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Fat Replacers In Contemporary Diets: Classification, Technological Functions, And Health Outcomes (Review Article)

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ABSTRACT

This review explores recent dietary fat intake trends, focusing on fat replacers' classification, energy density, and functional roles. Fat replacers mimic fats' sensory and physical properties while aiming to reduce caloric content and improve nutritional value. Given the association between high intake of saturated fats and elevated risks of cardiovascular disease, obesity, and certain cancers, fat substitutes offer a promising strategy for health promotion. They may contribute to weight management, improve lipid profiles by reducing LDL cholesterol, and enhance satiety. Natural ingredients like egg whites, milk proteins, pectin, and fruit-based pastes (e.g., prune or cherry) not only act as fat replacers but may also increase antioxidant intake. This review also examines their applications in various food systems and evaluates their health implications. Future research should provide long-term clinical data on the health effects of fat replacers and explore novel sources and nano-formulations to enhance their effectiveness and consumer acceptans.

Keywords: *fat replacers, health benefits, producing, diseases, classification*.

INTRODUCTION

In recent years, global public health concerns have increasingly centered on lifestyle- related diseases, including obesity, cardiovascular disease, and type 2 diabetes. Among the primary dietary contributors to these conditions is excessive dietary fat intake, particularly beyond recommended levels. Sudarshan and Sharan [1] noted that high-fat diets are associated with increased energy consumption and a heightened risk of obesity. Numerous chronic degenerative diseases are now understood to be closely linked to dietary patterns, with high-fat consumption correlating with increased incidence of certain cancers and metabolic disorders. Obesity, in turn, is a major risk factor for hypertension and type 2 diabetes. Moreover, saturated fat intake has been shown to significantly elevate total blood cholesterol levels, contributing to the development of atherosclerosis and coronary artery disease [2]. Beyond its role as a macronutrient, fat is a key structural and functional component of the food matrix. It serves as a dense source of energy and plays a critical role in determining the sensory and qualitative attributes of food, including mouthfeel, texture, aroma, and appearance [3]. These properties influence consumer perception, palatability, and product acceptance. For example, fats are essential in baked goods, where they contribute to both soft and crisp textures, as well as in snack foods that rely on fat to enhance flavor and encourage repeat consumption [2, 4]. In response to growing health concerns, various strategies have been developed to reduce fat content in food products without compromising sensory quality. These include using air or water as fat volumizers, substituting lean meats in prepared meals, replacing whole milk with skim milk in desserts, and opting for baking over frying in snack food production. Additionally, reformulation approaches aim to replace fats with compounds that mimic their physical and sensory properties [5]. Fat replacers can be derived from lipids, proteins, or carbohydrates, and may be used individually or in synergistic combinations. They are typically classified into two major categories: fat mimetics and fat substitutes. According to Nourmohammadi et al. [6], fat replacers are designed to replicate the physicochemical properties of fats and often share structural similarities with them. A variety of technological strategies have been employed to lower the fat content in foods, including the incorporation of low-fat ingredients, alternative sources, and additives that provide desirable textural and flavor characteristics. These interventions are crucial not only for reducing saturated and trans-fat intake but also for maintaining the sensory appeal and consumer acceptability of the reformulated products [7]. This review provides a comprehensive overview of fat replacers, exploring their classification, mechanisms of action, functional roles in food systems, and potential health benefits. Their primary objective is to reduce the fat and caloric density of foods, thereby contributing to improved dietary patterns and public health outcomes.

Classification of Fat Replacers

Fat replacers are classified into three main categories:

- Carbohydrate-based fat replacers
- Protein-based fat replacers
- Lipid-based fat replacers

Each class includes multiple compounds and technologies with unique functional, sensory, and nutritional characteristics.

Carbohydrate–based fat replacers

Carbohydrate-based fat replacers are widely employed in the development of low-fat and reduced-fat food products. These compounds are typically derived from complex carbohydrates such as modified starches, dietary fibers, and certain oligosaccharides, and are specifically designed to replicate the functional and sensory characteristics of lipids. By mimicking the textureviscosity, and other organoleptic properties of fats, these replacers contribute to the overall sensory quality of the final product. Incorporating carbohydrate-based fat replacers allows food manufacturers to significantly lower the fat and caloric content of food formulations without compromising consumer acceptability. Their use supports the production of nutritionally improved products that align with dietary recommendations aimed at reducing fat intake while preserving desirable attributes such as creaminess, thickness, and palatability [8].

Starch–derived fat mimetics Maltodextrins

The incorporation of a 20% maltodextrin solution derived from powdered lotus seed skin has been demonstrated to effectively reduce fat content in pasta products while maintaining acceptable sensory characteristics. However, increasing the fat replacement level to 30% or 40% was associated with a noticeable decline in sensory quality, particularly in attributes related to taste and texture. In a study conducted by [9], it was observed that the application of a low concentration (2%) of maltodextrin in cake formulations preserved the desired sensory attributes, whereas higher substitution levels (30–40%) resulted in diminished sensory performance. Moreover, extended storage was shown to negatively affect product quality. After 20 days, pasta samples exhibited deterioration in texture, with higher levels of fat replacers (30–40%) leading to undesirable consistency, such as stickiness and excessive thickness. These findings suggest that a 20% substitution level provides a more favorable balance between fat reduction and product integrity. The adverse effects of prolonged storage were attributed to lipid oxidation and reduced structural stability, which compromised flavor and textural properties [10]. The stability of lipid-rich food matrices is influenced by several factors, including temperature, moisture content, and storage conditions. These variables can affect critical product characteristics such as discoloration, isoflavone degradation, and antioxidant capacity. To mitigate the effects of lipid oxidation and preserve product quality, strategies such as the incorporation of antioxidants and optimization of storage parameters are essential [11].

Modified starches

Starch modification is a widely employed technique aimed at enhancing its functional properties and expanding its potential applications across various food products. The most common form of modification involves altering the viscosity profile of starch, though other modifications, such as the introduction of ionic charges or the enhancement of emulsifying properties, are also frequently utilized. Accurate and reliable methods for assessing the type and degree of chemical substitution are crucial, as there are stringent regulations governing the types of modified starches that can be safely used in food applications [12]. The simplest modification is acid hydrolysis, which decreases the peak viscosity of starch while increasing the viscosity of the storage paste. The evaluation of the viscosity profile is essential in understanding these modifications. Starch treated with hypochlorite under acidic conditions forms a stable, low- viscosity paste that is transparent and exhibits a reduced peak viscosity. To quantify the degree of modification, carboxyl groups introduced during the treatment process can be measured through titration with an alkali, following their conversion into hydrogen. Additionally, the anionic nature of the modified starch can be confirmed by applying methylene blue stain to the starch granules. Modified starches, often used in combination with emulsifiers, proteins, gums, and other modified food starches, primarily function as bodying agents and texture enhancers. Among the commercially available modified starches, Oatrim and Z-trim are two of the most commonly used products [13].

Oatrim

Enzymatically processed hydrolyzed oat flour, known commercially as Oatrim, contains approximately 5% soluble β-glucan fiber. This product is derived from oat flour that undergoes enzymatic hydrolysis, resulting in a composition of water-soluble and water-insoluble components, which are subsequently separated and dried. According to [14], the final product consists of a dry substance that readily dissolves in water. Oatrim stands out as a unique fat replacer due to its natural composition, which includes both carbohydrates and gums. This distinctive combination allows it to function as a versatile ingredient in a wide range of food formulations, particularly those requiring flavor enhancement. Following the enzymatic treatment, much of the oat cereal's inherent flavor is removed, rendering Oatrim ideal for use in various flavored food systems. Unlike many other carbohydrate-based fat substitutes, the β-glucan content imparts a characteristic velvety smoothness to the texture, which contributes to its potential as a fat replacer in both partial and full substitutions in recipes [15]. This form of fat mimetic is produced through the partial enzymatic hydrolysis of oat starch, a process that results in water-soluble byproducts with functional properties suitable for fat replacement and texturization. One example of such a product is α-Trim™. According to the U.S. Food and Drug Administration (FDA), Oatrim is recognized as safe for consumption by the general population. It has proven applications in a variety of food products, including baked goods, fillings, icings, frozen desserts, dairy beverages, salad dressings, processed meats, and confections [16].

Z-trim

Z-Trim is an innovative fat substitute derived from natural dietary fibers, primarily sourced from maize and other cereal grains. Developed by the United States Department of Agriculture (USDA), Z-Trim has been shown to effectively reduce the fat content of food products without compromising their sensory attributes, such as texture and mouthfeel. According to [17], Z-Trim offers a viable alternative to traditional fat replacers by mimicking the creamy and rich qualities of fats, yet without the added calories or cholesterol. This unique product structure imparts functional benefits, particularly in applications where a gel-like consistency is desired. Z-Trim fibers, by absorbing water, provide texture and consistency improvements in a variety of food categories, including baked goods, dairy products, condiments, and processed meats. In addition to its role as a fat replacer, Z-Trim offers further nutritional benefits by increasing the fiber content of food products, which is particularly valuable for promoting digestive health. Its neutral flavor profile, along with its stability under both heat and acidic conditions, makes it versatile in various food formulations and industrial applications. As noted in [18], Z-Trim not only reduces calories but also serves as a functional ingredient that can help manufacturers address consumer demands for healthier food options without sacrificing taste or texture. The positive impact of Z-Trim on reducing saturated and trans-fat intake further enhances its appeal to health-conscious consumers. The insoluble fiber in Z-Trim is derived from various sources, including oats, soybeans, peas, rice hulls, maize, and wheat bran. When consumed, Z-Trim provides a mouthfeel that closely resembles real fat, feeling smooth, dense, and moist. As an added benefit, Z-Trim contributes to increased fiber intake, making it suitable for a wide range of food products, including cheese, burgers, hot dogs, baked goods, ice cream, and yogurt. However, despite its heat stability, Z-Trim is not recommended for use in fried food applications due to its inability to replicate the properties of fat in high-temperature frying environments [20].

Fiber-based fat mimetics Microcrystalline cellulose

These products are formulated through the co-processing of microcrystalline cellulose (MCC) with sodium carboxymethyl cellulose (CMC), resulting in the formation of colloidal materials. According to [21], microcrystalline cellulose has found widespread application as a fat replacer in various food products, including processed meats, ice cream, frozen desserts, dairy products, salad dressings, and baked goods. This combination leverages the functional properties of MCC and CMC, enabling the development of products that mimic the texture and mouthfeel of fat while offering a reduction in caloric and lipid content.

Methylcellulose gums

Foods containing methylcellulose or hydroxypropylmethyl cellulose (HPMC) exhibit enhanced structural integrity, reduced volume loss, and improved moisture retention, primarily due to their ability to trap air or carbon dioxide bubbles within the matrix. The chemical structures of methylcellulose and hydroxypropylmethyl cellulose can be seen in Figure 1. These cellulose derivatives are commonly utilized in a wide range of food applications, including fried foods, liquid foods, baked goods, frozen dairy products, and low-fat whipped toppings.

Methylcellulose and hydroxypropylmethyl cellulose are particularly effective in fried foods, as they help reduce fat absorption during the cooking process. This results in a decrease in overall caloric content and an improvement in cooking efficiency, as less oil is required. Additionally, these compounds are beneficial in the formulation of reduced-fat baked goods, where they facilitate air entrainment. This, in turn, supports the formation of a consistent fine cell structure within the crumb and compensates for the loss of fat, thereby maintaining desirable texture and mouthfeel [22].

Slendid

A variety of pectins have been specifically developed for use as fat replacers in food products. These pectins possess several advantageous properties, including stability under varying conditions of heat, pH, shear, and salt, as well as an absence of detectable flavor. Additionally, they exhibit fat-mimicking dissipation behavior, are nearly calorie-free, and require relatively low usage levels, typically ranging from 0.2% to 1.5%. Pectins are commonly utilized in a broad spectrum of food applications, including spreads, mayonnaise, salad dressings, processed meats, ice creams, soups, sauces, confectionery, and baked goods, where they can function as partial or complete fat substitutes [23].

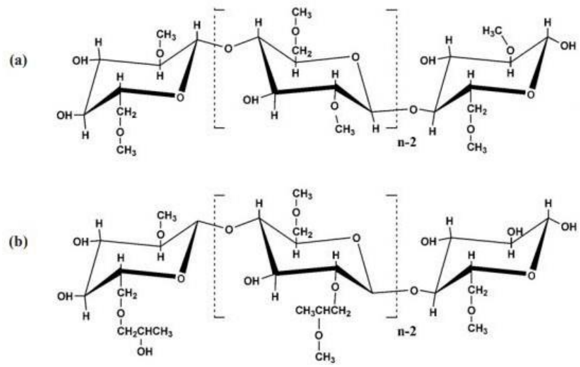

Fig. 1: Typical chemical structures of (a) methylcellulose and (b) hydroxypropylmethylcellulose [23].

Hydrocolloid gums

Hydrocolloid gums are derived from various plant sources, including seaweeds, seeds, and tree exudates, and may also be produced through microbial fermentation or chemical modification of polysaccharides. Among the most commonly utilized hydrocolloid gums for fat mimetic applications are guar gum and locust bean gum. These gums function primarily by regulating viscosity and texture, as well as binding excess water within their three-dimensional network structure. While they do not directly mimic fat in terms of fat replacement, they contribute to modifying the physical properties of food, thereby enhancing texture and consistency [24].

Polydextrose

Polydextrose is a complex carbohydrate that has been utilized in the human diet as a low- calorie bulking agent. It is synthesized through the random polymerization of glucose, sorbitol, and citric acid. In addition to its diverse culinary applications, polydextrose serves various functional roles, including cryoprotection, thickening, humectancy, and texturization. Although not technically classified as a fat replacer, polydextrose's relatively high solution viscosity allows it to contribute to the sensory perception of creaminess and smoothness in fat-reduced formulations. According to Deng et al. [25], polydextrose can be employed as a fat mimetic in specific applications, such as low-fat pastries, chewy confectionery, and sauces, where it helps improve texture and mouthfeel while maintaining a desirable consistency for spooning or pouring.

Fruit and fruit purees

In many instances, the pectin and fiber naturally present in fruits contribute to the enhancement of the texture and structure of food products. Fruit purees, such as those derived from bananas, melons, and persimmons, have been successfully utilized as fat replacers in various formulations. Notably, cakes incorporating 50% to 75% Diospyros kaki exhibited reduced fat content while maintaining comparable flavor profiles to those made with traditional persimmon fruit, all without the direct inclusion of persimmon. These findings suggest that persimmon fruit may play a significant role in improving lipid metabolism and hold promise as an effective fat substitute. When used in high concentrations, persimmon fruit has been shown to increase the water content of cake products, thereby influencing their texture and moisture retention. Previous research [33]. Indicates that persimmon fruit is rich in glucose and fructose, both of which are water-soluble carbohydrates. Furthermore, Yu et al. [34] reported that the soluble fiber content in persimmon peel powder ranges from 2.44 to 7.09 g/100 g, while the insoluble fiber content varies from 34.89 to 50.76 g/100 g. The combination of wheat proteins and persimmon sugars results in the formation of molecular linkages that assist in water retention, thereby enhancing the overall moisture content of the product. The potential impact of increased water content on the shelf life of baked goods underscores the importance of carefully balancing ingredients in cake formulations.

Protein–based fat replacers

To mitigate the risk of various diseases while preserving the flavor and organoleptic qualities of food, fat replacers can be incorporated into diets either partially or fully. By utilizing amphiphilic compounds and proteins as emulsifiers and stabilizers, stable oil-in-water emulsions with unique physicochemical characteristics can be generated [33]. A variety of products have successfully employed protein-based fat substitutes in this context. One such method involves creating nanoparticles using soy protein isolate (SPI) as the structural scaffold, a process referred to as "nano soy protein isolate." According to [34], SPI enhances both intramolecular and intermolecular interactions due to its amino acid side chains, which are equipped with flexible functional groups. When nano-SPI is incorporated into low-fat mayonnaise, it effectively reducesfat content and increases protein levels by up to 1.5%, improving the overall quality of the mayonnaise and positioning it as a viable fat substitute. However, using high concentrations of nano-SPI can detrimentally affect the product's appeal. Research by [35] indicates that increasing the concentration of nano-SPI in low-fat mayonnaise diminishes emulsion stability, as the nanoparticles tend to aggregate. This underscores the importance of precisely formulating low-fat mayonnaise with an optimal concentration of nano-SPI. Additionally, bean flour, due to its high nutrient density, can serve as a fat replacer in baked goods [34]. The use of a microgel (WPM) in the production of Cheddar cheese has also shown significant potential. Reduced-fat Cheddar cheese products made with WPM exhibit altered physicochemical properties, such as increased moisture content and improved sensory characteristics, including reduced chewiness, hardness, and stretchiness. The increased moisture content significantly influences the ripening process, causing the reduced-fat Cheddar cheese to soften. Moreover, the increase in water content results in a more porous texture, with an increase in both the number and size of holes in the cheese structure, thereby enhancing the overall sensory properties [33].

Microparticulated Proteins

Cheese powders have incorporated fat replacers such as microparticulated protein (MP) to enhance their flavor, maintain emulsion stability, and improve texture. However, the inclusion of large quantities of MP may increase the susceptibility of the powder to lipid oxidation. This is particularly significant as oxidative damage to lipids and proteins is closely associated with the intensity of the heat applied during production [23]. Denaturation, a structural change that MP undergoes, renders the protein more prone to oxidation, as it exposes reactive amino acid residues. While MP has the potential to improve the texture and flavor of low-fat cheese, excessive protein usage without appropriate processing elevates the risk of oxidation during storage, ultimately reducing the final product's quality. An example of functional innovation in dairy products is the incorporation of microparticle whey (Mwhey) in beverage drinks. Research has shown that adding Mwhey to dairy beverages enhances their rheological and sensory qualities, yielding consumer- acceptable sensory ratings for texture, creaminess, hardness, and oiliness. Furthermore, the surface appearance of the product correlated with an enhanced imitation of the sensory perception of fat. However, it was noted by [26] that clumping could occur if whey undergoes excessive denaturation. Denaturation causes whey to interact with casein micelles, leading to the formation of large particle aggregates. The use of stabilizers is critical to maintaining the uniform distribution of proteins in the product, preventing these undesirable changes. In the absence of stabilizers, these structural alterations compromise the texture and overall stability of the product.

Lipid-based fat replacers

Among the various types of fat substitutes currently available, lipid-based substitutes stand out due to their ability to most closely replicate the flavor and sensory characteristics of natural fats. These substitutes provide superior flavor fidelity, which is essential in maintaining consumer acceptance of reduced-fat products. Additionally, lipid-based substitutes address one of the major challenges associated with fat replacement: thermal stability. Their chemical composition, which closely mirrors that of natural fats, allows them to be employed in high-temperature applications such as frying, where stability is critical [27]. Vegetable oils, as opposed to animal fats, offer several advantages when used as fat substitutes. Due to growing health concerns over the negative impact of saturated fats on public health, particularly in relation to degenerative diseases, vegetable oils have gained favor as a means to reduce saturated fat intake. These oils are capable of mimicking animal fats in many food products, thereby meeting consumer demand for healthier alternatives [28]. One notable development in this area is the creation of Olestra, a fat substitute designed to lower the calorie and fat content of foods, particularly in snacks. Olestra is unique in that it has a similar texture and flavor to natural fat but is not absorbed by the body, providing consumers the ability to enjoy familiar flavors without the associated weight gain. As a result, olestra is commonly found in solid food products such as savory snacks. However, despite its benefits, Olestra comes with some significant drawbacks, including potential digestive issues and a reduced ability to absorb fat-soluble vitamins, which raises concerns regarding its long-term nutritional impact [29].

Emulsifiers

Examples of polyvalent alcohols and fatty acid partial esters include glycerol, sorbitol/sorbitan, sucrose, and lactic acid. These compounds can be esterified with various organic acids, such as acetic, citric, diacetyl tartaric, and succinic acids, to form partial esters. These modified esters possess a range of functional properties that make them useful as fat substitutes. In addition to their role in forming films or spreading on surfaces, these esters also enhance viscosity through hydration and can soften or modify the structural integrity of systems composed of polysaccharides or proteins. Emulsifiers derived from these esters exhibit several characteristics similar to those of fats and oils, including fatty consistency, lubricity, texture, and cohesiveness, thereby contributing to the overall sensory experience typically provided by fats [30]. Although these fat substitutes retain the same caloric value as fats, their primary function is to supplement low-fat diets and replace some of the functional properties of fat when combined with other ingredients. These substitutes are particularly useful in a variety of food products, such as ice cream, salad dressings, cookies, cakes, baking emulsions, and yellow fat spreads, where they can mimic the sensory and functional attributes of fats while contributing to reduced fat content [31].

Olestra

Olestra, a synthetic fat substitute, is characterized by its indigestibility and absence of caloric content, which can be attributed to its unique chemical structure. This composition prevents it from being absorbed in the gastrointestinal tract, allowing it to mimic the sensory properties of fat without contributing to calorie intake. The U.S. Food and Drug Administration (FDA) approved Olestra for use in food products in 1996, specifically for incorporation into salty snacks like crackers. In addition to its use in salty snacks, such as chips, crisps, and extruded snacks, Olestra serves as an alternative to traditional fats and oils. It is also employed in the formulation of frying fat substitutes, dough conditioners, oil sprays, and flavoring agents, providing a versatile solution for reducing fat content in a variety of food applications [32].

Sobestrin

Sugar-fatty acid esters are synthesized by linking hydrophilic sugar alcohols, such as sorbitol, with hydrophobic fatty acids. This reaction creates molecules that possess both hydrophilic and hydrophobic properties, making them useful in various food and industrial applications. Other polyols, such as tetrahalose, raffinose, and stachyose, are also employed in the formation of sugar- fatty acid esters. These polyols, due to their specific chemical structure, contribute to the functional properties of the esters, enhancing their ability to mimic fat in food systems while maintaining desirable texture and stability [34].

Structured lipids

Triacylglycerols that have been altered to alter the content and/or distribution of fatty acids by interesterification in the glycerol backbone are called structured lipids. Lipids with specific structural and/or functional requirements may be efficiently synthesised using structured lipids, which can have positive effects on health. Chemical, enzymatic, or genetic interesterification may be used to create the structured lipids [35].

Salatrim,

Salatrim, also known commercially as Benefat, is a structured lipid composed of modified triacylglycerol molecules in which short-chain fatty acids are esterified at the sn-1 and sn-3 positions of the glycerol backbone, while a long-chain fatty acid is esterified at the sn-2 position. This specific arrangement results in a lipid with reduced caloric content, as short-chain fatty acids are metabolized more rapidly and contribute fewer calories. Due to its functional and organoleptic properties, salatrim is well-suited for use in a variety of low-fat and reduced-calorie food products, including confections, cakes, cookies, brownies, and pie crusts [36].

Caprenin,

Caprenin is a modified medium-chain triacylglycerol (MCT) in which the glycerol backbone is esterified with caprylic acid (C8:0), capric acid (C10:0), and behenic acid (C22:0). This lipid structure results in a fat substitute that mimics the physical and sensory characteristics of cocoa butter while providing fewer calories due to the rapid metabolism of medium-chain fatty acids. As noted by [37], Caprenin is particularly well-suited for use in confectionery applications, where it imparts a desirable texture and mouthfeel comparable to that of traditional fats such as cocoa butter.

Health Implications and Safety Considerations

While fat replacers provide notable benefits, such as reducing caloric intake and improving lipid profiles, certain products (e.g., Olestra) have been associated with gastrointestinal discomfort and impaired absorption of fat-soluble vitamins [29, 32]. Therefore, regulatory oversight and proper labeling are essential. Additionally, excessive use of some protein-based substitutes can lead to oxidative degradation and altered product stability [23, 26]. A balanced evaluation of both benefits and limitations is necessary when incorporating fat replacers into food systems. Long- term clinical studies are limited, and more evidence is needed to confirm safety and efficacy.

Challenges and Limitations

Fat replacers often face challenges in fully replicating the functional and sensory qualities of traditional fats. Issues such as textural inconsistency, flavor masking, storage instability, and production cost can impact consumer acceptance. Moreover, the success of fat replacers varies depending on food matrices and cooking methods [30, 31, 37].

Future Trends and Research Directions

Future developments should focus on:

1. Nanotechnology and microencapsulation techniques for enhancing delivery and stability [34, 35].
2. Exploring local and underutilized plant-based sources for sustainable fat mimetics [33].
3. Designing multifunctional fat replacers with added health benefits (e.g., prebiotics, antioxidants).
4. Conducting long-term human trials to assess metabolic impacts.

Conclusion

Fat replacers are increasingly utilized in a wide range of food products, including baked goods, dairy items (such as cheeses, yoghurt, and sour cream), margarine, salad dressings, sauces, gravies, and other formulations. These substitutes can be derived from carbohydrate-, protein-, or lipid-based sources and are designed to mimic the functional, sensory, and physicochemical properties of dietary fats, while significantly reducing caloric intake. The present review highlights that fat replacers are inherently non-lipid in composition and are strategically applied to reformulate traditional high-fat foods. Common strategies for fat reduction involve not only the use of synthetic or natural fat mimetics but also culinary and formulation techniques, such as incorporating air or water in place of fat, substituting lean meats in ready-to-eat meals, using skim milk instead of whole milk in frozen desserts, and opting for baking over frying in snack preparation. Through such techniques, along with the incorporation of tailored fat replacers that simulate the organoleptic and rheological properties of fats, it is feasible to achieve reduced-fat formulations without significantly compromising taste, texture, or consumer acceptability.

References:

[1]. Sudarshan, M., Sharan, S., 2023. Global lifestyle diseases: lessons for the future. Int. J. Sci. Res. 12, 30–34. https://doi.org/10.36106/ijsr.

[2]. Samakradhamrongthai, R.S., Maneechot, S., Wangpankhajorn, P., Jannu, T., Renaldi, G., 2022. Polydextrose and

guar gum as a fat substitute in rice cookies and its physical, textural, and sensory properties. Food Chem. Adv. 1. https://doi.org/10.1016/j. focha.2022.100058.
[3]. Munialo, C.D., Vriesekoop, F., 2023. Plant-based foods as meat and fat substitutes. Food Sci. Nutr. https://doi.org/10.1002/fsn3.3421.
[4]. Mili´cevi´c, N., Saka˘c, M., Hadnađev, M., Skrobot, ˇ D., Sari ˇ ´c, B., Hadnađev, T.D., Jovanov, P., Pezo, L., 2020. Physico-chemical properties of low-fat cookies containing wheat and oat bran gels as fat replacers. J. Cereal. Sci. 95. https://doi. org/10.1016/j.jcs.2020.103056
[5]. Camara, A.K.F.I., Okuro, P.K., Cunha, R.L.da, Herrero, A.M., Ruiz-Capillas, C., Pollonio, M.A.R., 2020. Chia (Salvia hispanica L.) mucilage as a new fat substitute in emulsified meat products: technological, physicochemical, and rheological characterization. LWT 125. https://doi.org/10.1016/j.lwt.2020.109193.
[6]. Nourmohammadi, N., Austin, L., Chen, D., 2023. Protein-based fat replacers: a focus on fabrication methods and fat-mimic mechanisms. Foods. https://doi.org/10.3390/ foods12050957
[7]. Nikoli´c, I., Pajin, B., Lon˘carevi´c, I., Subari ˇ ´c, D., Jozinovi´c, A., Lon˘cari´c, A., Petrovi´c, J., Sere ˇ ˇs, Z., Doki´c, L., Soronja-Simovi ˇ ´c, D., 2023. Technological characteristics of wheat-fiber-based fat mimetics in combination with food additives. Sustainability (Switzerland) 15. https://doi.org/10.3390/su15031887.
[8]. Zhang, M., Sun, C., Li, Q., 2018. Interaction between the polysaccharides and proteins in semisolid food systems. Encycl. Food Chem. https://doi.org/10.1016/B978-0-12- 814026-0.2147.
[9]. Zhu, F., 2019. Starch based Pickering emulsions: fabrication, properties, and applications. Trends. Food Sci. Technol. 85, 129–137. https://doi.org/10.1016/J. TIFS.2019.01.012.
[10]. Damak, A.M.A., Akubor, P.I., Ariahu, C.C., Okereke, G.O., 2022. Functional and nutritional properties of various flour blends of arrowroot starch and wheat flour. Asian Food Sci. J. 12–25. https://doi.org/10.9734/AFSJ/2022/V21I630432.
[11]. Rodrigues, L.B.O., Veloso, C.M., Bonomo, R.C.F., Rodrigues, L.B., Minim, L.A., Costa, R. A.S., 2018. Rheological and textural studies of arrowroot (Maranta arundinacea) starch-sucrose-whey protein concentrate gels. J. Food Sci. Technol.-mysore 55, 2974–2984. https://doi.org/10.1007/S13197-018-3215-X.
[12]. Park, J.J., Olawuyi, I.F., Lee, W.Y., 2020. Characteristics of low-fat mayonnaise using different modified arrowroot starches as fat replacer. Int. J. Biol. Macromol. 153, 215–223. https://doi.org/10.1016/j.ijbiomac.2020.02.331
[13]. Arango, O., Trujillo, A.J., Castillo, M., 2020. Influence of fat substitution by inulin on fermentation process and physical properties of set yoghurt evaluated by an optical sensor. Food Bioprod. Process. 124, 24–32. https://doi.org/10.1016/j. fbp.2020.07.020.
[14]. Narala, V.R., Orlovs, I., Jugbarde, M.A., Masin, M., 2022. Inulin as a fat replacer in pea protein vegan ice cream and its influence on textural properties and sensory attributes. Appl. Food Res. 2. https://doi.org/10.1016/j.afres.2022.100066.
[15]. Ari Anggraeni, A., Triwitono, P., Arsanti Lestari, L., Harmayani, E., 2023. Evaluation of glucomannan as a fat replacer in the dough and cookies made from fermented cassava flour and soy protein concentrate. Food Chem., 137452 https://doi.org/ 10.1016/j.foodchem.2023.1374.
[16]. Saengphol, E., Pirak, T., 2018. Hoary basil seed mucilage as fat replacer and its effect on quality characteristics of chicken meat model. Agric. Nat. Resour. 52, 382–387. https://doi.org/10.1016/j.anres.2018.06.001.
[17]. Ribes, S., Pena, ˜ N., Fuentes, A., Talens, P., Barat, J.M., 2021. Chia (Salvia hispanica L.) seed mucilage as a fat replacer in yogurts: effect on their nutritional, technological, and sensory properties. J. Dairy. Sci. 104, 2822–2833. https://doi.org/10.3168/ jds.2020-19240
[18]. Yashini, M., Sahana, S., Hemanth, S.D., Sunil, C.K., 2021. Partially defatted tomato seed flour as a fat replacer: effect on physicochemical and sensory characteristics of millet-based cookies. J. Food Sci. Technol. 58, 4530–4541. https://doi.org/10.1007/ s13197-020-049
[19]. Auriema, B.E., Braz Corrˆea, F.J., Guimar˜ aes, J., de, T., Soares, P.T.dos S., Rosenthal, A., Zonta, E., Rosa, R.C.C., Luchese, R.H., Esmerino, E.A., Mathias, S.P., 2021. Green banana biomass: physicochemical and functional properties and its potential as a fat replacer in a chicken mortadella. LWT 140. https://doi.org/10.1016/j. lwt.2020.110686.
[20]. Rakshit, M., Srivastav, P.P., 2022. Sensory evaluation and storage stability of fat reduced shortdough biscuit using hydrolysable tannin encapsulated double emulsion as fat replacer. LWT 154.
[21]. https://doi.org/10.1016/j.lwt.2021.112816.
[22]. Summo, C., De Angelis, D., Difonzo, G., Caponio, F., Pasqualone, A., 2020. Effectiveness of Oat-Hull-based ingredient as fat replacer to produce low fat burger with high betaglucans content. Foods .9
[23]. https://doi.org/10.3390/foods9081057.
[24]. Dipti, S., Kumari, A., Kaur, N., Tripathi, A.D., Agarwal, A., 2023. Development of cake by using persimmon fruit (Diospyros kaki) as a fat replacer and its chemical and structural profile analysis. LWT .178
[25]. https://doi.org/10.1016/j.lwt.2023.114601.

[26]. Fontes-Candia, C., Martínez-Sanz, M., Gomez-Cort ´ ´es, P., Calvo, M.V., Verdú, S., Grau, R., Lopez-Rubio, ´ A., 2023. Polysaccharide-based emulsion gels as fat replacers in Frankfurter sausages: Physicochemical, nutritional and sensorial evaluation. LWT 180. https://doi.org/10.1016/j.lwt.2023.114705.
[27]. Elsebaie, E.M., Mousa, M.M., Abulmeaty, S.A., Shaat, H.A.Y., Elmeslamy, S.A.E., Elgendy, M.S.A., Saleh, F.M., Essa, R.Y., 2022. Application of Gurma Melon (Citrullus lantus var. colocynthoides) pulp-based gel fat replacer in mayonnaise. Foods. 11. https://doi.org/10.3390/foods11182731.
[28]. Deng, N., Li, Z., Li, H., Cai, Y., Li, C., Xiao, Z., Zhang, B., Liu, M., Fang, F., Wang, J., 2023. Effects of maltodextrin and protein hydrolysate extracted from lotus seed peel powder on the fat substitution and lipid oxidation of lotus seed paste. Food Chem. X 20. https://doi.org/10.1016/j.fochx.2023.100967.
[29]. Ghaderi-Ghahfarokhi, M., Yousefvand, A., Ahmadi Gavlighi, H., Zarei, M., 2021. The effect of hydrolysed tragacanth gum and inulin on the probiotic viability and quality characteristics of low-fat yoghurt. Int. J. Dairy. Technol. 74, 161–169. https://doi. org/10.1111/1471-0307.12742.
[30]. Chen Y, She Y, Zhang R, Wang J, Zhang X, Gou X (2020) Use of starch-based fat replacers in foods as a strategy to reduce dietary intake of fat and risk of metabolic diseases. Nutr Food Sci 8:16–22. https:// doi. org/ 10. 1002/ fsn3. 1303
[31]. Colla K, Costanzo A, Gamlath S (2018) Fat replacers in baked food products. Foods 7:192. https:// doi. org/ 10. 3390/ foods 71201 92
[32]. Curti E, Federici E, Diantom A, Carini E, Pizzigalli E, Wu Symon V, Vittadini E (2018) Structured emulsions as butter substitutes: Effects on physicochemical and sensory attributes of shortbread cookies. J Sci Food Agric 98:3836– 3842
[33]. Edwards JS, Hettiarachchy NS, Kumar TKS, Carbonero F, Martin EM, Benamara M (2019) Physicochemical properties of soy protein hydrolysate and its formulation and stability with encapsulated probiotic under invitro gastrointestinal environment. J Food Sci 8:3543–3551.
[34]. Elangkovan DR, Ganapathy D (2020) A comprehensive review on the effects of Olestra. J contemp Issues Bus Gov 26:1970
[35]. Jadhav HB, Annapure U (2021) Designer lipids-synthesis and appli-cation–A review. Trends Food Sci Technol 116:884–902.
[36]. Szafranska, ´ J.O., Terpiłowski, K., Sołowiej, B.G., 2022. Pumpkin and kale fibers - a potential hydrocolloids in processed cheese sauce formulations with different fat source. LWT 167. https://doi.org/10.1016/j.lwt.2022.113843
[37]. Yu, B., Zeng, X., Wang, L., Regenstein, J.M., 2021. Preparation of nanofibrillated cellulose from grapefruit peel and its application as fat substitute in ice cream. Carbohydr. Polym. 254. https://doi.org/10.1016/j.carbpol.2020.117415.
[38]. Sumonsiri, N., Panjun, B., Naksuk, S., Boonmawat, S., Mukprasirt, A., Phasuthan, P., 2020. Effect of oatmeal as a fat replacer on physical properties and sensory acceptance of creamy salad dressing. In: E3S Web of Conferences. EDP Sciences. https://doi.org/10.1051/e3sconf/202014102006.
[39]. Mei, J., Feng, F., Li, Y., 2017. The effect of isomaltooligosaccharide as a fat replacer on the quality of nonfat kefir manufacture. Int. J. Dairy. Technol. 70, 407–414. https:// doi.org/10.1111/1471-0307.12363
[40]. Karaca, O.B., Saydam, ˙ I.B., Güven, M., 2019. Physical, chemical, and sensory attributes of low-fat, full-fat, and fat-free probiotic set yogurts fortified with fiber-rich persimmon and apple powders. J. Food Process. Preserv. 43. https://doi.org/ 10.1111/jfpp.13926.

بدائل الدهون في األنظمة الغذائية المعاصرة: التصنيف، الوظائف التقنية، والنتائج الصحية (مقالة مراجعة).

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الخلاصة
قد تُسهم إضافة بدائل الدهون، وهي مركّبات كيميائية أو مكونات غذائية محددة، في منح المنتجات الغذائية خصائص فيزيائية وحسية مشابهة لتلك المرتبطة بالدهون التقليدية. في هذا السياق، يستعرض هذا القسم أحدث البيانات المتعلقة باتجاهات استهلاك الدهون الغذائية، مع تصنيفها وفقًا لمصادرها التغذوية، وحساب كثافتها الطاقية، وتحليل خصائصها الوظيفية، إلى جانب التطرق إلى تطبيقاتها التكنولوجية كبدائل للدهون. كما تتم مناقشة الأثر الصحي المحتمل لاستخدام بدائل الدهون، إلى جانب استعراض تطبيقاتها العملية في الصناعات الغذائية. تشير الأدبيات العلمية إلى أن بعض المكونات الغذائية تُعد من العوامل المفترضة المساهمة في تطور عدد من الأمراض التنكسية المزمنة. فقد أظهرت الدراسات وجود علاقة وثيقة بين الاستهلاك المفرط للدهون المشبعة وارتفاع مستويات الكوليسترول في الدم، مما يزيد من خطر الإصابة بأمراض القلب التاجية. كما يرتبط النظام الغذائي عالي المحتوى من الدهون بزيادة خطر الإصابة ببعض أنواع السرطان، فضلًا

عن تأثيره في زيادة الوزن نتيجة لتحقيق توازن طاقي إيجابي وزيادة استهلاك السعرات الحرارية.

الكلمات المفتاحية: بدائل الدهون، الفوائد الصحية، الإنتاج، الأمراض، التصنيف.