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Mini Review Article

Fortification of Fish Oil: A New Gateway for Malnutrition

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Abstract

Fish oil supplements have become more popular in recent decades due to their numerous health advantages, resulting in a substantial increase in the number of fish oil supplements marketed to customers during the COVID-19 epidemic. Fish oil has been frequently used in fortified food items due to its unique health advantages, particularly its high levels of unsaturated fatty acids, particularly Docosahexaenoic Acid (DHA) and Eicosapentaenoic Acid (EPA). Various fortified foods with fish oil are now available on the market. The fundamental problem in fortifying food items with fish oil is its oxidation susceptibility and the impact on sensory qualities during storage. Direct addition through bulk fish oil, emulsion, or microencapsulation fortification techniques might significantly increase the oxidative stability of fish oil and cover undesirable fishy flavors in fortified goods. As a result, this page presents an overview of methodologies, their benefits, and their limits, as well as the impacts of integrating fish oil into food items.

Introduction

The tissues of oily fish are used to make fish oil. It includes the omega-3 fatty acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which are the building blocks of eicosanoids, which lessen inflammation throughout the body. In order to have the greatest impact on health, cellular metabolism, and typical physiological processes, fish oils must be administered in very small amounts [1]. Customers are seeking foodstuffs that can influence health benefits and body function in addition to providing basic nutritional requirements as a result of growing consumer demand for functional foods that contain specific ingredients [2,3]. Design, fortification, and manufacture of functional foods employing bioactive and nutraceutical substances have received attention in the field of nutrition research. In this sense, the industry for producing functional foods is expanding along with research to produce new products. Fatty acids are hydrocarbon chains with carboxyl (-COOH) and methyl (-CH3) groups attached to each end. The length, position of double bonds, and degree of unsaturation of fatty acids varied. The fatty acids referred to as Omega-3 fatty acids are created when the initial double bonds are positioned three carbons from the methyl end. Fish oil is now regarded as a functional component due to its high n-3 fatty acid content and positive impacts on human health (particularly for the heart, brain, and nervous system functions) [2,3]. Thus, the utilization of fish oil is being considered carefully by food and pharmaceutical companies. One way to meet the daily need for fatty acids is by using fish oil as a supplement.

Health Benefits of Fish Oil

Fish oil consumption has been linked to reduced risk of cardiovascular disease, cancer (colon, breast, and prostate), and Alzheimer's disease. Additionally, it's possible that fish oil's fatty acids have been examined as a possible treatment for additional conditions like obesity, Type 2 diabetes, depression, non-alcoholic fatty liver disease, and inflammation [1]. O mega-3 fatty acids also improved heart rate and decreased the risk of heart attack, blood pressure, blood cholesterol levels, and artery hardening in addition to lowering the risk of cardiovascular disease [2,3].

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Fortification of Food Using Fish Oil

Consumers and the food industry both support the practice of fortifying food with fish oil in an effort to improve the nutritional content of healthy eating and diets. Fortifying foodstuff with fish oil offers useful products that protect against autoimmune and inflammation-related illnesses, cancer, and cardiovascular diseases. Because fish oil is particularly vulnerable to oxidation and affects the sensory qualities of fortified food items, adopting fish oil in food fortification is challenging [2,3]. A maximum limit should be imposed in order to prevent the impact of fish oil on sensory qualities. Depending on the food type, it may be possible to overcome the limitation of utilizing fish oil in fortified food items by adding it in amounts between 1.0 and 60.0 g per kg, using packaging to prevent oxygen and light penetration, and avoiding exposure to intense heat [1]. The spectrum of fish oil fortification and consumption of fortified goods must be greatly increased in order to achieve fatty acid requirements. Various fortified food items containing fish oil would boost EPA and DHA consumption through the diet at sensory acceptable levels.

Fortification Techniques for Incorporating Fish Oil in Food Products

Emulsion

The method for making an emulsion is the one used the most frequently to create fish oil microcapsules. By emulsifying the nonpolar fish oil droplets with a surface-active carrier, it is possible to disseminate them in aqueous systems. Fish oil emulsions can be used directly (in drinks or meat systems) or produced into microcapsules or powder by removing the solvent (water) from the system [2,3]. Fish oil, in emulsified form, was added during the preparation of mortadella, several other meat products, energy bars, and pan bread. Emulsion-based delivery methods have recently attracted more attention as a suitable technique for integrating and safeguarding lipids in food items [4]. There are several kinds of emulsion delivery systems, including conventional, multiple, and multilayer emulsions as well as solid lipid particles, filled hydrogel particles, and standard emulsions. The nutritional value and better lipid profiles of food items have been found to be improved by utilizing emulsion delivery methods as fat substitutes [1]. Different techniques, such as creaming, coalescence, Ostwald ripening, and aggregation, are utilized to overcome the thermodynamic instability of emulsions. Emulsion properties are important for the stability of fish oil in microcapsules [4]. Fish oil has been encapsulated using a variety of emulsions, including double emulsions, ordinary emulsions (O/W), micro/nanoemulsions, multilayer emulsions (using layer-by-layer deposition technique), and emulsions that are small enough to fit within hydrogel beads.

Gelled Emulsion

An emulsion with a gel-like network structure and solid-like mechanical capabilities is referred to as a gelled emulsion. The most popular technique for creating gelled emulsions involves adding an oil phase to an aqueous phase that also contains hydrocolloid gelling agents like carrageenan and alginate [1]. The emulsions were then maintained overnight in the refrigerator after being cooled to room temperature to allow the hydrocolloid to polymerize. Comparing gelled emulsions to oil-in-water emulsions, hardness and water-holding capacity may be mimicked to aid in the reformulation of various meat products. In the literature, basic and double gelled emulsion applications in food items have been discussed, albeit there have been relatively few reports of the development of gelled double emulsions [2]. Gelled double emulsions for food applications might be used to reduce fat, provide a healthier fatty acid profile, and encapsulate hydrophilic and lipophilic bioactive substances.

Encapsulation

A novel method known as microencapsulation has been employed to cover or enclose delicate substances as the core material within another material acting as the wall material of a protective shell or wall. Microencapsulation aims to achieve the following goals: protecting the core materials from the negative effects of the environment (light, moisture, and oxygen); regulating the release of chemicals at a certain time and location; hiding an off-flavors taste or odor; changing the physical characteristics and handling capabilities by converting liquids to solids form, and boosting oxidative stability. There are several methods of encapsulation, including physical ones like spray-drying, spray-chilling/coating, freeze-drying, extrusion, or fluidized bed coating, chemical ones like molecular inclusion, and physicochemical ones like single- or multi-core complex coacervation and liposome entrapment.

Spray Drying

The fundamental steps in the spray-drying process include dissolving the core material in a dispersion of the wall material, creating an emulsion, pumping the emulsion within an atomized chamber, atomizing the emulsion into hot air, dehydrating the droplets, and creating microcapsules [5]. The size of the microcapsules might range from 10 to 50 nm at the small end to 2-3 mm at the big end depending on the properties of the core and wall materials, the infeed emulsion, and the operating parameters of the spray-drying. Although the spray-dryer has seen widespread usage because to its low cost, flexibility, ease of scaling up, and use of readily accessible equipment, some literates have pointed out several drawbacks to this technology. Spray-drying is excellent for encapsulating heat-sensitive compounds like fish oil, it was claimed, due to the quick drying durations. The use of high air temperature while drying the emulsions by spray-drying led to the production of microcapsules with a porous structure even though the short drying durations and the high rate of evaporation of water kept the core temperature below 100 °C during surface film solidification. Thus, non-encapsulated oils that were present on the surface or in the porous architectures of the microcapsules encouraged the system to produce peroxides and generate an unpleasant off-flavor.

Freeze-Drying

Low-temperature dehydration is called freeze-drying or lyophilization. The product frizzed in the first phase, and then the pressure was reduced and the ice was removed via sublimation in the next. A high-quality product with less oxidation can be produced by freeze-drying at low temperatures and without oxygen. Although this method is more suited for the microencapsulation of components that are extremely sensitive to heat, such as fish oil, it is more expensive and takes longer to dehydrate than, say, spray drying. [6] used spray- and freeze-drying to encapsulate fish oil containing phytosterol ester and limonene in whey protein isolate and soluble corn fiber wall materials. At the beginning of storage, it was discovered that spray-drying microcapsules had higher retention of the volatile fraction and less surface oil, while freeze-drying microcapsules had higher oxidative stability. However, overall, there were no appreciable differences between the two drying methods in terms of protecting the core materials.

Extrusion

Extrusion is an alternative approach to producing droplets of fish oil by adding an active substance as the core material to a hydrocolloid that has been dissolved. The mixture is then forced through a syringe to create the droplets. This approach uses pressure to push a combination of biopolymer-containing core material through a nozzle and into a bath of hardening. Extrusion has the advantages of generating fewer porous particles, employing gentle pressure and temperature conditions, completely encapsulating the core material by the wall material, and cleaning any core from the outside [3]. The extrusion process has additional drawbacks, including high cost (nearly double that of spray-drying) and significant shear pressures that led to reduced fish oil stability.

Conclusion

Consumers and the food industry both support the practice of fortifying food with fish oil in an effort to improve the nutritional content of healthy eating and diets. According to [7], fortifying meals with fish oil offers useful goods that protect inflammatory and autoimmune illnesses, cancer, and cardiovascular diseases. Because fish oil is particularly vulnerable to oxidation and affects the sensory qualities of fortified food items, using fish oil in food fortification is challenging. A maximum limit should be imposed in order to prevent the impact of fish oil on sensory qualities. One of the primary difficulties with fish oil Omega-3 fatty acids and functional goods enriched with fish oil is their vulnerability to oxidative degradation. Numerous ways have been researched to fortify food items with fish oil in an effort to overcome these constraints. The most popular processes for adding fish oil to food items include the direct addition of bulk fish oil, emulsification, and microencapsulation.

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