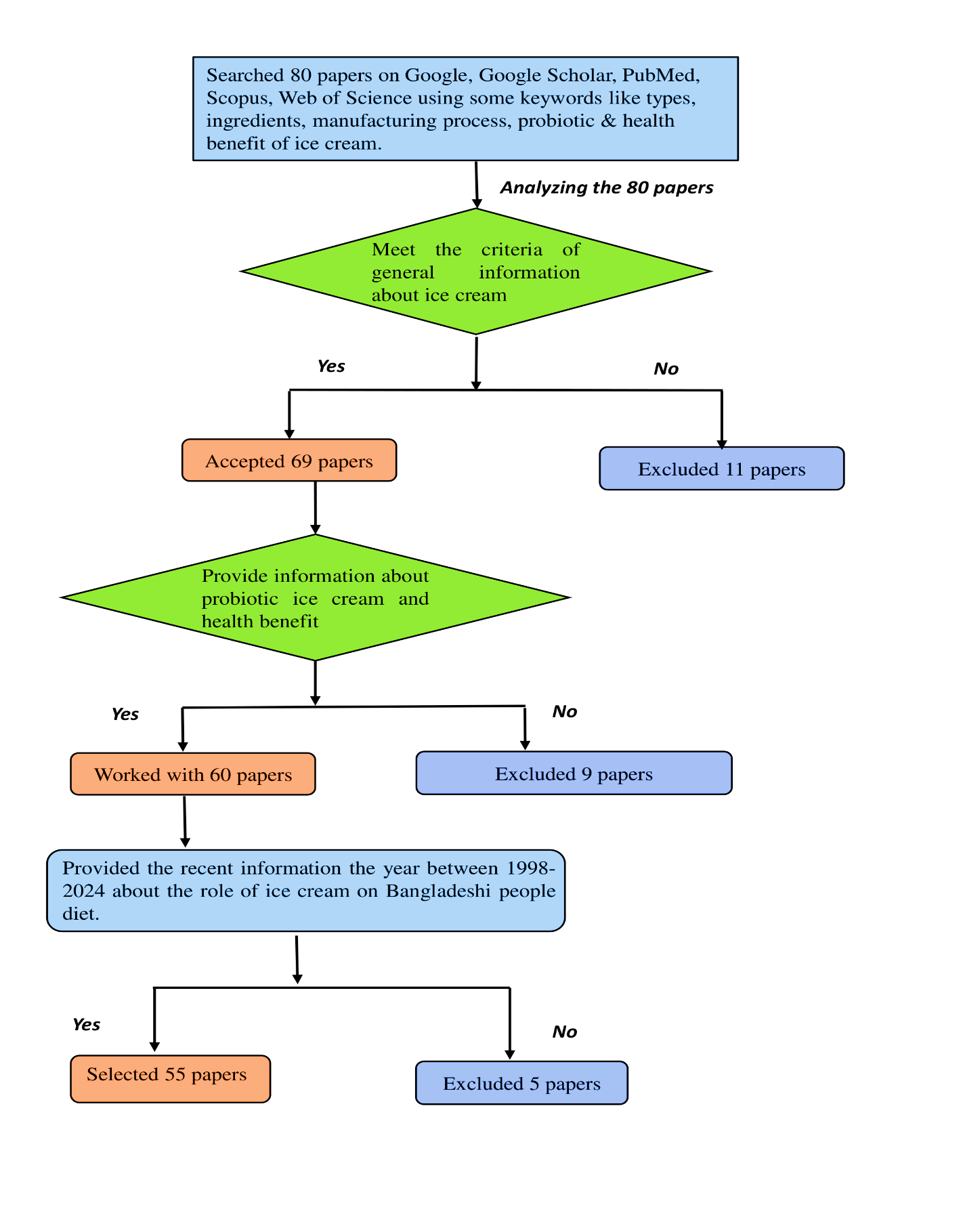
This review paper employs a comprehensive methodology to examine the role of ice cream in the diet of Bangladeshi people by systematically collecting and analyzing both quantitative and qualitative data from a variety of sources, including reviewed articles, reports, market surveys, and original articles. A focused literature search was conducted using databases such as Google Scholar, PubMed, and Scopus, with keywords related to ice cream consumption, significance, and nutritional impacts in Bangladesh. The selected studies were categorized into themes including significance, ingredients, types, nutritional content, and health implications. Data were critically assessed for relevance and reliability, synthesizing findings to identify overarching patterns in ice cream consumption, preferences, and its broader impact on Bangladeshi dietary habits. The review also involved comparing local trends with broader regional practices to provide context. The methodology ensures a holistic understanding of ice cream's health-related effects, and its significance in the food market.

In the first stage of selection, we screened all 80 papers from multiple academic databases and accepted 69 that met the predefined criteria. In the second stage of selection, the 80 papers were analyzed based on whether they met the general information criteria about ice cream. Here, 69 papers met the criteria and it was accepted but 11 papers did not meet the criteria and so these were excluded.

In the third stage of selection, the 69 accepted papers were further assessed to determine if they provided information about probiotic ice cream and health benefits. Here, 60 papers contained relevant information, it was retained but 9 papers did not meet the criteria and so these were excluded.

In the fourth stage of selection, the 60 remaining papers were then evaluated for their relevance in providing recent information (1998-2024) on the role of ice cream in the Bangladeshi diet. Here, 55 papers contained relevant information, it was retained but 5 papers did not meet the criteria and so these were excluded.

After applying all the selection criteria, 40 research papers were finally chosen for the study. (Figure 1)



**Figure 1: Flowchart illustrates the process of selecting relevant research papers for our study**

**Ingredients of ice cream**

Ice cream is a frozen dairy product that is created by freezing a well-mixed combination of ingredients while continuously stirring. It is made from various food components, including dairy products, sweeteners, stabilizers, colors, flavors, and sometimes egg products. The unfrozen blend of these ingredients, known as the ice cream mix, contains all the necessary components except air and flavoring agents. The composition of ice cream is typically measured in terms of the percentage of its key constituents, such as milk fat, non-fat milk solids, sugar, egg solids, and stabilizers. Stabilizers play a crucial role in regulating the formation and growth of ice crystals, ensuring the desired texture and consistency of the final product. Maintaining the balance of these ingredients is essential to preserving the sensory qualities that consumers expect. While sugars and milk fats serve as the primary ingredients, additional components like emulsifiers, flavors, stabilizers, and colors are incorporated based on the specific type of ice cream being produced (*Legassa, 2020*) (Table 1). Ice cream is a microcrystalline structure that consists of both liquid and solid phases. It contains air bubbles trapped in the liquid phase, along with other components like proteins, fat globules, stabilizers, sugar, and both soluble and insoluble salts. This creates a complex physicochemical and colloidal system, where various ingredients impact the ice cream's structure, influencing its functionality both positively and negatively. Stabilizers and emulsifiers enhance the texture of ice cream by increasing its viscosity and restricting the movement of free water molecules. However, an excess of these ingredients may lead to a lower melting point and reduced whipping ability (*Abbas Syed, 2018*).

Table 1: Most commonly used ingredients of ice cream ((*Legassa, 2020*)

|  |  |
| --- | --- |
| Ingredients types | Brief explanations |
| Emulsifiers | To create ice cream with a smoother texture and body, as well as to add a dry consistency. - Commonly used emulsifiers include monoglycerides, diglycerides, sorbates, and polysorbates. However, an excessive amount of these emulsifiers can lead to slow melting and defects in the product's body and texture. |
| Flavors | The key characteristics of ice cream are influenced by the type of flavoring, as even a slight off-flavor can affect its overall taste. Consumer preferences play a crucial role in determining the flavor choices, which can be either natural or synthetic. |
| Colors | Most colors are chemically derived and come in either liquid or powder form. Manufacturers typically prefer dry colors because they are more cost-effective and can be easily dissolved in boiling water when required. |
| Stabilizers | Stabilizers help prevent the formation of undesirable large ice crystals, maintain uniformity in the product, and stop ice crystal growth during storage. They are typically added at a rate of 0.2–0.3% of the mix. Common examples include sodium alginate, sodium carboxymethyl cellulose (CMC), guar gum, locust bean gum, carrageenan, gelatin, and pectin (*Legassa, 2020*). |

**Manufacturing process of ice cream**

Ice cream manufacturing begins with the mixing and blending of all the ingredients required in the base. Dairy components, sweeteners, stabilizers, emulsifiers, and flavorings are carefully measured and combined in large mixing tanks. Then, this mixed fluid/ice cream base is pumped into the pasteurizer, where the ice cream base is pasteurized. The standard pasteurization process involves heating the mixture to a specific temperature for a set period, followed by rapid cooling. The pasteurization process is essential for all ice cream mixes as it effectively eliminates harmful pathogenic and spoilage microorganisms, ensuring the safety of consumers. Additionally, pasteurization is crucial in neutralizing hydrolytic enzymes, including those naturally occurring in raw milk, which have the potential to adversely affect the flavor and texture of the ice cream. Following pasteurization, the ice cream base is pumped into a homogenizer, where the mix is subjected to carefully controlled pressure and temperature conditions. Homogenization is crucial to improving ice cream’s texture, consistency, and mouthfeel, by preventing the formation of large fat globules and ensuring the uniform distribution of fat, stabilizers, and other ingredients. The pressure is normally generated by a positive displacement pump, which forces the mix through a small orifice or valve. Pasteurization and homogenization bring about alterations in the physical characteristics of the suspended solids in ice cream mixes. Pasteurization results in the melting of all the fat content, whereas homogenization serves to decrease the diameters of fat globules. Consequently, this process leads to the formation of new and distinct fat globule membranes. Therefore, the ice cream mix is subjected to an aging process at a temperature of 40°F (4°C) from 4 to 24 hours. During this aging period, several beneficial transformations occur including hydration of added powders. Cooling the mix prepares it for freezing, facilitates the partial crystallization of milk fat, and allows proper fat destabilization during freezing. These changes collectively enhance the mix’s ability to be effectively whipped/blended. Finally, inclusions are added as the ice cream is packaged in batches of cones, plastic cups, or cartons, and then hardened by blast freezing *(Harfoush et al., 2024*) (Figure 2).

**Figure 2: Manufacturing process of ice cream**

**Types of ice cream**

New ice cream flavors are being launched in the global market; however, consumers tend to prefer traditional flavors and are reluctant to try new ones. Worldwide, vanilla remains the most popular flavor, followed by chocolate. As noted by *Singer (2022),* the major types of ice cream available globally are illustrated in Table 2.

Table 2: Types of ice cream (*Sarkar, 2024 & Legassa, 2020*)

|  |  |  |
| --- | --- | --- |
| No: | Types: | Short descriptions: |
| 1 | Plain Ice  Cream | The fat content ranges from 8% to 16%, with some reaching up to 22%, while serum solids range from 6% to 12%, and sugar content varies between 12% to 17%. Eggs are often included in the mixture. It is typically frozen with a single flavor, such as vanilla, chocolate, maple, mint, butterscotch, or coffee. |
| 2 | Nut Ice Cream | Frozen using the same base mixture as plain ice cream, but with the addition of various nuts like walnuts, almonds, hazelnuts, pistachios, chestnuts, and more. These nuts are often combined with the flavors typically found in plain ice cream, such as pistachios paired with mint flavor. |
| 3 | Fruit Ice Cream | Made using the same base as plain ice cream, with fruits added during the freezing process. Often, the fruit flavor is enhanced with natural or artificial extracts, and color is typically added as well. |
| 4 | Frozen Custards | This type of ice cream contains significant amounts of whole eggs or egg yolks, with the yolk content being the key distinguishing feature. Parfait, French Ice Cream, and New York Ice Cream are commonly considered the same as Frozen Custard. According to U.S. standards, frozen custard should have an egg yolk solids content of at least 1.4% by weight. |
| 5 | Frozen yogurt | Frozen yogurt is a relatively low calorie soft serve-style dessert that consists of sweetened yogurt, along with other dairy or non-dairy ingredients. |
| 6 | Kulfi | Kulfi is the traditional Indian ice cream is made by freezing the mixture of slowly heated caramelized sweetened milk in cone-shaped and is denser and creamier than American ice cream, with a custard-like quality. Kulfi is frequently flavoured with aromatics like cardamom, rose or saffron or popular flavours such as mango and pistachio. |
| 7 | Puddings | Commercial practices for making puddings lack consistency. Puddings differ from fruit ice cream mainly because they use a mixture of fruits, with a typically larger amount of fruit added. To be considered a pudding, the product should also contain egg yolks in quantities similar to those in Frozen Custards. |
| 8 | Milk or Milk Ice | They contain around 4% fat, 12 to 14% serum solids, and are similar to ice cream in terms of sugar, stabilizer content, and overrun. |
| 9 | Ices | This product is made by diluting fruit juices with water and sweetening them with sugar. Typically, color, fruit flavorings, and a stabilizer are also included. To achieve the desired tartness, citric acid or other edible acids are added. |
| 10 | Rolled ice cream | Rolled ice cream is made by combining milk, cream, and sugar, then subjecting the mixture to heating, aeration, and rapid cooling to form thin, ribbon-like rolls resembling a Swiss roll. |

**Nutritional composition of ice cream**

# Ice cream is the most popular frozen dairy product, it shows good potential to help people improve their diets by reducing the intake of certain nutrients associated with the increased risk of obesity and other related diseases. Moreover, it supplies beneficial and essential components. (*Alessandro et al., 2022*)

Table 3: Nutritional composition of ice cream (*Legassa, 2020*)

|  |  |
| --- | --- |
| Components | Details |
| Proteins | - Milk proteins have high biological value, containing all essential amino acids.  - Essential amino acids like tryptophan and lysine are present.  - Important for infant growth and tissue maintenance in adults.  - Milk proteins are 5-6% more completely assimilated than other proteins. (*Legassa, 2020*) |
| Carbohydrates | - Provide significant energy in human diets.  - Various sugars used, including starch, dextrin, cellulose, pectin, gums.  - Sucrose is the most commonly used sugar (from cane or beet).  - Lactose makes up over one-third of solid matter in milk and 20% of ice cream carbohydrates.  - Lactose enhances calcium and phosphorus utilization.  - Supports growth of Lactobacillus acidophilus, which inhibits harmful bacteria. (*Legassa, 2020*) |
| Fat | - Major contributor to flavor and texture.  - Correct milk fat percentage is crucial for mix balance and legal standards.  - Average ice cream fat content: 12%, but some studies report 16%.  - Milk fat contains at least 60% fatty acids, adding to nutritive value.  - Carrier of fat-soluble vitamins A, D, E, and K.  - Contains essential fatty acids like linoleic and arachidonic acids. (*Legassa, 2020*) |
| Minerals | - Rich source of calcium, phosphorus, and other essential minerals.  - Lactose in ice cream aids calcium absorption.  - Calcium content: Milk (0.118 g/100 g), Ice cream (0.132 g/100 g).  - Phosphorus content: Milk (0.093 g/100 g), Ice cream (0.105 g/100 g). (*Legassa, 2020*) |
| Fat-Soluble Vitamins | Vitamin A: Anti-infective vitamin, essential for growth and retina function (492 IU/100 g).  Vitamin D: Present in small amounts (4 IU/100 g); fortified versions available.  Vitamin E: Antioxidant, prevents degenerative disorders (3 mg/kg). (*Deosarkar et al.,* *2016*) |
| Water-Soluble Vitamins | Vitamin B1 (Thiamine): Essential for metabolism (0.48 mg/kg, range 0.38–0.65 mg/kg).  Vitamin B2 (Riboflavin): Important for energy production (2.3 mg/kg, range 2.0–2.6 mg/kg).  Vitamin B6 (Pyridoxine): Coenzyme in amino acid metabolism (0.0047 mg/kg, range 0.0026–0.0078 mg/kg).  Vitamin B12 (Cyanocobalamin): Prevents anemia (0.0047 mg/kg, range 0.0026–0.0078 mg/kg).  Vitamin C (Ascorbic Acid): Found in fruit ice creams (3 mg/kg, range 0–11 mg/kg). (*Legassa, 2020*) |

Table 4: Nutritive value of commercial ice cream and related products (*Legassa, 2020*).

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Type of Product** | **Weight (g)** | **Water (%)** | **Fat (%)** | **Protein (%)** | **Carbohydrate (%)** | **Total Solids (%)** | **Energy (Cal)** | **Wt/100 Cal (g)** |
| **Chocolate Ice Cream** | 100 | - | 13.1 | 3.6 | 25.8 | 42.1 | 221 | - |
| **Vanilla Ice Cream** | 100 | - | 12 | 4 | 20.7 | 38.3 | 204 | - |
| **Mango Ice Cream** | 100 | - | 10 | 3.5 | 21.2 | 36.3 | 188 | - |
| **Strawberry Ice Cream** | 100 | - | 8 | 3.6 | 21.2 | 40.8 | 194 | - |
| **Diabetic Ice Cream** | 100 | - | 9 | 4.3 | 20.6 | 28.6 | 152 | - |
| **Ice Milk** | 100 | 61.7 | 4 | 4.1 | 20.5 | 33.5 | 144 | 50.8 |
| **Ice Lolly** | 60 | - | - | - | 27.6 | 14.5 | 54 | - |
| **Water Ice** | 100 | 66.9 | Trace | 0.4 | 32.6 | - | 78 | 128.4 |

**Figure 3: The graph provides a detailed nutritional comparison of different ice cream and frozen dessert products, including their composition in terms of water content, fat, protein, carbohydrates, total solids, energy (calories), and weight per 100 calories.**

**Ice cream as a probiotic carrier**

Probiotics are live microorganisms, such as bacteria and yeasts, that offer health benefits by maintaining or improving intestinal microbial balance (*Mohammadi et al., 2011*).

Recent research supports ice cream as a suitable probiotic carrier due to its ability to preserve probiotics at low temperatures and its natural content of Lactobacillus. However, its high sugar and fat content makes it unsuitable for some individuals. Studies suggest that reducing sugar and fat levels in ice cream can help address this issue while maintaining its probiotic benefits, thereby enhancing its nutritional value (*Legassa, 2020*).

Ice cream serves as an effective vehicle for probiotic cultures due to its composition, which includes milk proteins, fat, and lactose. Additionally, its frozen nature aids in probiotic preservation. A pH range of 5.5 to 6.5 supports probiotic survival during storage while also improving consumer acceptance, particularly among those who prefer mild flavors. Despite its traditionally high sugar and fat content, ice cream is considered a nutritious food, often containing milk and fruit. Incorporating probiotics into ice cream not only enhances its value as a functional food but also offers health benefits. For instance, regular consumption of probiotic ice cream containing Bifidobacterium lactis Bb-12 has been shown to reduce salivary streptococci and lactobacilli, which are associated with dental caries. This effect may result from probiotics adhering to oral surfaces and competing with harmful bacteria (*Cruz et al., 2009*).

### **Techniques to Enhance Probiotic Viability in Probiotic Ice Cream:**

* **Probiotic Viability Importance:** Ensuring probiotic survival in ice cream is crucial for maintaining health benefits.
* **Key Techniques for Improved Viability:**
* Selecting probiotic strains that can withstand oxygen exposure.
* Eliminating molecular oxygen using oxygen-scavenging substances.
* Implementing oxygen-resistant packaging and advanced active packaging methods.
* Enhancing milk with essential nutrients and prebiotics (*Mohammadi et al., 2011*).
* Adding prebiotics to support probiotic viability (*Sabet-Sarvestani et al., 2021*).
* Utilizing microencapsulation (ME) techniques for probiotic protection (*Champagne et al., 2015*).
* Employing rapid freezing methods to reduce ice crystal formation (Adil et al., 2022).
* Integrating co-encapsulation techniques that combine probiotics with prebiotics (*Spigno et al., 2015*).
* Lowering overrun levels in ice cream production (*Ferraz et al., 2012*).
* Carefully selecting or combining appropriate encapsulating agents (*Gul et al., 2019*).
* Using freeze-concentrated milk for improved texture and stability (*Camelo-Silva et al., 2022*).
* **Prebiotic Supplementation:** Adding prebiotics like inulin and oligo-fructose enhances probiotic stability while improving sensory and physicochemical properties of synbiotic ice cream (*Mohammadi et al., 2011*).

**Challenges in the Manufacture of Probiotic Ice Cream**

The ice cream industry faces the same challenges encountered by the rest of the food industry and additional challenges such as maintaining consistent quality, responding to customizing flavors and healthier ice cream requests, ensuring food safety, and establishing a sustainable production system. Similar to the general food industry, the ice cream industry can be significantly helped by smart manufacturing to enhance its production systems (Harfoush et al., 2024).

**Ingredient Selection:** The survival of probiotics in ice cream is influenced by the levels of sugar and fat, with their effects varying depending on the specific probiotic strain used.

**Choice of Probiotic Strains:** The persistence of probiotics in ice cream is determined by the particular strains incorporated, as well as the pH and titratable acidity of the mixture. Different strains, even within the same species, may exhibit varying levels of viability under distinct physicochemical and processing conditions.

**Processing Parameters:** The method of ice cream production, including the stage at which probiotics are introduced, plays a crucial role in their survival. The freezing process, which introduces air to achieve the required overrun, poses a challenge since probiotic strains respond differently to low temperatures and oxygen exposure.

**Storage Considerations:** The longevity of probiotics during storage is affected by factors such as the composition of the ice cream, whether the probiotics are in free or encapsulated form, and the storage temperature and duration. Additionally, different probiotic strains exhibit varying levels of stability under these conditions. (*Sarkar, 2024*).

**Significance of ice cream**

Ice cream is a popular frozen dairy product and consumed by all age groups during the whole year (*El-Sharef et al., 2006*). Now-a-days paving new opportunities in research and development of new ice cream varieties having beneficial functional attributes and interest of health conscious public segment is expected to grow in days to come in developing countries. The varieties discussed above in this review are expected to set new trends in markets worldwide in days to come. Ice cream varieties like soy based, spirulina based, phytochemical, probiotic impregnated, and lean fat ice creams etc. are expected to show more demand and are expected to be advertised for their health promoting properties. Challenges do occur for the ice cream industries, it is factual that there is set back for ice cream sales and revenue generation from many years as reason being non perennial demand and market for ice creams in tropical countries like India (*Patil, et al., 2017*).

Ice cream is good enough and the concentration of living bacteria fulfills demand for probiotic products. Ice cream can serve as an excellent vehicle for dietary incorporation of probiotic bacteria. Frozen storage of the products has little effect on cultures survival, and bacterial cultures remained at levels sufficient to offer the suggested therapeutic effects. Supplementation with probiotic bacteria has been found to exert a little effect on flavour or compositional characteristics of ice cream (*Salem et al., 2005*).

The popularity of ice cream is increasing day by day not only in Bangladesh but also in many countries around the world. During industrial production, ice cream can potentially be contaminated due to the use of impure water, milk, eggs, nuts, stabilizers, sweetening agents, colors, and flavors (*Deosarkar et al., 2016*). Owing to improper manufacturing practices and anthropogenic stresses, regular monitoring of toxic metals in highly consumed ice cream is required. In Bangladesh, the majority of the textile, mining, printing, tannery, dyeing, fertilizer, pharmaceutical, cement, and other industrial effluents are directly discharged into the air, water, and soil without any pre-treatment (*Saha & Zaman, 2012; Uddin et al., 2019*). As a consequence, different kinds of heavy metals are drastically entering the food chain and instigating ecological imbalance. Furthermore, burning fossil fuels, vehicular emission, household organic and inorganic solid wastes, and inappropriate agricultural practices are the possible sources of toxic metal accumulation in the ecosystem (*Dhar, Naznin, et al., 2021*).

**Purchase frequency of consumers**

The frequency of purchase plays a significant role in determining consumer preference. Approximately 41% of consumers purchase ice cream once a week, with the majority being children. The study revealed that the second-largest group of consumers (36%) purchases ice cream occasionally, with the most common occasion being hanging out with friends. Additionally, 16% of consumers prefer to have ice cream only on hot days, highlighting its role as a refreshing treat. A small percentage (6%) of consumers reported eating ice cream every day. This group primarily consists of children aged 10-16 years from nuclear families, where one or both parents work in the private or government sector. These children receive money daily to buy ice cream, viewing it similarly to chocolates or chips as a regular snack. Interestingly, only one respondent mentioned disliking ice cream and, as a result, never purchases it. (*Begum, A. et al, 2020*) (Figure 4)

**Figure 4: The graph presents data on the buying intensity of ice cream among consumers in Bangladesh, showing the frequency of consumption along with the number of consumers and their corresponding percentages** (*Begum, A. et al, 2020*)**.**

**Influential factors of purchasing ice cream**

Approximately 41% of consumers stated that they eat ice cream purely for its taste as a dessert, rather than for caloric intake or relief from hot weather. Around 33% consume it specifically to cool down on hot days, while 24% enjoy ice cream to enhance or uplift their mood, with the majority being teenagers and young children. Only 1% of health-conscious consumers mentioned consuming ice cream to increase their calorie intake. (*Begum, A. et al, 2020*)

**Figure 5: The table presents various factors influencing ice cream consumption among consumers, along with the number of consumers and their respective percentages.**

**Health impacts of ice cream on Bangladeshi people’s diet**

**Good effects:**

In Bangladesh, the ice cream industry contributes around BDT 6.5 billion, among them 85% constitutes is the branded ice cream producer and the remaining is the artisanal maker (Dhar, Hossain, et al., 2021).

In Bangladesh unfortunately it is very difficult to monitor how the consumer can be affected by taking ice creams. However, much attention is still needed to apply in aspects of microbiological quality control for attaining desired safety margins and giving assurance that the ice cream product received by the consumer will be pure, healthful and of the quality claimed. To do so useful and effective legislation must have to be enacted and enforced, the chief aim of which is to ensure that the production, handling, processing, distribution and storage of ice cream could be maintained under strict hygienic control to protect consumers against health hazard and under quality standards. (Hasan et al., 2016).

Several steps in the production of ice cream can cause microbiological hazards. However, pasteurization, freezing and hardening steps can eliminate most of these hazards. Pasteurization of milk can destroy most of the pathogens posed risk to public health. Most ice creams become contaminated with microbes during production, transit, and preservation. Such contaminated food product can be responsible for food borne infections in children, elderly people and immune-suppressed patients. In our country, ice cream industries distribute the ice cream to their out lets by using vehicle equipped with fridge system. But, contamination may occur from ingredients used, during loading and unloading. Once the ice cream becomes contaminated, freezing temperature later could not make the product safer. There are psychrophilic microorganisms that can survive in a low storage temperature. Because, it is unbelievable to say ice cream is safe due to low temperature storage (Legassa, 2020).

To get the desired appearance, texture, consistency, and taste of the final product various kinds of raw materials are used. Some minerals especially Ca, Mg, Na, K, and P play pivotal roles in metabolic processes, maintaining blood sugar levels, and enhancing weight gain. Besides, Ca and P are necessary for bone growth and proper development of newborns. In the human body, mineral components account for four percent of total body mass. Several studies reported that these minerals have biochemical, structural, and nutritional functions, which are very important for both mental and physical health (Dhar, Hossain, et al., 2021).

The consumption of ice-cream is higher in vulnerable age groups like children and these are also consumed by hospital patient in case of throat and mouth operation which raises the necessity to maintain a high microbiological safe standard of ice creams throughout the world (Khatun et al., 2023).

Ingestion of probiotic ice cream containing probiotics alleviates certain diseased condition and is dependent on the type of probiotics used. A number of reports on efficacy of probiotic ice cream for prevention of dental caries have been reported. A significant reduction in the counts of Streptococcus mutans (*Ashwin et al., 2015; Alwani et al., 2017*) and Candida albicans (Vivek and Shwetha, 2015) with the ingestion of probiotic ice cream containing probiotic cultures (Bifidobacterium lactis Bb-12, L. acidophilus LA-5) have been reported (*Ashwin et al., 2015; Vivek and Shwetha, 2015; Alwani et al., 2017*). Lee and Kim (2014) reported that Lactobacillus species strongly inhibited the growth of the Streptococcus mutans by oral biofilm formation. Ingestion of probiotic ice cream also proved to be advantageous for other diseases such as colonic carcinogenesis, allergy, postprandial hyperglycaemia and neurodegenerative disease *(Sarkar, 2024*).

Ingestion of probiotic ice cream also proved to be advantageous for other diseases such as colonic carcinogenesis, allergy, postprandial hyperglycaemia and neurodegenerative disease. Consumption of rice berry milk ice cream or sesame-rice berry milk ice cream, may be advantageous as ingestion of rice berry have been reported to prevent memory impairment, neurodegeneration, Alzheimer’s disease (*Pannangrong et al., 2011*). Functional properties of probiotic ice cream have been evaluated for limited diseases and disorders and needs further investigations (*Sarkar, 2024*).

The use of banana as main component of ice cream can become a win-win solution for those problems (*D & D, 2020*). It is expected not only to find a new healthy food innovation for cancer sufferers, but also become a sustainable food. Therefore, banana ice cream can be sold as a social business product at a low price, so everyone can reach it. Then, the profit generated by the business can circle back for the needs of cancer patients. It is the most consumed fruit in cancer patients since it is safe for consumption, not cause gas, and can decrease constipation as a side effect of some therapies. Instead of causing indigestion, banana tend to strengthen the digestive system. Its soft texture helps cancer patients that have trouble swallowing during their treatments. Furthermore, banana contains some compounds cancer patients needed. Ice cream can give several psychology benefits, such as: sensation of freshness, satiation and even a symbolic sense of happiness (*Casas et al., 2012*). Those characteristics make ice cream can be eaten not only by cancer patients, but also by common society. This is also the advantage on social aspect *(Hillary, 2022*).

Falooda ice cream has many health benefits because it contains vitamins and basil seeds that are essential for your health and brain. Basil seeds have cooling properties so mostly people preferred it during hot days or in summer. The shape of falooda looks like rice noodles. Falooda ice cream available in many flavours such as rabdi falooda, mango falooda, vanilla ice cream falooda and royal falooda. But the patients of diabetes should avoid by eating too much falooda ice cream because it contains too much sugar and cream. It also causes the weight gain. But people preferred it due to its advantages because it contain protein basil seeds and cream all these boost your brain power and essential for healthy life style. So, we should eat it 4 to 5 times per week *(Qadir & Saleem, 2019*).

**Bad effects:**

As a tropical country, the summer season is very long with hot weather in Bangladesh. Moreover, a huge number of unauthorized ice cream factories are developed here, particularly in the summer season. As a sweetened and cheap food item, ice cream is very popular among school-going students during the summer season. However, contamination of ice cream by pathogenic bacteria and their antibiotic-resistance pattern were not clearly documented in the previous research studies, but little information is reported regarding bacterial load and their biochemical identification (*Sohel et al., 2022*).

The most frequently isolated strains *Proteus* spp. and *E. coli* imply that they may have come from the contaminated water used in the ice cream industry. These types of pathogens cause a series of diseases like diarrhea and gastrointestinal illness. Milk is the major source of *Staphylococcus aureus* in the dairy industry that cause numerous food-borne diseases by producing toxins, especially when the dairy product is kept at room temperature. In our study, we also found that the tested ice cream samples were contaminated by *Vibrio cholera*, possibly due to improper handling, undercooking, and washing with unhygienic water. Contamination of ice cream by this bacterium may cause diarrheal diseases, nausea, stomach cramping, and fever among ice cream consumers. Milk, different raw materials, fruit juice, and fruits pulps are frequently used in the ice cream industry, which are signi9cant sources of *Klebsiella* spp. and *Aeromonas* spp. and contribute to developing pneumonia, septicemia, wound infections, and gastroenteritis like diarrhea, abdominal pain, headache, vomiting, or fever (*Sohel et al., 2022*).

Children who consumed ice cream were suffered from several food-borne diseases like cholera, typhoid, bacillary dysentery, salmonellosis, typhimurium, meningitis, encephalitis, sepsis, hemorrhagic colitis, a hemolytic uremic syndrome in children, gastroenteritis, septicemia, and wound infection, cholera, fever, cough, dysentery, acidity, poisoning, vomiting, dysuria, diarrhea, stomach pain, and weakness (*Sohel et al., 2022*).

Salmonella is still the most important agent causing acute food borne diseases and Consumption of ice cream contaminated with enteropathogenic bacteria such as Salmonella has been the cause of several disease outbreaks (*Legassa*, *2020*).

**Conclusion**

Ice cream has evolved beyond being a mere indulgent dessert to playing a significant role in the Bangladeshi diet, influenced by changing consumer preferences, nutritional awareness, and the growing demand for functional foods. This review highlights that ice cream, particularly probiotic-enriched varieties, can contribute to gut health, enhance immunity, and offer essential nutrients like calcium and protein. However, concerns over high sugar and fat content necessitate the development of healthier formulations, including low-fat and sugar-free alternatives. The increasing popularity of ice cream in Bangladesh is driven by urbanization, lifestyle changes, and the influence of global food trends. Despite its benefits, moderation is key, as excessive consumption may lead to health issues such as obesity, cardiovascular diseases and diabetes. Future research should focus on developing innovative, nutritionally optimized ice cream formulations that align with the dietary needs of Bangladeshi consumers while maintaining sensory appeal. Ice cream holds potential as both a treat and a functional food in Bangladesh. With advancements in food technology and consumer awareness, it can be integrated into a balanced diet, providing enjoyment along with health benefits.

**Data Availability**

Not applicable.

**References**

Aboulfazli, F., Baba, A. S., & Misran, M. (2015). Effects of fermentation by Bifidobacterium bifidum on the rheology and physical properties of ice cream mixes made with cow and vegetable milks. *International Journal of Food Science and Technology*, *50*(4), 942-949.

Adil, S., Jana, A.H., Mehta, B.M. and Chandgude, P.B. (2022), “Icecream and frozen yoghurt- a suitable carrier for probiotics: a review”, Agricultural Reviews, Vol. 43, pp. 436-442.

Alwani, A., Venkataraghavan, K., Panda, A., Trivedi, K., Jani, J. and Dave, J. (2017), “Comparative evaluation of probiotic ice-cream and normal ice-cream on salivary Mutans Streptococci count in children”, Indian Journal of Applied Research, Vol. 7, pp. 58-60.

Ashwin, D., Ke, V., Taranath, M., Ramagoni, N.K., Nara, A. and Sarpangala, M. (2015), “Effect of probiotic containing ice-cream on salivary mutans streptococci (SMS) levels in children of 6-12 years of age: a randomized controlled double blind study with six-months follow up”, Journal of Clinical and Diagnostic Research, Vol. 9, pp. 6-9.

Aslan Türker, M. Dogan, Effects of ultrasound homogenization on the structural and sensorial attributes of ice cream: optimization with Taguchi and data envelopment analysis, J. Food Meas. Charact. 15 (2021) 4888–4898. <https://doi.org/10.1007/s11694-021-01044-z>.

Begum, A., Palash, M. S., Alam, M. A., & Begum, M. (2020). Ice cream consumption in a selected area of Bangladesh: Effect of demographic, psychometric and product factors. *Journal of the Bangladesh Agricultural University*, *18*(1), 165-171.

Camelo-Silva, C., Barros, E.L.S., Verruck, S., Maran, B.M., Canella, M.H.M., Esmerino, E.A., Silva, R. and Prudencio, E.S. (2022), “How ice cream manufactured with concentrated milk serves as a protective probiotic carrier? An in vitro gastrointestinal assay”, Foods and Science Technology, Vol. 42, p. e28621.

Casas, F., León, C., Jovell, E., Gómez, J., Corvitto, A., Blanco, R., Alfaro, J., Seguí, M. Á., Saigí, E., Massanés, T., Sala, C., Librán, A., & Arcusa, A. (2012). Adapted ice cream as a nutritional supplement in cancer patients: Impact on quality of life and nutritional status. Clinical and Translational Oncology, 14(1), 66–72. https://doi.org/10.1007/S12094-012-0763-9

Champagne, C.P., Raymond, Y., Guertin, N. and Belanger, G. (2015), “Effects of storage conditions, microencapsulation and inclusion in chocolate particles on the stability of probiotic bacteria in ice cream”, International Dairy Journal, Vol. 47, pp. 109-117.

Cogné, P. Laurent, J. Andrieu, J. Ferrand, Experimental Data and Modelling of Ice Cream Freezing, Chem. Eng. Res. Des. 81 (2003) 1129–1135. <https://doi.org/10.1205/026387603770866281>

Cruz, A. G., Antunes, A. E., Sousa, A. L. O., Faria, J. A., & Saad, S. M. (2009). Ice-cream as a probiotic food carrier. *Food Research International*, *42*(9), 1233-1239.

D, D. D., & D, S. (2020). An Overview on Utilization of Food Waste. International Journal of Progressive Research in Science and Engineering , 1(3), 36–42. <https://journals.grdpublications.com/index.php/ijprse/article/view/40>

Deosarkar, S.S., Kalyankar, S.D., Pawshe, R.D., et al. Ice Cream: Composition and Health Effects. (2016) Encyclopedia of Food and Health 385-390.

Dhar, P. K., Naznin, A., Hossain, M. S., & Hasan, M. K. (2021). Toxic element profile of ice cream in Bangladesh: a health risk assessment study. *Environmental monitoring and assessment*, *193*(7), 421.

El-Sharef, N., Ghenghesh, K. S., Abognah, Y. S., Gnan, S. O., & Rahouma, A. (2006). Bacteriological quality of ice cream in Tripoli-Libya. *Food Control, 17*(8), 637–641.https://doi.org/10.1016/j.foodcont.2005.04.001.

Ferraz, J.L., Cruz, A.D., Cadena, R.S., Freitas, M.Q., Pinto, U.M., Carvalho, C.C., Faria, J.A.F. and Bolini, H.M.A. (2012), “Sensory acceptance and survival of probiotic bacteria in ice cream produced with different overrun levels”, Journal of Food Science, Vol. 71, pp. 24-28.

G. C. Lima, M. R. Loiko, L. S. Casarin, and E. C. Tondo, “Assessing the epidemiological data of *Staphylococcus aureus* food poisoning occurred in the State of Rio Grande do Sul, Southern Brazil,” *Brazilian Journal of Microbiology*, vol. 44, no. 3, pp. 759–763, 2013.

Genovese A, Balivo A, Salvati A, Sacchi R. Functional ice cream health benefits and sensory implications. Food Res Int. 2022 Nov;161:111858. doi: 10.1016/j.foodres.2022.111858. Epub 2022 Aug 27. PMID: 36192980.

Gul, O., Atalar, I. and Gul, L.B. (2019), “Effect of different encapsulating agent combinations on viability of Lactobacillus casei shirota during storage, in simulated gastrointestinal conditions and dairy dessert”, Food Science and Technology International, Vol. 25, pp. 608-617.

H.D. Goff, R.W. Hartel, Ice Cream, Springer US, Boston, MA, 2013. <https://doi.org/10.1007/978-1-4614-6096-1>.

Harfoush, A., Fan, Z., Goddik, L., & Haapala, K. R. (2024). A review of ice cream manufacturing process and system improvement strategies. *Manufacturing Letters*, *41*, 170-181.

Hasan, M. K., Rahman, M. M., Khan, M. S. R., & Afroz, F. (2015). Determination of bacterial loads of ice cream in Dinajpur District, Bangladesh. *Microbes and Health*, *4*(2), 1-4.

Hillary, J. (2022). Banana Ice Cream as An Eco-friendly Social Enterprise Product for Helping Cancer Patients During Treatment. *IJEBD International Journal Of Entrepreneurship And Business Development eISSN*, 2597-4785.

Humayun, F. 2018. Consumer Analysis of Bloop Ice Cream”, An unpublished internship report submitted to the BRAC Business School, BRAC University, Dhaka-1212, Bangladesh.

K. S. Ghenghesh, K. Belhaj, W. B. El-Amin, S. E. El-Nefathi, and A. Zalmum, “Microbiological quality of fruit juices sold in Tripoli-Libya,” *Food Control*, vol. 16, no. 10, pp. 855–858, 2005.

Khatun, A., Mia, M. Y., Masuma, M., & Das, K. K. (2023). Assessment of Microbiological Contamination of Branded and Street Vended Ice-Cream: A Comparative Study in Tangail Municipality, Bangladesh. *Food ScienTech Journal*, *5*(1), 47-59.

L. Park, C. E. Ayala, S. E. Guzman-Perez, R. Lopez-Garcia, and S. Trujillo, “Microbial toxins in foods: algal, fungal, and bacterial,” *Food Toxicology*, vol. 5, pp. 93–135, 2000.

Laskar, P. 2017. Ice Cream; New Industry of Future Prospect, Available online at: http://www.thepages.com.bd/2017/04/ 19/ice-cream-new-industry-future-prospect-prosantalaskar/ [Accessed at 15 December 2018]

Lee, S.H. and Kim, Y.J. (2014), “A comparative study of the effect of probiotics on cariogenic biofilm model for preventing dental caries”, Archives of Microbiology, Vol. 196, pp. 601-609.

Legassa, O. (2020). Ice cream nutrition and its health impacts. *International Journal of Food and Nutritional Science*, *7*(1), 19-27.

M. A. Desta Sisay, “A review on major food borne bacterial illnesses,” *International Journal of Tropical Diseases*, vol. 3, 2015.

M. K. Hasan, M. M. Rahman, M. S. R. Khan, and F. Afroz, “Determination of bacterial loads of ice cream in dinajpur district, Bangladesh,” *Microbes and Health*, vol. 4, no. 2, pp. 1–4, 2016.

M. K. Miettinen, K. J. Bjorkroth, and H. J. Korkeala, ¨ “Characterization of Listeria monocytogenes from an ice cream plant by serotyping and pulsed-9eld gel electrophoresis,” *International Journal of Food Microbiology*, vol. 46, no. 3, pp. 187–192, 1999.

M. T. Hossain and A. H. Kober, “Microbiological quality of ice cream available in chittagong,” *Bangladesh Journal of Microbiology*, vol. 25, no. 2, pp. 135-136, Jan. 1970.

Mohammadi, R., Mortazavian, A. M., Khosrokhavar, R., & da Cruz, A. G. (2011). Probiotic ice cream: viability of probiotic bacteria and sensory properties. *Annals of microbiology*, *61*, 411-424.

Mrityunjoy, F. Kaniz, J. Fahmida, J. S. Shanzida, U. Aftab, and N. Rashed, “Prevalence of *Vibrio cholerae* in different food samples in the city of Dhaka, Bangladesh,” *Ce International Food Research Journal*, vol. 20, no. 2, pp. 1017–1022, 2013.

Muhib, M. I., Chowdhury, M. A. Z., Easha, N. J., Rahman, M. M., Shammi, M., Fardous, Z., Bari, M. L., Uddin, M. K., Kurasaki, M., & Alam, M. K. (2016). Investigation of heavy metal contents in cow milk samples from area of Dhaka. *Bangladesh. International Journal of Food Contamination, 3*(16), 1–10. <https://doi.org/10.1186/s40550-016-0039-1>

Pannangrong, W., Wattanathorn, J., Muchimapura, S., Tiamkao, S. and Tong-Un, T. (2011), “Purple rice berry is neuroprotective and enhances cognition in a rat model of alzheimer’s disease”, Journal of Medicinal Food, Vol. 14, pp. 688-694.

Patil, A. G., & Banerjee, S. (2017). Variants of ice creams and their health effects. *MOJ Food Process. Technol*, *4*(2), 58-64.

Qadir, M. I., & Saleem, Z. (2019). How blood pressure relevance with falooda ice cream loving?

R. Podschun and U. Ullmann, “Klebsiella spp. as nosocomial pathogens: epidemiology, taxonomy, typing methods, and pathogenicity factors,” *Clinical Microbiology Reviews*, vol. 11, no. 4, pp. 589–603, 1998.

Sabet-Sarvestani, N., Eskandari, M.H., M.H., Hosseini, S.M.H., Niakousari, M., Gahruie, H.H. and Khalesi, M. (2021), “Production of synbiotic ice cream using Lactobacillus casei/Lactobacillus plantarum and fructooligosaccharides”, Journal of Food Processing and Preservation, Vol. 45, p. e15423.

Saha, N., & Zaman, M. R. (2012). Evaluation of possible health risks of heavy metals by consumption of foodstuffs available in the central market of Rajshahi City, Bangladesh. *Environmental Monitoring and Assessment, 185*, 3867–3878. <https://doi.org/10.1007/s10661-012-2835-2>

Salem, M. M., Fathi, F. A., & Awad, R. A. (2005). Production of probiotic ice cream.

Sarkar, S. (2024). Probiotic ice cream as a functional food-a review. *Nutrition & Food Science*, *54*(5), 865-889.

Seong, G. U., Kim, J. Y., Kim, J. S., Jeong, S. U., Cho, J. H., Lee, J. Y., ... & Kang, J. W. (2023). Quality Characteristics of Rice-Based Ice Creams with Different Amylose Contents. *Foods*, *12*(7), 1518.

Singer, E. (2022), “12 Types of ice cream you should know and sample”, Purewon, available at: www. purewow.com/food/types-of-ice-cream.

Sohel, M., Akter, M., Hasan, M. F., Mahmud, S., Islam, M. J., Islam, A., ... & Al Mamun, A. (2022). Antibiotics resistance pattern of food‐borne bacteria isolated from ice cream in Bangladesh: a multidisciplinary study. *Journal of Food Quality*, *2022*(1), 5016795.

Spigno, G., Garrido, G., Guidesi, E. and Elli, M. (2015), “Spray-drying encapsulation of probiotics for icecream application”, Chemical Engineering Transactions, Vol. 43, pp. 49-54.

Syed, Q. A., Anwar, S., Shukat, R., & Zahoor, T. (2018). Effects of different ingredients on texture of ice cream. *Journal of Nutritional Health & Food Engineering*, *8*(6), 422-435.

T. Markovic, M. Leon, B. Leander, S. Punnekkat, A Modular Ice Cream Factory Dataset on Anomalies in Sensors to Support Machine Learning Research in Manufacturing Systems, IEEE Access 11 (2023) 29744– 29758. https://doi.org/10.1109/ACCESS.2023.3252901.

Turgut, T., & Cakmakci, S. (2009). Investigation of the possible use of probiotics in ice cream manufacture. *International journal of dairy technology*, *62*(3), 444-451.

U.S. Food and Drug Administration, “Foodborne illness causing organisms in the U.S. what you need to know,” *Ce U.S Food Drug Adm. Cent. Food Saf. Appl. Nutr.*vol. 888, p. 888, 2016.

Uddin, N., Hasan, M. K., & Dhar, P. K. (2019). Contamination status of heavy metals in vegetables and soil in Satkhira, Bangladesh. *Journal of Materials and Environment Sciences, 10*(6), 543–552.

Vivek, S. and Shwetha, R. (2015), “Effect of commercially available probiotic icecream on salivary levels of streptococcous mutans, lactobacillus and Candida albicans”, IOSR Journal of Dental and Medical Sciences Vol. 14, pp. 64-68.