NOVEL FUNCTIONAL INGREDIENT TRENDS IN ICE CREAMS AND THEIR HEALTH BENEFITS

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Abstract:
Ice creams are one of the most popular desserts among all age groups due to their unique taste and cooling effect. However, conventional dairy ice creams are prepared with cow milk and have high amounts of sugar which has been linked to several health concerns, such as lactose intolerance, hypercholesterolemia, and diabetes. Likewise, these ice creams are rich in fats and calories making them unsuitable for consumption by people with dietary restrictions. Consequently, research has focused on enhancing ice cream's properties in terms of nutrition and sensory by substituting various functional ingredients in ice creams like probiotics and herbal extracts, antioxidants, and bioactive compounds. These ingredients provide advantages, like increasing the nutritional value of the product as well as its quality, and also help in improving consumer health. Millets are nutri - cereals, which are high energy-yielding nutritious foods with low fat and a low glycemic index value, which aid in addressing malnutrition and also possess various health benefits. The review focuses on the use of herbal extracts, probiotics, and millets as functional ingredients in Ice creams and their positive impact on consumer's health.

Keywords: Ice creams, herbal extract, probiotics, millets.

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Introduction:

Ice cream is a frozen sweetened dairy product that can be consumed as a snack or dessert. It is produced from milk and milk products. Other key ingredients include raw or dried fruits, along with flavors and colors. Usually, sugar or sugar substitutes are used to sweeten it. To make ice cream with the properties per consumer requirements, stabilizers, and emulsifiers are combined with flavors and colors (Legassa, 2022). It provides a cooling effect; hence it is generally liked by customers of all ages during hot summer days. Before being stirred to incorporate voids or air spaces, the manufactured ice cream mixture is quickly chilled below the water's freezing point to produce the required characteristics. The finished ice cream would have a smooth, semi-solid foam at room temperature. It softens once more as the temperature increases(Goff & Hartel, 2013; Saleh et al., 2020).

The type of ice cream and the ingredients used to make ice cream helps in determining its nutritional value (Syed, 2018). Ice cream has a significant value of fat, proteins, and carbohydrates, which raises its caloric value. Ice cream typically contains 10–14% fat, which provides 180–250 kcal/100 g, 8–20% sugar, 13–20% stabilizer–an emulsifier, and 0–0.7% ice cream contains 3–4 times as many fats and 12–16% more protein than milk in terms of total solids(Mostafavi et al., 2017). Cow milk, along with fats from buffalo and other animals, is commonly utilized in the making of ice cream in many countries, including India. Yet, a significant number of studies in the literature have revealed that conventional dairy ice cream has been linked to health concerns, such as lactose intolerance, hypercholesterolemia, and other issues(Bhatt, 2019). Ice creams are a great way to address malnutrition, but their nutritional quality is compromised due to our overdependence on dairy products. Because of their low storage temperature and ability to stabilize functional ingredients, ice creams can serve as carriers of nutraceuticals, this substitution of a dairy base with functional ingredients can help address malnutrition (Mohammed et al., 2022).

Figure 1: Essential Ice cream ingredients and their functions (Legassa, O., 2022)

In India, sales of ice cream have been rising at a steady rate of 10-15%. Producers want growth through product and service innovation in response to the expanding ice cream consumer base, widespread acceptance of the product, and fierce competition (Mastud et al., 2018). Esteem expansion to dairy items has expanded altogether as of late, attributable to rising pay levels and customer well-being concerns. Ice cream fortress with supplements or other bioactive compounds is extremely popular and widely upheld in the current market (Vedashree et al., 2020). Because commercially available ice cream lacks natural antioxidants and phenolic compounds, makers are exploring flavoring and functional ingredient advancements. To appeal to customers who are concerned about their health, new flavors of ice cream are being developed that contain functional ingredients like antioxidants, phenolics, and phytosterols(Goraya & Bajwa, 2018).

This review article goes into great detail about the various kinds of alternative ice creams made with probiotics and herbs to make ice cream healthier and more nutritious for consumers. A major focus is also given to millet as a promising and novel functional ingredient for ice cream production.

Figure 2: FSSAI Ice Cream Regulations

Incorporation of herbal extracts into ice creams:

A diet high in phenolics has been linked to a lower risk of chronic diseases like atherosclerosis and type 2 diabetes (Kumar et al., 2018). Due to their functional, wholesome, and pharmacological properties, for example, gastrointestinal well-being, hypoglycemia, immunomodulation, hostile to stretch, pain relieving, antipyretic, mitigating, antiulcerogenic, antihypertensive, radioprotective, antitumor, and insusceptible framework support, herbal ice cream is turning out to be an ever-increasing number of famous over-engineered items (Pinokiyo & Kumar Borthakur, n.d.). Herbs have been linked to the treatment of several disorders. Herbal concentrates can be used in meds, ayurvedic formulations, confectionary, nutritious meals, ready-to-drink blends, quick food sources, dairy items, spices mixes, etc.(Gremski et al., 2019).

Ginger was also employed as an herb in ice cream. Ice cream was flavored with ginger in the form of juice and chunks. To make ginger ice cream, ginger juice, and pieces were included in the ice cream mixture in proportions of 3, 4, 5% and 4, 6, and 8%, respectively. This ginger ice cream was then compared to a control that was vanilla-flavored. It was discovered that adding 4% ginger juice and 4% ginger shreds was the best way to make ginger ice cream (Pinto et al. (2009).

Karaman and Kayacier (2012), reported the use of herbal teas, such as chamomile. The tactile profile of enhanced ice cream as well as the rheological and physicochemical properties of ice cream blends seasoned with dark tea or home-grown teas were assessed. Considering these aspects, a novel ice cream recipe was made with black tea along with a few more samples which include herbal tea—linden, sage, and chamomile. The total phenolic content of the ice cream samples fell between 123.37 to 415.20 mg/kg when tea or herbal teas were consumed. The development of dim tea and local teas, save chamomile, reduced the material assessments of ice cream and stood out from the control test. All blend tests showed non-Newtonian pseudoplastic conduct.

Ali et al., 2014 reported antioxidant potential due to the use of herbs in ice creams using asparagus, green asparagus, salep, orchid, and pomegranate. A 4% herbal infusion was responsible for this. To improve herbal-based ice cream with health benefits that exceeded those of traditional dairy products, as well as to examine how herbs like Tulsi altered the functional, rheological, and textural qualities of ice cream about their sensory attributes (Kumar et al., 2013). Manoharan (2013) reported that when infused with 20% aloe vera pulp, aloe vera ice creams with strawberry flavor and natural color beetroot significantly reduced the use of artificial sweeteners and investigated the physiochemical and microbial properties.

Amla fruit shreds, pulp, preserve, sweets, and powder were added to the ice cream by Goraya & Bajwa (2015) during the freezing stage of the manufacturing process. The ice cream's composition is significantly affected by the addition of processed amla products. Ascorbic acid, antioxidant activity, total phenols, and tannins are examples of functional components that significantly increased in number. On the other hand, a higher presence of amla arrangements decreased the ice cream flood and helped dissolve opposition. At 5% shreds and pulp integration, 10% preserve and sweets, and 0.5 percent powder, overall approval was highest.

Incorporation of Probiotic Cultures in Ice Creams:

When given to the host in sufficient quantities, probiotics are a variety of live microorganisms that provide health benefits (Binda et al., 2020). Foods containing probiotics should be routinely ingested, and the product's probiotic microbe count should be at least 10^6-10^8 CFU/g for the desired therapeutic impact on the body.

Bifidobacterium, *Lactobacillus*, and *Saccharomyces* species, as well as *lactic acid bacteria*, are widely used probiotic microorganisms. *Lactic acid bacteria* are the most important type (Sharma et al., 2020). Ice cream with probiotic cultures is more valuable and serves as a better example of a food with nutritional value (Chandra et al., 2017). Every step of manufacturing needs to be optimized to ensure functioning qualities and optimum levels of temperature, as well as pH, has to be maintained. Milk serves as a substrate for fermentation (Granato et al., 2010) Probiotic cultures are typically added to processed cow milk (Wang et al., 2022). A few examinations have likewise detailed the utilization of, non-dairy originated milk, for instance, soy milk, almond milk, and oat milk as a transporter for probiotic societies in ice creams (Aboulfazli et al., 2016, Ranadheera et al., 2018, Shori, et al., 2021)

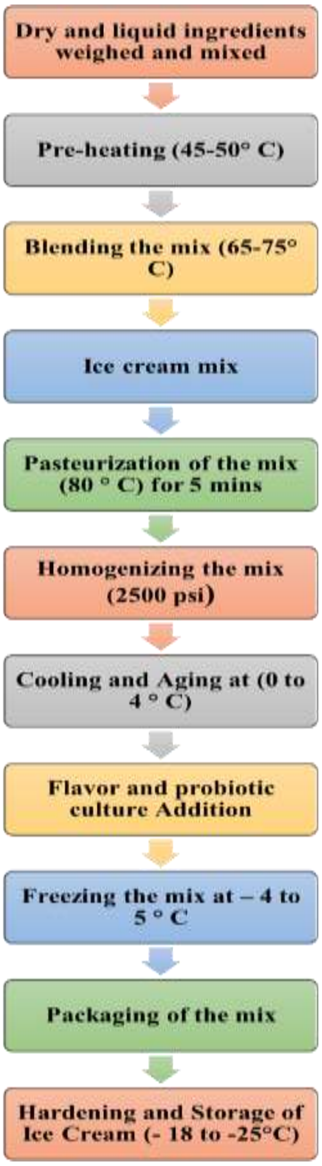

Figure 3: Processing flowchart of Probiotic Ice Cream (Guler-Akin et al., 2016; Legassa, 2022)

For probiotic ice cream to be considered, several requirements must be met, including the following:

a) to help the purchaser's well-being;
b) to be taken from the Generally Recognized as Safe (GRAS);
c) to be exceptionally reproducible;
d) Prebiotics should be fermentable by probiotics;
e) to be hereditarily stable throughout their period of usability;
f) The fermentation that occurs after the probiotics are present should not have any negative effects;
g) to be a component of the human body that occurs naturally (Hanafi et al., 2022)

Turgut & Cakmakci, 2009 looked into whether or not certain kinds of probiotic bacteria could be used to make ice cream to make new functional foods. To test how different probiotic bacteria strains (*Lactobacillus acidophilus*, *Bifidobacterium bifidum*, and both) affected the quality of the ice creams in each group, various cream levels (5% and 10%) were used in the production of ice cream. The results after storage revealed that while the counts of *L. acidophilus* and *B. bifidum* decreased during storage, the probiotic properties of all ice cream samples appeared to remain intact even after 90 days. In double-cultured samples, higher concentrations of probiotic microorganisms were found in those containing either *B. bifidum*, *L. acidophilus*, or both. It was observed that 5% pre-biotic ice cream was found to be appealing overall and its stability with respect to probiotic properties was more than three months. There was a reduced score of sensory attributes in probiotic ice cream still these ice creams were tasty throughout.

Senaka Ranadheera et al., 2013 reported the possibility to consolidate the new probiotic *P. jensenii 702* with *L. acidophilus LA-5, B. animalis* subsp. here goat milk along with lactic BB-12 was used instead of cow's milk. In order to improve dietary fiber content, Akaln et al., 2018 used apples, oranges, oat, wheat, and bamboo and studied the impact of various parameters such as physicochemical, rheological, and textural characteristics, sensory attributes, and cultural survival of probiotic ice cream for the period of 6 months. It was observed that the rheological properties and melting resistance of probiotic ice creams improved due to apple, while the fibers in wheat helped to improve the *Bifidobacterium animalis* sub ps was used in the preparation of probiotic ice cream (Akca & Akpinar, 2021). By incorporating vegetable seed pulp powder, sesame, pomegranate, grape seed oils, and *lactobacillus rhamnosus* as starter cultures into the ice cream mixtures, pH, acidity, total phenolic content, flavonoid content, and antioxidant capacity were evaluated. Grape seed powder, grape seed powder + seed oil, and pomegranate seed powder ice cream samples encouraged the growth of probiotic bacteria due to their high phenolic content and antioxidant activity.

Zaeim et al., 2020 demonstrated the incorporation of probiotics into ice cream formulations via electrohydrodynamic atomization and microencapsulation in multi-polysaccharide microcapsules. The microcapsules contained inulin, a prebiotic, and *Lactobacillus plantarum,* a probiotic strain. Bacteria survival was evaluated after 90 days. Microcapsules containing probiotic-prebiotic mixes were used to make ice cream. After the ice cream was made and stored, the bacteria's ability to survive was also looked into. FTIR spectra confirmed the formation of polyelectrolyte complexes between alginate and chitosan. After integrating inulin into the microcapsules, the inulin signal was found at 935 cm1 and the starch signal was followed at 1157 and 930 cm1 in their FTIR spectra. Both polysaccharide lattices emphatically expanded probiotic endurance during microcapsule conservation. By the by, inulin-containing microcapsules outflanked starch-containing microcapsules. Therefore, it can be used in ice cream as a useful ingredient.

Goktas et al., 2022 made ice cream with *Lactobacillus rhamnosus GG* and *Saccharomyces boulardii*. Before and during the aging processes used to make ice cream, probiotic strains were added as single or mixed cultures to the ice cream mixes. After that, probiotic ice cream products were defined, and the probiotic strains' ability to survive storage was evaluated. Both probiotic strains endure the capacity span and had levels of more than 6.18 log CFU/g on the last day of capacity. Both before and after the aging stage, the co-inoculation of *S. boulardii* and *L. rhamnosus* improved the rheological properties of ice cream products. Notably, ethanol was the main volatile molecule in ice cream samples made with *S. boulardii* injected before the aging stage, and probiotic inoculation affected the fragrance profile of the samples. The introduction of *S. boulardii* and *L. rhamnosus* as separate cultures resulted in the creation of distinctive fragrance components for ice cream products. The ice cream items created with probiotic immunization in the wake of maturing got the best generally speaking acknowledgment score in the tangible assessment of ice cream products.

Problems with Including Probiotics in Ice Cream:

The creation of probiotic ice cream faces several challenges, some of which include the type of probiotic, the quantity that must be added for it to have a beneficial effect, its toxicity, the probiotic culture's viability or sustainability, the substrate type and pretreatment, heating, freezing, and the concentration of the strains or cell populations that must be inoculated. The type of strain, interactions between microbial species, bacterial metabolism's production of H2 O2, pH, and acidity all affect the probiotics' storage stability (Kaushik, 2017).

Millets as a functional Ingredients for ice cream formulations:

One of the main food sources in the world's arid and semiarid regions is millets. They are grown for their tiny kernels, which are produced by tiny grassy plants in the *Poaceae* family and are referred to as small millets. ("Millets and Millet Technology," 2021). The alternative term for small millets may imply that they are minor crops, although they are significant for their nutritional content, medical advantages, animal feed, and role as lifesavers in times of food need (Madella et al., 2016).

There are two distinct categories of millets: Major and Minor millets. Pearl (*Pennisetum glaucum*), Proso (*Panicum miliaceum*), Finger (*Eleusine coracan*), and Foxtail (*Seratiaitalica*) millets are the most important millets. Barnyard (*Echinochloa colane*), little (*Panicum miliare*), Kodo (*Paspalum scrobiculatum*), black *(Digitariaiburua*), white (*Digitariaexilis*), and teff *(Eragrostis tef*) millets are among the minor millets (Mahajan et al., 2021).

Minerals, proteins, and other compounds necessary for biological function are abundant in millets. These cereals contain cell reinforcements, nutrients, minerals, fundamental unsaturated fats, phytochemicals, and different supplements that can support the treatment of many infections brought about by nourishing inadequacies (Millets and Millet Technology, 2021). Millets are the 6th most-delivered cereal grain on the planet (Hassan et al., 2021). Millions of people in Africa and Asia's food security depend on these underutilized grains. According to Temba et al., 2016 India is widely regarded as the world's largest producer of both major and minor millets. The Government of India has designated 2018 as the "National Year of Millets," and the United Nations has designated 2023 as the "International Year of Millets," in recognition of its significance to climate adaptation and nutritional and health security (Mathew et al., 2022).

Most of the time, millet is eaten in the form of roti, bhakari, and other traditional dishes. It can also be used to make drinks out of finger millet. The possibility of incorporating millet into various food products presents a vast opportunity for scientific rationalization of its health-healing properties (A. Kumar et al., 2018). Millets can transform food products into magical food products or superfoods by utilizing various agri-processing and other modern technologies that integrate the fundamental knowledge of genomics, bioinformatics, biotechnology, and nanotechnology. promoting millet production and adding value (SDGs) greatly aids several Sustainable Development Goals (Budhwar et al., 2020). Dairy products like ice cream, beverages made from millet milk, yogurt, the addition of probiotics to millets milk, bakery items like biscuits, cookies, and multigrain bread, snacks, and confections are among the novel foods that can be made from millet (Srilakshmi, 2003).

Some of the Millets that have been used in the preparation of Ice Creams include:

1. Finger Millet:

Finger millets (Ragi, Eleusine Coracana) are a rare staple crop throughout eastern and focal Africa, as well as areas of India. They contain a lot of vitamins, iron, calcium, fiber, and protein. The calcium focus is higher than that of different cereals, and the iodine level is accounted for to be the best of any food grain. Ragi is high in protein, essential amino acids, vitamins A and B, phosphorus, and other nutrients (Sahoo et al., 2010) (2003 Srilakshmi). Due to its strong thickening and water-binding properties, it is anticipated that using ragi as a functional component in ice cream can effectively substitute fat and reduce the amount of stabilizer required. According to Patel et al.,2015 finger millet grain has 22% more total dietary fiber than the majority of other cereal grains (12.6%, 4.5%, 13.4%, and 12.8% for wheat, rice, maize, and sorghum, respectively). 2015). Ice cream's nutritional and functional qualities will be enhanced by including ragi, a highly nutritious ingredient (Ranawat et al., 2015). As stated before, Ice cream typically contains between 12 and 14% fat. This gives an open door to the creation and commercialization of low-fat ice cream that can promptly fit inside the dietary prerequisites of individuals experiencing cardiovascular diseases. (Patel et al., 2015).

In 2021, Eimie Xavier researched the use of ragi in kulfi and developed a millet-based "musk melon kulfi" technology. Malted ragi flour is rich in vitamins, minerals, fiber, and minerals like iron and calcium. Ragi milk is loaded with fat and protein. The kulfi samples were made in two different ways with malted ragi flour and ragi milk. The two examples were made with three distinct blends of muskmelon and ragi: 50:50, 75:25, and 25:75 (muskmelon, malted ragi flour, and ragi milk). Both groups agreed that the best formula was the 75:25 ratio. When finger millet was added, the muskmelon kulfi got more nutrients.

2. Pearl Millet:

The popular millet pearl millet, commonly called bajara, is grown in tropical and semi-arid regions all over the world. Protein's nutritional value is significantly affected by its amino acid content. It is gluten-free, high in energy, and low in starch. Pearl millet is comparable to maize in terms of nutritional quality but typically performs better than sorghum in terms of protein content/quality, metabolizable energy levels, and digestibility (Shruti et al., 2018). Pearl millet was utilized in the creation of conventional cooking dishes as well as a feed for poultry and animals (Punia et al., 2021). Pearl millet is a less expensive and more economically feasible method of starch separation due to its lack of commercial applications (Azubuike et al., 2022). According to Shaikh et al.,2022 the extraction and use of pearl millet starch as native and modified starch may open up new opportunities for starch-based businesses. Because modified starches make it more viscous in the aqueous phase and slow the formation of ice crystals, low-fat ice cream has a smoother texture. Moreover, Octenyl Succinate Anhydrate (OSA) esterified substitutes for fat in ice cream and yogurt. OSA starch (1% and 2% fat) and soft ice cream (7.5 and 5% fat, from a reference product with 10% fat) were found to be comparable to other fat replacers like whey protein concentrate, inulin, and starch on the market.

3. Sorghum:

In some arid African regions, sorghum, a drought-resistant cereal grain, serves as a nutritional staple. Sorghum is a slow-digesting carbohydrate that may reduce glycemic sensitivity and increase satiety. Sorghum also contains a unique group of polyphenols that are linked to protection against oxidative stress and inflammation-related chronic diseases (Awika, 2017).

Kigozi et al., 2014 developed the process for sorghum-based ice cream cones and suggested that future research on cone development should focus on improving the cone's appearance and texture for better consumer acceptance. For fifteen different sorghum cone formulations, sensory analysis was used in this study to determine differences in product texture caused by formulation changes; given that improving the texture of the sorghum cone. The texture was evaluated based on its crispness, hardness, and overall acceptability using the sensory panel. Hardness was rated by panelists on a 6-point sensory evaluation scale, with 6 being "extremely hard" and 1 being "soft"; A nine-point hedonic scale was used to measure crispness (9 = "like extremely"); 1 = "extremely dislike") to determine the acceptance level overall. Formulations with cones ranked higher; In terms of consumer acceptance, F14 (where sorghum was reduced by 25%) and F9 (where water was reduced by 14%) performed 8.25 and 8.06 better than the control (7.5). Formulation F14 which brought about the best surface was in this way chosen and embraced as the detailing for the sorghum ice cream cones.

Myers et al., 2022 made improvements to the compositions of sorghum biscuits that could be used in cookies made with ice cream. Regardless of the flour source, these biscuits had identical instrumental color profiles and physical characteristics. Arrowroot powder and xanthan gum were used in the blonde recipe, while cocoa and arrowroot powder were used in the chocolate recipe to make identical sorghum and wheat flour cookies. The utilization to make cookies had an impact on a number of their structural and textural properties. The flour source had a significant impact on the moisture content and water activity of all biscuit recipes. Fructose had a smaller impact on frozen hardness when used as inclusions, whereas formulation had a larger impact. The flour source does appear to alter the blonde cookies' crumbling profile when evaluating their crumbling profiles. According to the findings of this study, sorghum flour cookies can be used in ice cream and frozen desserts. Additionally, gluten-free cookies that are suitable for use in frozen desserts are viable from a functional, textural, and moisture perspective.

4. Barnyard Millet:

The grains of barnyard millet (*Echinochloa frumentacea*) are a good source of micronutrients like iron, zinc, calcium, protein, magnesium, fat, vitamins, and some essential amino acids. (Renganathan et al., 2020). Barnyard millet-based ice cream formulations and proximate evaluation were the focus of Amirtha G, 2021's research. The formulated plant-based ice cream had a significant amount of carbohydrates, protein, fat, calcium, and phosphorus, according to the proximate analysis results. The sensory evaluation revealed that the ice cream prepared with barnyard, soybean, and coconut extract was more popular than the ice cream made with barnyard, sesame, and coconut extracts altogether. In the future, vegans, lactose intolerant individuals, and people with allergies to cow's milk protein can consume plant-based non-dairy ice cream.

For product development, Puniyamoorthy Sheela (2018) demonstrated the optimization of millet milk extraction parameters. For milk extraction from the barnyard millet and the other four millets, the response surface approach was used to optimize the soaking and germination times at 8 and 18 hours, respectively. At various stages of processing, the nutritional content of each of the five millets—raw grains, germinated grains, and millet milk—was determined. Millets lose a lot of phytic acids, ash, crude fiber, and fat. They also have less protein and carbs, but they have more moisture and total sugars. Extricated millet milk can be utilized to make esteem-included merchandise on its own or in blend with different fixings like ice creams and other dairy items.

5. Foxtail Millet:

Due to their unique protein composition, which contains a high quantity of important amino acids, the seeds of the annual grass species foxtail millet (Setaria italica) have health-promoting effects (Sachdev et al., 2021).

Sivakumar (2017) examined the microbiological and sensory acceptability of foxtail millet-based softy ice cream during storage. Three flavors of ice cream were made by combining different amounts of Foxtail millet (Setaria italica) with probiotic bacteria like *Lactobacillus helveticus.* The softy ice cream made with foxtail millet was then kept at deep refrigeration (-18 to 20 degrees Celsius) to see how well it kept. After deep cold storage for 0, 2, 4, 6, 8, and 10 days, sensory evaluations and shelf-life tests were carried out. Based on how it felt, the panelists preferred the second composition, which had 2% *Lactobacillus helveticus* and 3% foxtail millet. During the period of usability examination, it was found that the third synthesis (3% *Lactobacillus helveticus*) had the most noteworthy practical count for *Lactobacillus helveticus* when contrasted with the first (1%) and second (2%). Only a few colonies were found in the third and second years. On the tenth day of storage, the composition (2.6 and 2.8 CFU/ml) was within the allowed range. There was no colony discovered during storage of 0 to 9 days. When the coliform count of the three softy ice cream compositions based on foxtail millet was tested, none of the compositions had any coliform count in the product. The discoveries uncovered that Foxtail millet-based softy ice cream can be extremely gainful since it contains a significant number of probiotics.

Conclusion:

The present review is an updated report of novel approaches or increased trends towards value addition of developing herbal, probiotics, and millet-based functional ice creams. Nowadays there is increased trend/demand from health-conscious consumers for such kind of value-added functional food. Ice cream is a very commonly consumed dairy product in almost every season. The present review covers the updated trend of developing innovative approaches to ice creams.

References:

1. Aboulfazli, F., Shori, A. B., & Baba, A. S. (2016). Effects of the replacement of cow milk with vegetable milk on probiotics and nutritional profile of fermented ice cream. *LWT*, *70*, 261-270.
2. Awika, J. M. (2017). Sorghum: It is a Unique Nutritional and Health-Promoting attribute. In *Gluten-Free Ancient Grains* (pp. 21–54). Elsevier. https://doi.org/10.1016/B978-0-08-100866-9.00003-0
3. Azubuike, C. P., Oseni, B. A., Amaeze, A. I., Isimoya, F. O., & Igwilo, C. I. (2022). Characterization of Physicochemical and Micromeritics Properties of Carboxy-methylated Starches Derived from Vigna unguiculata Seeds and Pennisetum glaucum Grains with an Intermediate Degree of Substitution: http://www. doi. org/10.26538 /tjpps/v1i1. 5. *Tropical Journal of Phyto-chemistry and Pharmaceutical Sciences*, *1*(1), 23-29.
4. Bhatt, A. (2019). *Milk and milk products*.
5. Binda, S., Hill, C., Johansen, E., Obis, D., Pot, B., Sanders, M. E., Tremblay, A., & Ouwehand, A. C. (2020). Criteria to Qualify Microorganisms as “Probiotic” in Foods and Dietary Supplements. In *Frontiers in Microbiology* (Vol. 11). Frontiers Media S.A. https://doi.org/10.3389/fmicb.2020.01662
6. Chandrakala, N., & Priya, S. (2017). Vibriosis in shrimp aquaculture a review. *International Journal of Scientific Research in Science, Engineering, and Technology*, *3*(2), 27-33.
7. Eimie Xavier, R. R. and B. E. P. (2021). A study on nutritional properties of millet-based muskmelon kulfi. *Life Sciences for Sustainable Development*.
8. Guler-Akin, M. , Goncu, B. and Serdar Akin, M. (2016) Some Properties of Probiotic Yoghurt Ice Cream Supplemented with Carob Extract and Whey Powder. *Advances in Microbiology*, **6**, 1010-1020. doi: 10.4236/aim.2016.614095.
9. Granato, D., Branco, G. F., Cruz, A. G., Faria, J. D. A. F., & Shah, N. P. (2010). Probiotic dairy products as functional foods. *Compre-hensive reviews in food science and food safety*, *9*(5), 455-470.
10. Goff, H. D., & Hartel, R. W. (2013). Freezing and Refrigeration. In *Ice Cream* (pp. 193–248). Springer US. https://doi.org/10.1007/978-1-4614-6096-1_7
11. Goktas, H., Dikmen, H., Bekiroglu, H., Cebi, N., Dertli, E., & Sagdic, O. (2022). Characteristics of functional ice cream produced with probiotic Saccharomyces boulardii in combination with Lactobacillus rhamnosus GG. *LWT*, *153*, 112489. https://doi.org/10.1016/j.lwt.2021.112489
12. Goraya, R. K., & Bajwa, U. (2015). Enhancing the functional properties and nutritional quality of ice cream with processed amla (Indian gooseberry). *Journal of Food Science and Technology*, *52*(12), 7861–7871. https://doi.org/10.1007/s13197-015-1877-1
13. Goraya, R. K., & Bajwa, U. (2018). Intransience of functional components and distinctive properties of amla (Indian gooseberry) ice cream during short-term storage. *Journal of Food Science and Technology*, *55*(5), 1746–1755. https://doi.org/10.1007/s13197-018-3087-0
14. Gremski, L. A., Coelho, A. L. K., Santos, J. S., Daguer, H., Molognoni, L., do Prado-Silva, L., Sant’Ana, A. S., da Silva Rocha, R., da Silva, M. C., Cruz, A. G., Azevedo, L., do Carmo, M. A. V., Wen, M., Zhang, L., & Granato, D. (2019). Antioxidants-rich ice cream containing herbal extracts and fructooligosaccharides: manufacture, functional and sensory properties. *Food Chemistry*, *298*. https://doi.org/10.1016/j.foodchem.2019.125098
15. Hanafi, F. N. A., Kamaruding, N. A., & Shaharuddin, S. (2022). Influence of coconut residue dietary fiber on physicochemical, probiotic (Lactobacillus plantarum ATCC 8014) survivability and sensory attributes of probiotic ice cream. *LWT*, *154*, 112725. https://doi.org/10.1016/j.lwt.2021.112725
16. Hassan, Z. M., Sebola, N. A., & Mabelebele, M. (2021). The nutritional use of millet grain

for food and feed: a review. *Agriculture & food security*, *10*, 1-14.

17. Karaman, S., & Kayacier, A. (2012). Rheology of Ice Cream Mix Flavored with Black Tea or Herbal Teas and Effect of Flavoring on the Sensory Properties of Ice Cream. *Food and Bioprocess Technology*, *5*(8), 3159–3169. https://doi.org/10.1007/s11947-011-0713-5
18. Kaushik, I. (2017). Organogelation: It's Food Application. *MOJ Food Processing & Technology*, *4*(2). https://doi.org/10.15406/mojfpt.2017.04.00088
19. Kigozi, J., Banadda, N., Byaruhanga, Y., Kaaya, A., & Musoke, L. (2014). Optimization of Texture in Sorghum Ice Cream Cone Production Using Sensory Analysis. *The Open Food Science Journal*, *8*(1), 18–21. https://doi.org/10.2174/1874256401408010018
20. Kumar, R., Atanu, J., Satish, P., & Ankit, D. (2018). Suitability of type of herb and its form as flavoring in herbal ice cream. *~ 1562 ~ International Journal of Chemical Studies*, *6*(5).
21. Legassa, O. (2022). *International Journal of Food and Nutritional Science Ice Cream Nutrition and Its Health Impacts*. https://doi.org/10.15436/2377-0619.20.2678
22. Mastud, S. K., Mote, G. V, & Sahoo, A. K. (2018). Development of value-added products by using purslane (Portulaca oleracea). *~ 1761 ~ Journal of Pharmacognosy and Phyto-chemistry*, *7*(4), 1761–1766.
23. Mathew, J., & Joseph, M. K. (2022). International year of millet 2023: Millet promotion in India for food security.
24. Mohammadi, Reza & Mortazavian, Amir & Khosrokhavar, Roya. (2011). Probiotic ice cream: Viability of probiotic bacteria and sensory properties. Annals of Microbiology. 61. 411-424. 10.1007/s13213-010-0188-z.
25. Mohammed, N. K., Badrul Khair, M. F., Ahmad, N. H., & Meor Hussin, A. S. (2022). Ice cream as functional food: A review of health-promoting ingredients in the frozen dairy products. *Journal of Food Process Engineering*, *45*(12). https://doi.org/10.1111/jfpe.14171
26. Mostafavi, F. S., Tehrani, M. M., & Mohebbi, M. (2017). Rheological and sensory properties of fat-reduced vanilla ice creams containing milk protein concentrate (MPC). *Journal of Food Measurement and Characterization*, *11*(2), 567–575. https://doi.org/10.1007/s11694-016-9424-y
27. Myers, J. S., Bean, S. R., Aramouni, F. M., Wu, X., & Schmidt, K. A. (2022). Textural and functional analysis of sorghum flour cookies as ice cream inclusions. *Grain & Oil Science and Technology*. https://doi.org/10.1016/j.gaost.2022.12.002
28. Nayeem Ali Scholar, M., Prasad, S., Srivastava Scholar, P., Ibrahim Scholar, M., Singh Assistant professor, A., Nayeem Ali, M., Srivastava, P., Ibrahim, M., & Singh, A. (2014). Assess the antioxidant activity of herbal ice cream prepared by selected medicinal herbs. In *~ 57 ~ The Pharma Innovation Journal* (Vol. 3, Issue 7). www.thepharmajournal.com
29. Pinokiyo, A., & Kumar Borthakur, S. (n.d.). *Analyses of the Forest Cover Change in Rani and Garbhanga Reserve forest, Assam, North East India Using Geospatial Technique Digital database of bioresources of Northeast India View project Associated Project 6: PC Panda (Project Coordinator) Multicentric DBT Project on Preventing Extinction and improving the conservation status of threatened plants through the application of biotechnological tools View project*. https://www.researchgate.net/publication/308413272
30. Ranadheera, C. S., Naumovski, N., & Ajlouni, S. (2018). Non-bovine milk products as emerging probiotic carriers: Recent developments and innovations. *Current Opinion in Food Science*, *22*, 109-114
31. Rawat, N., & Indrani, D. (2015). Functional ingredients of wheat-based bakery, traditional, pasta, and other food products. *Food Reviews International*, *31*(2), 125-146.
32. Saleh, A., Moussa, M., Hassabu, E., & Ewis, A. (2020). The use of colostrum to improve the functional and chemical properties of ice cream. *Journal of Productivity and Development*, *25*(4), 363–375. https://doi.org/10.21608/jpd.2020.140137
33. Satyavathi, C. T., Ambawat, S., Khandelwal, V., & Srivastava, R. K. (2021). Pearl millet: a climate-resilient nutricereal for mitigating hidden hunger and providing nutritional security. *Frontiers in Plant Science*, *12*, 659938.
34. Sivakumar, G. M. (2017). Sensory evaluation of foxtail millet incorporated sugar-free ice cream. *International Journal of Science, Environment, and Technology, 6(4), 2576-2580.*
35. Shaikh, M., Ali, T. M., & Hasnain, A. (2020). Comparative study on the application of chemically modified corn and pearl millet starches in white sauce. *Journal of Food Processing and Preservation*, *44*(4), e14393.

36. Sharma, A., Lee, S., & Park, Y. S. (2020). Molecular typing tools for identifying and characterizing lactic acid bacteria: a review. *Food science and biotechnology*, *29*, 1301-1318.
37. Sharma, M., Singh, A. K., & Yadav, D. N. (2017). Rheological properties of reduced fat ice cream mix containing octenyl succinylated pearl millet starch. *Journal of Food Science and Technology*, *54*, 1638-1645.
38. Shori, A. B., & Al Zahrani, A. J. (2021). Non-dairy plant-based milk products as alternatives to conventional dairy products for delivering probiotics. *Food Science and Technology*, *42*.
39. Sruthi[1], V., Waghray, K., & Rathod, A. N. (2018). Development of Wafers Incorporated with Pearl Millet Flour & Barnyard Millet Flour.
40. Syed, Q. A., A. S., S. R., & Z. T. (2018). Effects of different ingredients on the texture of ice cream. *Journal of Nutritional Health & Food Engineering, 8(6), 422-435.*
41. Temba, M. C., Njobeh, P. B., Adebo, O. A., Olugbile, A. O., & Kayitesi, E. (2016). The role of compositing cereals with legumes to alleviate protein energy malnutrition in Africa. *International Journal of food science & Technology*, *51*(3), 543-554.
42. 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. https://doi.org/10.1111/j.1471-0307.2009.00494.x
43. Vedashree, M., Asha, M. R., Roopavati, C., & Naidu, M. M. (2020). Characterization of volatile components from the ginger plant at maturity and its value addition to ice cream. *Journal of Food Science and Technology*, *57*(9), 3371–3380. https://doi.org/10.1007/s13197-020-04370-0
44. Wang, Y., Feng, K., Jin, J., Murad, M. S., Mu, G., & Wu, X. (2022). Comparison of properties between normal and A2 bovine milk fermented using commercial bacteria mixed with/without two probiotics from human milk. *International Journal of Biological Macromolecules*, *216*, 105-113.
45. Zaeim, D., Sarabi-Jamab, M., Ghorani, B., Kadkhodaee, R., Liu, W., & Tromp, R. H. (2020). Microencapsulation of probiotics in multi-polysaccharide microcapsules by electro-hydrodynamic atomization and incorporation into ice-cream formulation. *Food Structure*, *25*, 100147. https://doi.org/10.1016/j.foostr.2020.100147