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Recent advances in the ice cream making

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Abstract
Food industry and researchers have to engage in the production of novel and beneficial ice cream because of a rising interest in foods that enhance human nutrition and health. Now-a-days people are more interested in the nutrient-rich foods along with enhancing flavors. Consumers of all ages prefer ice cream as an appealing dairy product. An enriched dairy product that has been frozen before serving is called ice cream. It is an interconnected system of both solid and liquid microcrystals. Since ice cream is the most popular frozen product, it has a significant chance of benefiting individuals in altering their diets by modifying the nutritional properties of ice cream. Additionally, it provides necessary and helpful components along with pleasing flavor and taste. However, the sensory properties and storage stability must not be compromised by the reduced amount or omission of typical ice cream ingredients. Each ingredient plays an important role in the formulation of an ideal ice cream. At present, a large number of flavored and innovative ice creams are available in the market. Various new studies have resulted in the positive impact of ice cream incorporated with nutritive components. Thus, the current review focuses on the recent advances taken place in the making of ice cream along with the modification in nutrients for nutraceutical applications.

Keywords: Food industry, production, ice cream

1. Introduction
In recent years, there has been an increase in customer demand for a variety of milk-like alternatives. The popularity of substitutes for milk has grown significantly as a result of modifications to lifestyles, specialised dietary demands, and the appeal of functional foods. Plants, such as cereal, bean, nut-based (milks) or foods based on plant by-products, are used as milk substitutes in prepared foods (Asres *et al*., 2022) [4]. One of the most popular food groups is milk and dairy products and it comprises of mammal's milk, yoghurt, ice cream and others. An ice cream is a frozen product that may be manufactured from a variety of dairy and non-dairy products. Ice cream is composed of an intricate structure of fat clusters, sugars, non-fat solids, water, ice crystals, and additives. Due to its distinct taste and the addition of several delectable flavors, ice cream has become an increasingly popular food across all age groups.
The interaction of fat with additional ingredients improves the ice cream's texture, mouth-feel, a creamy texture, and taste in general. As ice cream is a thermodynamically unstable substance, the use of certain ingredients with stabiliser and emulsifier capabilities in the manufacturing of ice cream serves for maintaining stability for this purpose (Kasapoglu *et al*., 2023) [9]. This includes proper mix of ingredients that gives the optimum texture and nutritional values. In order to create a novel formulation for low-fat ice cream products, researchers are focusing to use alternative components. Ice cream's chemical structure, consistency of texture, melting resistance, and flavour all have a significant role in customer acceptability.
Rheological characteristics play a significant role in the food industry and have a significant impact on the sensory appeal of the final product, including ice cream. Functional dietary ingredients can help avoid several diseases naturally, including gastrointestinal issues, weight gain, elevated cholesterol levels, and diabetes. As a result, bioactive chemicals, probiotic organisms, and prebiotic substances are frequently employed to give food functional qualities Zagorska *et al*., 2022) [23]. Ice cream is one of the examples of dairy products that are excellent for providing useful characteristics to meals. It is simple to lower the percentage of fat along with addition of nutritious elements to such dairy products. Additionally, people who are vegan or vegetarian have vigorously promoted the benefits of plant-based alternatives in foods

than naturally produced dairy milk.

Customers who lack the enzyme lactase may develop lactose sensitivity as a result of the product's lactose content. Thus, these alternatives provided health benefits to individuals who are suffering from lactose intolerance or are allergic to cow's milk. As a result, people have switched to ice cream produced without dairy products (Pontonio *et al*., 2022) [17]. The inclusion of cow's milk in ice cream deters some individuals from accepting its creamy flavour and smooth texture. Businesses in the food industry have made attempts to alter their recipes while preserving their original flavour and consistency. There is a demand for milk alternatives that may maintain the texture and flavour of ice cream (Asres *et al*., 2022) [4]. This review focuses on the most recent advances done in the making of ice cream as well as the importance of modification in the ingredients to enhance nutraceuticals properties of ice cream.

2. Ice Cream

Ice cream is a cherished and delightful product, manufactured with ingredients such as milk, cream, and sugar. However, in recent years, plant-based milk alternatives have also started to be utilised. In this regard, nutritional ice cream is a recent entry in the food market and is winning popularity mainly to its unique flavour and addition of a variety of appetising flavours. With careful composition balancing, researchers are working on probiotic-infused ice cream to have significant nutritional characteristics with acceptable sensory attributes. Ice cream can also help probiotic cultures remain more viable during manufacture and storage (Hanafi *et al*., 2022) [8]. Particularly vegetarians, vegans, lactose-sensitive individuals, and people who usually desire a healthy lifestyle choose this nutritional ice cream. A physico-chemical complex known for its hardness and melting characteristics, ice cream typically comprises at least 10% fat, stabilisers, and sweeteners (Leahu *et al*., 2022) [10].

2.1 Ingredients

The market offers a variety of ice cream components, all of which have a significant impact on the product's quality. Dairy and non-dairy components from various sources are capable of being used to make different types of ice cream. Fat Sugar, stabilisers and emulsifiers, corn starch, dextrose, water, additional flavours and egg products (optional), are the basic ingredients of ice cream. The ultimate result is a three-phase of ice cream network made up of air, solids, and liquid. Ice crystals are imbedded in the liquid phase, and air cells are scattered throughout (Abbas Syed, 2018) [1]. Additionally, the liquid phase includes carbohydrates, soluble salts and insoluble salts, fat particulates, and dairy protein. The primary components that impact ice cream consistency comprise sugar, water, fat and SNF, emulsifiers, and stabilising agents.

2.2 Role of Ingredients

The ingredients incorporated in the ice cream consist of various major roles in order to make the ice cream stable and palatable. Each ingredient has its own properties to formulate the texture and flavour of ice cream. Fat, one of its components, also plays a major role to add positive impacts on texture and flavour, emulsion properties, and melting point stability. The ice cream melts faster, as well as the breakdown and accumulation of fat droplets occur when levels of fat surpass the required concentration. When air cells collapse because of higher overflow, the structure ultimately contracts. Due to high overrun values, hardness may be decreased as a result of fewer ice crystals. While sugar promotes viscosity and thickness; it also imparts a sweet flavour to foods. When used excessively, sugar can transform ice cream into a mushy structure above a solid content of roughly 42% (Abbas Syed, 2018) [1]. To make ice cream easier to handle, store and more affordable, corn syrup can be added to the recipe. Solids of corn syrups with low conversion rate are preferred as they have no effect on the characteristics of ice cream and increase total solids. Sucrose serves a variety of purposes in ice cream, including sweetening the final product, enhancing the flavour with a pleasant sweetness, and improving the viscosity and texture.

In order to raise the quantity of the mixture while making ice cream, overrun is generated. The quantity of air integrated to ice cream impacts its quality. Air inflow could be consistently regulated to influence product quality. Filters placed in refrigerators preserve the air quality itself. The emulsion, which traps the air, is made up of fat globules, water and ice crystals. The combined amount of solid and dry components in ice cream is known as the total solids. Total solids are influenced by emulsifiers, stabilisers, MSNF, sugar, fat, and sugar. Total solids replace water in the ice cream mixture. Buttermilk, egg yolk, or sweet cream is incorporated into ice cream to enhance the properties such as whipping ability and overrun. Despite very tiny concentrations in the formulation, stabilisers and emulsifiers are substances that give the end product distinct and essential properties (Zagorska *et al*., 2022) [23]. Stabilisers serve a variety of purposes in the creation of ice cream. They aid in improving the viscosity, regulating the protein content, ensuring the smoothness and proper texture of the ice cream. Additionally, they offer melting resistance, and lower the formation of ice and lactose crystals in the ice cream.

By increasing viscosity and restricting the movement of free water molecules, stabilisers and emulsifiers both enhance ice cream's texture. However, using excessive amount of either can result in lesser melting point and decreased whipping ability. The rheological characteristics of ice cream are influenced by a variety of variables. The formulation, ice cream type, components used along with the technology employed, packaging material and other factors all impact the kind of stabiliser chosen. Sodium carboxymethyl cellulose, guar gum, xanthum, alginates, and gelatin are only a few examples of the materials that have been utilised as stabilisers. The rheological characteristics and composition of ice cream are modified by emulsifiers, which also improve the instability of fat after freezing. Phospholipids, cyclo-dextrins, mono-glycerides and di-glycerides of fatty acids and other substances are among the most often used emulsifiers in the manufacture of ice cream (Kasapoglu *et al*., 2023) [9].

2.3 Chemistry of Ice Cream

A frozen and aerated oil-in-water (O/W) emulsion with a high percentage of dairy or non-dairy fat (10–16%) serves as ice cream. Purpose. The primary ingredient used to make ice cream is often milk, having a fat content of 3.5–5.0% and comprises primarily triacylglycerol, lesser portions of free fatty acids, phospholipids, and cholesterol. It's noteworthy to take into account that milk fat, also known as fat globules, is triacylglycerol, which can be identified in milk as oil-in-water emulsion (Kasapoglu *et al*., 2023) [9]. The diameters of fat globules' particles range from 0.1 to 15 m. Because to the

larger variation in particle size, milk fat held at low temperatures may lead to coagulation in the form of fat crystals developed from the globule surface. This can harm the membrane's structure, leading to functional imperfections in stability of ice cream comprised from whole milk. Fat, which makes up 10-16% of the contents of ice cream on an average, is an essential component that influences a product's degree of hardness, form maintenance, and melting stability. Therefore, it can be said that fat is a crucial factor in establishing the ice cream's texture and, consequently, its unique sensory qualities.

Ice cream had been observed to lose some of its whiteness; gets harden, and melt quicker when the amount of fat concentration drops. Thus, a decrease in fat content in ice cream may result in textural flaws. Some of the fat in the mixture is transformed into clumps during the beating and chilling process, and a 3D aggregating fat matrix is subsequently generated, providing structural stability. This process is known as fat destabilisation. The three mechanisms of aggregation, clumping (partial), and fusion are the major causes of fat aggregates (Wang *et al*., 2022) [22]. Aggregation describes the way that fat particles collide with one another during the dynamical freezing stage as a result of the pulling forces. The integrity of the droplets is maintained because they are partially crystalline, which restricts the amount to which the fat really coalesces into bigger droplets. Destabilisation of the fat globules is necessary for fusion, and this is frequently achieved by adding emulsifiers that compete with proteins at the fat globule interface, resulting in more emulsifier-rich domains.

The strength of the protein layer adsorbed at the interface is weakened as a result, and the steric attraction between fat globules is diminished, which encourages partial clumping. Ice cream's level of fat destabilisation may be managed by adjusting the solid fat content, the emulsifier concentration, and the fat content. With an increase in fat content and emulsifier concentration, both fat aggregate size and percentage rose (Liu *et al*., 2022) [11]. As the pressure was increased, the mode of the fat globules decreased, and the viscosity improved as the homogenization pressure reduced and the fat content increased. A crucial step in separating fat globules and achieving an ideal dimension is homogenisation. By altering the crystal development, shape, and stiffness of the crystallised fat, emulsifiers also interact with fat and affect how it crystallises.

The intermediate membrane of fat globules must be permeated by fat crystals for partial clumping to take place. The stabilisation of the ice cream structure depends on the destabilisation of partly clumped fat, which is primarily in charge of stabilising the air cells and inducing the emergence of a fat structure that isolates them in the thawed liquid state. These both factors have an impact on how ice cream melts (Loffredi & Alamprese, 2023) [12]. The development and stabilisation of air cells depend greatly on milk fat, which is specifically connected to the melting rate. According to research, melting rate is correlated with characteristics like size of fat globule and particle distribution. They figured that the size of fat agglomerates in the unfrozen phase that were larger than the ideal diameter blocked the foam layers and prevented flow, which resulted in a significantly higher meltdown rate.

3. Recent Advances in Ice Cream Making

A recent development in the food industry is the manufacturing of food from plants. These days, there is a growing desire towards vegans due to issues with lactose intolerance, allergies from milk and dairy products, and difficulties brought on by diets that contain high cholesterol. Other factors contributing to the increase in demand include moral, ethical, and religious impulses, concerns for animal welfare, and commitment to sustainability. As a result, there is a growing trend among individuals today to adopt a vegetarian or vegan diet for moral and environmental grounds (Pontonio *et al*., 2022) [17]. The protein content and quantity of milk used to create plant-based ice cream with the appropriate texture and sensory attributes are of the utmost importance since ice cream requires an efficient protein structure because it is a multi-phase combination.

The following technology was used to make ice cream: dry ingredients were measured in accordance with the recipe and blended, followed by the addition of liquid ingredients to create the ice cream mix. In order to create plant-based milk substitutes, plant material such as grains, beans, nuts and oilseeds, must first be broken down and extracted in water. Then, the fluids must be further homogenised. Plant-based milk is comparable to cow's milk in look and consistency due to its particle size distribution (Bekiroglu *et al*., 2022) [6]. Other advances in making of ice cream making consist replacement of cow milk with other substitutes such as milk extracted from walnut, soyabean, fermented products. In addition, the ice cream is incorporated with nutrient sources such as coconut residue, probiotics, and black rice powders and others.

Lactose oxidation releases a relatively novel component named lactobionic acid (LBA), which has several potential uses in the fields of medicine, cosmetics, and the processing of food. In the recent advance, the LBA was used in the production of ice cream. Instead of using an emulsifier and stabilizer, LBA was used as a modified enhancer of the ice cream. However, in the research, the quantity of LBA concentration influences how significant the result is. The ice cream produced using 2 or 3 g/kg LBA had physical and chemical qualities that were comparable to those of the ones made with the commercial emulsifier and stabiliser. LBA at a greater concentration (5 g/kg) resulted towards a firmer ice cream texture with a decreased overrun (Zagorska *et al*., 2022) [23]. In conclusion, 3 g/kg of LBA was shown as the optimal concentration for the production of ice cream. In the method of making ice cream, lactobionic acid resulted in enhanced overflow and slower melting rate.

The other recent advances in the ice cream are being done with the addition of probiotics, fermented milk along with dietary fibre in the ice cream to enhance the nutritional value. According to the WHO and FAO's definition of probiotics from 2002, they are "live microorganisms that, when administered in sufficient amounts, confer a health benefit on the host." The significance of ice cream as a probiotic transporter has been highlighted in several research that has looked at the impact of probiotics on the flavours and health advantages offered by ice cream. Gut microbiota and oral wellness are improved by consuming probiotic ice cream. Yoghurt and L. *rhamnosus* along with wheat fibre and inulin is incorporated in the ice cream mix. The analysis and storage stability in terms of shelf life is evaluated at 25 degree Celsius within the period of 90 days. The best selected one among the compositions were L. *rhamnosus* and inulin and resulted as providing lower caloric value as compared to the standard ice cream available in the market (Sezer *et al*., 2022) [21].

As the interest towards vegan diet now-a-days, individuals are focused to adapt new innovations related to vegan based products. Ice cream blends are also incorporated with these plant based products. One of the examples of this type is coconut based ice cream. First, cold-pressed coconut oil by-products were used to create a plant-based beverage known as COB drink. The coconut drink produced from COB exhibited higher percentages of protein, fat and values of zeta potential than those from commercial products available. Without affecting the sensory properties, the COB drink may be added to plant-based ice cream, and ice cream containing low fat can be made in the same way so it resembles the attributes of full-fat ice cream (Kasapoglu *et al*., 2023) [9]. The outcomes of this study showed that COB can be successfully utilised as a low-cost raw material source in the manufacture of low fat (vegetable-based) or full fat ice cream.

Another possibly unique method for creating a nutrient-rich dessert is helpful to human health as well as minimising possible agricultural contamination. In order to make the ice cream, non-fat milk powder, the milk fat, sugar cream, egg yolk, stabiliser, and maltodextrin were used. They were also combined with 1% L. *plantarum* and varying coconut fibre ratios (0.01-0.03 g/mL). Coconut residue dried at 40 degree Celsius (3 days) in convection oven. Later was grinded and sieved into powder form and added to ice cream premix. This results in the complementary integration of coconut residues and probiotics in the formulation of ice cream (Hanafi *et al*., 2022) [8]. The optimum composition for probiotic ice cream production, according to the findings, showed that 0.02 g/mL of coconut residue provided sustained microbial viability, soft consistency, high protein content, a low melting point and fat content, the right pH, and acceptable sensory scores for general consumer approval prior to storage.

Being known for its medicinal properties, milk from camel has grown in popularity among consumers in the past few years. The goals of this present investigation were to create unique synbiotic ice cream using camel milk that included black rice powder (BRP) and test the probiotic bacteria Lactobacillus acidophilus LA-5 for viability during a 60-day storage period. BRP has been utilised in place of skim milk powder at different amounts of 0, 25, 50, and 75%. The outcomes showed that adding BRP to ice cream mixtures significantly increased the overrun, consistency, and melting rate. The findings of the sensory assessment revealed that the treatments that contained 25% BRP are the most preferable ice cream and could be extended to 50% BRP with no detectable alterations (Elkot *et al*., 2022) [7]. Over a 60-day storage period, the inclusion of BRP enhanced the survivability of Lactobacillus acidophilus LA-5 in the samples of ice cream.

An innovative plant-based ice cream was created using a gluten-and lactose-free based on plants yogurt-like as the main component. The food labels of both products appeared similar; the plant based exhibited greater protein digestibility and having a lack of lactose. The key characteristics of the unique ice cream were evaluated using integrated method. While developing yogurt-like products, lactic acid bacteria (LAB) fermentation ensured that the anti-nutritional compounds in the materials from legumes had been minimised and that the finished product possessed the appropriate technical and sensory qualities. In fact, both the plant-based and milk-based products had comparable sensory profiles with very minor differences in terms of appearance, structure, taste, odour, and texture characteristics (Pontonio *et al*., 2022) [17].

A novel soymilk and sweet lupine milk-based ice cream showed improved melting resistance, a quality that provides value for the customers by facilitating handling and extending the pleasure of the ice cream without melting. The purpose of this study was to look into the physicochemical as well as sensory characteristics of vanilla ice cream when varying degrees of sweet lupine and soymilk alternative were used. According to the analysis of the raw materials, sweet lupine (5.86%) had a greater protein content than soymilk (4.83%) and cow milk showed lesser amount than the both (3.40%). The combination of soymilk and sweet lupine to make ice cream was successful since an increase in overrun as of 84.05% was attained as opposed to 83% for ice cream produced from cow milk. When the created ice cream samples were assessed for sensory qualities, it was discovered that they tasted and appeared identical as to a replacement of 25% like ice cream produced with cow milk (Asres *et al*., 2022) [4]. As a consequence of this study, processors can help supply low-cost, nutritious contemporary alternatives for individuals who are allergic to milk.

In order to improve the rheological, textural, and sensory properties of vegetable ice cream made with vegetable milk (almond and hemp milk), this study looked at the possible use of dietary fibres (psyllium and pectin fibres added in varied quantities of 0–10%). To achieve a precise consistency and well-liked sensory qualities, ice cream with added psyllium can be made with a maximum of 6% added fibre, while ice cream with added pectin fibre can be made with a percentage of at least 8%. Due to interactions and stabilisations, the inclusion of dietary fibres increased the viscosities of the mix in all of the samples analysed when compared to the control sample. The size of their ice crystals, the amount of fat, and the proportion of dietary fibres supplied all had an impact on the materials' hardness, stiffness, and adhesiveness. The almond milk ice cream received higher overall ratings in the sensory study of the ice cream because the sweet flavour was valued at its highest level, while the hemp milk ice cream was assessed for flavour and taste (Leahu *et al*., 2022) [10].

One of the main elements in cookies is flour, which influences the qualities of the dough, physical alterations that occur during baking and the qualities of cookies after baking. With the intention of incorporating them into frozen desserts, two gluten-free cookie formulas were created. Sorghum flour or all-purpose wheat flour was used to make the blonde and chocolate cookies, which were then tested for their physical and chemical characteristics. Water activity and moisture content in all cookie compositions were considerably impacted by the flour source. Compared to formulation, flour's usage as inclusions had less of an influence on hardness at freezing temperatures. The flour source did appear to have an impact on the cracking characteristic of the blonde cookies, though, when crumbling profiles were examined (Myers *et al*., 2022) [15]. Additionally, different types of cookies have similar freezing characteristics. According to this study, ice cream and frozen desserts can use cookies made with sorghum flour as an ingredient. From a moisture, textural, and functional standpoint, it is also possible to create gluten-free cookies for use in frozen desserts.

3.1 Modification of Ingredients

Modification in the ingredients while making ice cream is related to provide different advancements in ice cream industry. To increase the shelf life and stability of products,

researchers are incorporating different ingredients as replacement of the basic one. The main focus is to make different flavours and enhancers to attract large number of people. Based on the primary ingredients, substitutes of fat in ice cream production are often grouped into three such as lipid, protein and carbohydrate-based. Each group has various functional characteristics and can be utilised separately or in combination. Emulsifiers, medium chain triacylglycerols, or surface-active structural fatty acids are all components of lipid-based substitutes that can stable the emulsions (Loffredi & Alamprese, 2023) [12]. The ingredients that make up carbohydrate-based fat substitutes include modified starches, maltodextrin, inulin, polydextrose, and other fibres (dietary).

Whey protein isolates are usually utilised for the production of protein-based fat alternatives. The best fat substitutes for making ice cream are those that are protein and carbohydrate-based. The viscosity, pH, and TSS of the ice cream increased with the increase in the percentage of carbohydrate-based fat, as this 2023 study showed. The best technique for lowering the melting rate included an equal mixture of whey protein isolate and hydroxypropyl distarch phosphate. It became apparent that alpha-starch and whey protein at a ratio of 1:4 used in low in fat ice cream (chocolate) had qualities that were most close to those of the conventional formula (Saentaweesuk & Chaikham, 2023) [19]. This makes it the best option for creating low in fat and low in calories chocolate ice cream.

By evaluating the physical properties of the most effective sample of ice cream, efficiency with the addition of carboxymethyl cellulose (CMC) as a stabilizer was been assessed. The characteristic test of CMC was done from the sample of kepok banana and corncobs. The results from the CMC characteristic, organoleptic and The Multiple Range Test resulted out as a beneficial influence on ice cream products. These tests indicated that the incorporation of CMC with different variations in the production of ice cream was effective and efficient in the ageing time of ice cream. The receptivity of human senses to the safety of the product is being evaluated during the course of continuous ice cream product testing (Arifan & Primartu, 2023) [3]. Additionally, it demonstrates the safety of using the alkalization-carboxymethylation process on edible raw materials and acceptable compositions.

On ice cream qualities, the other ingredient change was swapping milk fat for corn powder (roasted and grilled). In accordance with the findings of the 2023 study, the physical and rheological characteristics of ice cream mixes were significantly altered by the addition of roasted and grilled corn powders in concentrations of 2, 4, and 6%. The total phenolic compounds and antioxidant activity increased due to the variation of powder concentrations, and varied patterns were seen as the storage time increased. Additionally, the incorporation of roasted corn powder showed higher sensory assessment scores than other treatments. The inclusion of roasted or grilled corn in ice cream brought about a considerable improvement in the melting rate. The cost and profit of the ice cream that was manufactured were also assessed, and treatments that included corn powders showed reduced production expenses than the control one (Abdeldaiem *et al*., 2023) [2].

Through the process of recrystallization brought on by temperature changes during transportation, storage and handling, ice cream's flavour and consistency are negatively impacted. The ice cream hardens as a result of recrystallization, and customers are less likely to accept this texture. Combining native and modified starches helped to enhance the limitations and resist recrystallization. According to the 2022 results, ice cream with guar gum solely has the most overrun, which is around 97.8%, while ice cream without starches has the lowest overrun, which is roughly 48.1%. The ice cream without starch has the maximum viscosity, while the ice cream with maltodextrin alone has the lowest viscosity and melts at fastest pace (Ng *et al*., 2022) [16]. The ice cream that contains guar gum as well as maltodextrin in the same quantity melts at the slowest rate and showed best level of sensory acceptability. Therefore, the modifications in ingredients increases overall acceptable qualities and improved functionality in the ice cream.

3.2 Modification in Nutrients for Neutraceutical Applications

The competition in food business related to new variety of the products is exceeding day by day. The demand for frozen desserts such as ice cream in summer increases rapidly. In order to provide nutritious food, researchers are incorporating nutraceuticals properties in the food with the same sensory characteristics as the commercial ones. For people with dysphagia residing in long-term care centres, ice cream with variable quantities of whey protein (additive) was developed to enhance protein and fluid intake. The samples of thickened ice cream with whey protein concentrations of 6, 8, 10, 12, and 14% by volume were added to the ice cream. As stated in the study, thicker ice cream may include 10% whey protein by volume without having an adverse effect on consumer acceptance. Significantly more people preferred the ice cream with 6-10% concentration than the ice cream without whey protein. For people with dysphagia, whey protein additions up to 12% were acceptable (Moss *et al*., 2023) [14].

Consumption of ice cream has risen throughout time. Many studies have incorporated numerous nutritive ingredients to the ice cream with the goal to increase the ice cream's nutraceuticals significance. Amylose's prebiotic effects on the body can assist many people to maintain good digestion, as well as enhance their immune systems, stimulate weight reduction, manage their diabetic symptoms, and lower their risk of heart disease. The physical, chemical, and sensory qualities of rice-based ice cream manufactured from five types with varying amylose levels were investigated (Seong *et al*., 2023) [20]. The pH, total sugar level, and total solids of the ice cream with various amylose contents all showed significant changes. These results show that different amylose concentrations are suitable for producing rice-based ice cream in terms of their physiochemical, nutritional, and therapeutic qualities.

The well-known spices black pepper and cinnamon are used all over the world for a variety of therapeutic and flavour-enhancing applications. A member of the Piperaceae family of medicinal plants, black pepper is used widely in the culinary and pharmaceutical sectors today. In the scent and flavour sector, cinnamon is a well-known spice that is frequently used to flavour foods, fragrances, and pharmaceutical items. Thus, adding cinnamon powder (CP) and black pepper powder (BPP) to ice cream was to create a fresh and creative concept for the customers with health benefits. For dairy products to be compatible with herbs and spices, the BPP and CP may also offer great flavour and bioactive substances that can be utilised as additives (Aumpa *et al*., 2022) [5]. The findings from this study may be used to

create dairy products that are creatively spiced and fortified with herbs to promote customer usage and provide them with components that are good for their health.

While making vanilla ice cream, yam mucilage was used as emulsifier and stabiliser. The stability, rheological, and physical-chemical parameter were determined. Results indicated that with increase in the concentration of yam mucilage, the percentage of protein also gets increased. According to rheological analysis, ice cream exhibits the traits of a pseudoplastic fluid, exhibiting a viscoelastic structure where elastic behaviour predominates. Furthermore, mixtures with larger mucilage contents included more air and had longer melting durations. Indicating that the use of mucilage in the food sector is feasible given its high stabilisation and nutraceutical properties (Lozano *et al*., 2022) [13]. Thus, various modifications in the nutrient source for the ice cream development can enhance the nutraceutical properties of the product.

4. Future Prospects

Frozen foods and its products possess the potential to add nutritional and functional value to food. As a result of their low storage temperature and high stabilisation, frozen products have desirable choice to provide advantages above and beyond basic nutrition. Research geared at producing tasty, high-quality ice cream for consumers is becoming more and more popular. For various concerns, such as flavour enhancers, reducing fat %, researchers are exploring substitutes for lowering the usage of dairy products in the production of ice cream. While there are a lot of studies on adding healthy components to ice cream to make it low-fat and low-caloric (Seong *et al*., 2023) [20]. The food business employs both traditional and non-conventional raw materials to produce unique food products. They also promote new and alternative processing to boost market appeal and to raise the public's awareness. Food product efficiency demands a thorough analysis of the effects that various processing may have on the raw material in order to get useful findings. Conventional animal protein is not enough for fulfilling the dietary requirements of every individual in considering the population's constant growth and living standards.

Plant proteins are therefore viewed as promising replacements for animal-based proteins as sustainable alternatives. Additionally, plant proteins are more environmentally friendly. Manufacturers may help for a number of reasons by producing ice cream that is affordable, nourishing, and contemporary. The presence of alternative products for people allergic to milk or religious groups who refrain from consuming animal-based meals during fasting periods, plant based proteins are needed. Due to the fact that plant proteins frequently have low water solubility, this has an impact on other functional qualities including foaming and emulsification (Păucean & Mureșan, 2023) [18]. Thus, Fresh possibilities for study are created by the enhancement of these qualities. The enhancement of plant-based protein techno-functional aspects may result from the application of modern processing techniques. Future systems with numerous emulsions are anticipated to be stabilised by the introduction of novel food ingredients, utilizing by-products. This presumption is consistent with the present trend of deepening research into frozen foods made from plant-based ingredients. Therefore, these organic elements will be vital in the development of productive ice cream.

5. Conclusion

Since ice cream is an intricate colloidal system, there are numerous factors that must be taken into account while making ice cream in order to get the ideal taste, mouth feel, flavour and texture. Little modifications in any ice cream ingredient might develop flaws that would compromise the substance's integrity. In addition to the positive consequences, handling ice cream improperly and using excessive or insufficient ingredients can lead to unstable the ice cream mixture. With the change the proportions, certain imperfections, such as flavour rancidity, colour non-uniformity cannot be eradicated. Thus, accurate proportions of ingredients if incorporated into ice cream can be resulted out as an ideal ice-cream. Additionally, other ingredients have different effects on ice cream, such as emulsifiers and stabilisers that blend the basic ingredients together and thicken them, also make it easier to whip, bind free water, slower the melting rate, prevent wheying off, and helps to retain form. However, excessive usage may result in clumping and lower flow rate. Each ingredient plays a major role to enhance the ice cream formulation and sensory characteristics. There are numerous recent advances in ice cream making in account to increase the nutritional level and flavours of ice cream. Various modifications in ingredients and nutrients for nutraceuticals applications have taken place. The motive behind these modifications is to produce variety of the frozen product and develop nutrient rich food to attract the consumers.

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