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Review Article

Novel ingredient for fat reduction in bakery product preparation and its effect on baking characteristics

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Abstract

Background: Now a days, bakery is one of the important parts of the human life cycle. Every person is in a queue to consumed bakery items. During consumption, fat is one of the important factors to be considered whether it's harmful or not. If harmful, then what is the method of replacing the fat and what are the different approaches to remove the fat. Various novel ingredient incorporated in the bakery items due to this the change in the dough properties and the effect on the baking characteristic. **Methodology:** The primary research articles were sourced out from Google Scholar, PubMed, Research Gate and other peer reviewed journals published in English related to the context of discussion. This included thirty papers published before 2024. **Results**: This review help to understand the molecular structure of fat present in bakery good, the role of fat in dough, batter and in baking characteristics. Effect of novel ingredient in the bread, cake, muffins and cookies. **Conclusion:** These fat replacer shows similar characteristic as compare to traditional fat (Shortening and margarine) used in bakery and shows approximate similar baking characteristic and remove the fat successfully and make the product healthy and effective.

Keywords: bakery, fat replacers, fat reduction, novel ingredient

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Introduction

Hard fat such as animal fat, margarine and shortening are the important ingredients in the bakery industry because it provides desirable spread ability, texture, mouthfeel and shelf life to the food product **(Cui et al., 2022; Hwang, 2020).** Bakery products due to its nutrient value and affordability towards the consumers, are become the huge consumption. Due to the rapid increase in population, change in eating habits of consumer, they have gained popularity among the society, contributing significantly to the growth of the bakery industry. A number of healthy bakery products have been launched in this segment, and are gaining popularity at very high rate. This presence of bakery chains has further triggered the growth in the sector **(Majid et al., 2014).**

Fat replacer bakery product can be defined as, without reducing the calories of the product such as protein, carbohydrate, and fat-based compound that replaces one, two or more sensory and technology function of fat. These fat replacers can be categorized according to their function, composition which are used in bakery application and other industries applications **(Chen et al., 2016).**

Dietary fats which are triglycerides, in with each molecule contains three types of fatty acids on a glycerol backbone. The function and structure of these fatty acid vary greatly depending on the presence of number of double bonds, length of carbon chain and whether the double bonds are in a cis or trans position. Different fatty acids have different compound and having distinct properties such as biochemical properties and therefore it can produce different metabolic and physiological effects, but modify important properties can also happens, such as chemical stability and melting temperatures **(Forouhi et al., 2018).**

Saturated and trans fatty acid is high in the lipid ingredient. These saturated and trans-fatty acid composition has been linked to a higher risk of cardiovascular diseases, diabetes, some types of cancer and death in epidemiological studies. Because of trans fatty acid consumption and negative impact on health regulatory agencies passes the legislation request to industries to remove the trans-fat from the processed food **(Patel & Dewettinck, 2016a; Singh et al., 2017)**. With 9 kcal/g, fat is the most calorically rich of the three macronutrients, compared to 4 kcal/g for protein and carbohydrate, it delivers a lower feeling of fullness during eating than proteins and carbohydrates, making it easy to overeat. As a result, more extra calories are gained from fat consumption and retained by the human body, leading to weight gain **(Yazar & Rosell, 2022)**. A diet rich in fruits, vegetables, legumes, and whole grain cereals, with a total fat intake of up to 35 %, has been shown to help people avoid gaining weight that is harmful **(Dewettinck et al., 2008).**

The amount of fat in a bakery product is determined by the product. The fat content of many products varies. The amount of unsaturated and saturated fat may be high, but the problem is the trans-fat found in bakery products, which can be harmful. Some data that show the amount of fat and trans-fat present in bakery product are shown with the help of graph.

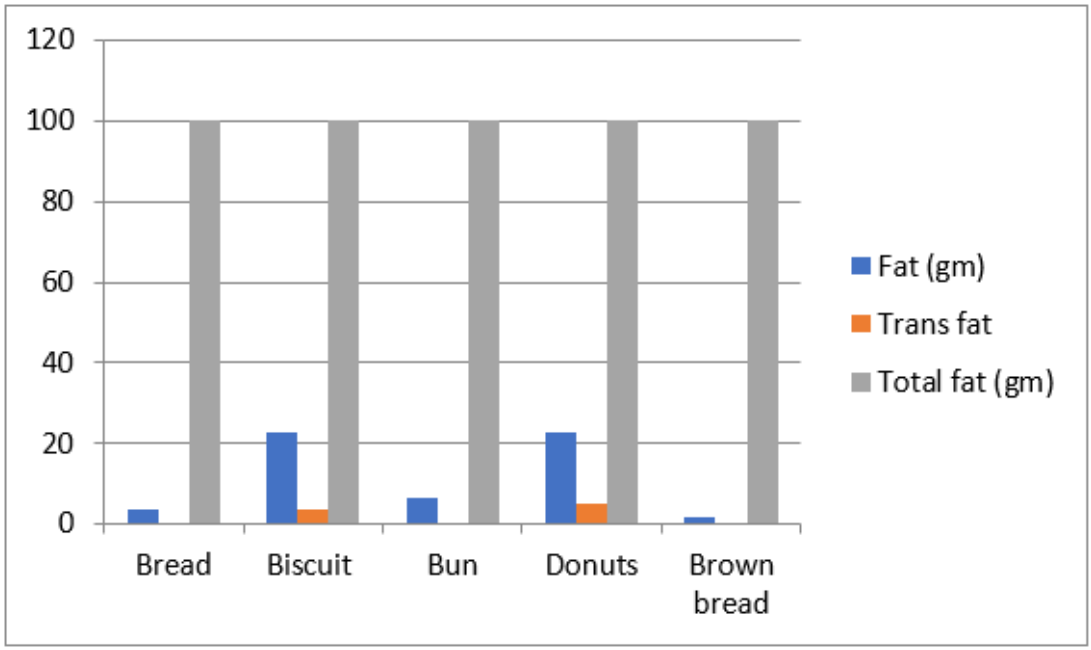

Figure 1: The amount of fat and trans-fat present in bakery product

Type of Fat used in bakery product and its structure

Shortening

Shortening are the natural occurring fat which are solid at room temperature due to the presence of high-melting triacylglycerols (TAGs), it forms crystal structure in room temperature and limit the low-melting triacylglycerols (LAGs). The primary purpose of shortening is to tenderize **(Renzyaeva, 2013)** the bakery product and also play important role to cover starch granular and gluten structure adherence, which can form complex with amylose and play important role in the reducing the water transport into starch granular, which give sensation to the mouth **(Mert & Demirkesen, 2016b)**. Therefore, it provides a lubrication to gluten particle and help in the air incorporation in dough. It also helps in to reduce the shrinking and elastic nature of the dough during molding. Tempering is applied for some time in shortening in ambient condition, during tempering recrystallization takes place in which mixed crystal “demix” and form more stable crystal and form softer product. In addition, shortening provide dough aeration, lubricating effect in mouth, delicate flavor and offer medium to heat transfer during baking.

Shortening have the simplest fat structure comparing all the fat due to its composition. Shortening solely include liquid oil and fat crystals. Various solid/liquid ratios can be achieved by blending various oils. These fat crystals are in the shape of needle or platelets. These 3-dimensional natural structure depend upon the composition and processing conditions; there individual crystal aggregate determine the characteristic of network.

Margarine

First margarine was introduced by Hippolyte Mege Mouries in 1869 as a butter substitute and a cost-effective water in oil emulsion than butter **(Pădureţ, 2022).** In other words, margarine is the emulsion which consists of a minimum of 80% (m/m) of the fat phase and a minimum of 16% (m/m) aqueous phase and having lower fat content **(Miskandar et al., 2005).** Along with water, the aqueous phase contains some amount of preservatives with salts, while the fatty phase represents crystal fat and mixture of liquid oil which admit the consistency and texture of margarine. The fat crystal aggregate matrix, creates the solid or semisolid structure of margarine which traps tiny droplets of water. The commonly used emulsifier is mono and diglycerides of fatty acid, lecithin, distilled monoacylglycerol and, diacylglycerol into which added dyes, antioxidant and flavor **(Bongers & Almeida-Rivera, 2011).**
Like shortening, margarine is also having the almost same fat crystal network. In margarine noticeable difference is found in the structure in presence of water. When water and fat are vigorously mixed, tiny water droplets of few microns are created and crystals may orient at the surface of the water droplet during this process. Surrounded water behave like “shell”, which seem interconnected with three-dimensional structure fat crystal network. The droplet size is influenced by the processing and intensive shear results in finer emulsion. The nature of the fat crystalline network is the primary microstructural variation present in all products containing 80% fat.

Butter

Sweet, neutralized, or matured creams that have been pasteurized and standardized to have a fat content of 30% to 40% are used to make butter. When churning of cream is done, fat particle is separated and the liquid part is known as buttermilk. To give the separated fat plasticity and consistency, it is cleaned and kneaded in a water wheel. Two type of butter is used first salted (contain some amount of salt which are used as a preservative) and unsalted. Generally unsalted butter are used in bakery because do its freshness which are used to prepare bakery cream which having low acid content **(Velazquez, 2022).**

A small amount of milk fat globules can still be found in butter after production. Survival of these fat globules during processing depends upon the ripening procedure of cream and working condition, during and after processing. Cold-warm-cold (CWC) ripening process produces crystal of thick layer having high melting triacylglycerols while the globule's inside is made up of liquid oil and crystal aggregates. Large number of fat globules survives during this process and are less stable and break during processing. Intensive working damage the fat globules which causing the interglobular phase to become more crystalline and the consistency to become harder. Fresh butter has crystals that are somewhat bent and occasionally cluster together with parallel orientation. Liquid phase contains ordered structure which are not different from amorphous structure. After some days storage fresh butter increase the newly formed crystal this resulting in stetting and hardening the butter.

Vegetable Oil

Vegetable oil is a fat that comes from plants and is liquid at normal temperature which obtain from various sources just like sunflower, palm, soyabean, coconut, rapeseed, olives, rapeseed, corn and other sources. Basic function of vegetable oil is to provide texture improvement, moisture retention, flavor and extend the shelf life. Lubrication is one of the most important for dough handling and provide better slicing. These oils having the mixture of triglycerides and fatty acid of various lengths and composition and free from animal cholesterol. Palm and coconut oil have high mono and polyunsaturated fat and low saturated fat. The major concern in the cooking oils is its instability resulted in loss of quality(rancidity) and nutrient value. Generally anti-oxidants are added to prevent from peroxidation.

Role of fat in bakery products and interaction with other bakery ingredients

Effect of fat in dough/batter

Fat have the ability to influence the baked product by lubricating, weakening or shortening the food structure and provide desirable texture properties **(Tanhehco & Ng, 2008).** In the dough making for bread, interaction between the flour and lipids molecules is known as “shortening effect” which have two mechanism physical and chemical mechanism. Chemical effect include lipid oxidation, whereas physical effect include lubrication, involvement of hydrogen, sealing and hydrophobic bonds, releasing of carbon dioxide and heat transfer **(Demirkesen & Mert, 2019).** Volume is depending up on the permeability of carbon dioxide in dough during earlier stage of baking. It reported that carbon dioxide released faster from dough with shortening/margarine. This indicate that envelopment of air bubble and increase the volume of baked product.

Component of the solid fat provide three-dimensional crystal network which hold the liquid portion and give plasticity nature to dough **(Demirkesen & Mert, 2019).** Fat plays an important role as a shortening agent which provide lubrication during mixing and also give content of the gluten network present in the dough. In the absence of shortening, sugar and water solution interact with the flour protein which create the cohesive force between the molecules and extend the gluten network but in the presence of fat/shortening in dough, these fat molecules surround the protein and the starch granular which isolate the water and help in baking continuously of protein and starch structure **(Mamat & Hill, 2014).**

In the case high moisture baked product such as cake/muffins, the role of fat in batter is to form the stable emulsion which are desired to endure the baking heat and help in the aeration through the small air cell/bubble present in the plastic shortening phase during batter blending. Instead of staying in the aqueous phase, air bubbles are entrapped in the continuous phase of the emulsion at room temperature. This mixing helps the fat crystal to cover the interfacial layers of the protein and then continuous heating of the batter during baking help in the bubble expansion. At this stage, the viscoelastic properties of film surrounded the air cell is necessary to maintain the integrity of bubble. There are many fundamental factor which govern the emulsion stability such as interfacial tension, interfacial rheology, stabilization by solid particle, surface charge, disproportionation and Ostwald ripening, film thinning and film rupture **(Tanhehco & Ng, 2008)**

The rheological behavior of dough/batter is thought to be the most important factor in the successful creation of bakery items. The ultimate quality of baked goods is heavily influenced by the rheological qualities of dough/batter. Wheat flour dough/batter is viscoelastic and thixotropic, with some nonlinear shear thinning because of the substantial displacement of its structure and the breakdown of the connections between the polymer chains ($G'' > G'$), dough exhibits viscose "liquid-like" behaviour at high strains (>0.1). At lower strains, however, its viscosity rises, and the dough takes on a more viscoelastic "solid-like" characteristic ($G' > G''$). The storage modulus (G') show the elastic behavior and energy stored recover per cycle whereas the loss modulus indicates (G'') viscous behavior and measure its energy loss per cycle. It's difficult to link dough's flow and deformation behavior to its true structure and baking quality since dough/batter is a complicated composite. Main objective of any rheology test of dough/batter is to determine the baking capacity without baking, each component in dough/batter effect the rheological characteristic at some extent **(Devi & Khatkar, 2016).** The table show the change in rheological behavior by replacing the fat.

Table 1: The change in rheological behavior by replacing the fat

Product	Fat	Fat replacer	Dough/ Batter	Rheology	Reference
Sweet pan bread	Shortening	Rice bran oil oleogel	Wheat flour doughs	Viscosity increases with oleogel concentration	(Jung et al., 2020)
Cake	Shortening	Oleo gel beeswax	Cake flour batter	Reduces steady shear viscosity	(Oh et al., 2017)
Muffins	Shortening	HPMC oleogels	wheat flour batter	Low viscosity behaviour	(Oh & Lee, 2018)
Cake	Butter	camellia oil-based oleogels with citrus pectin	wheat flour batter	Viscosity increases with citrus pectin	(Luo et al., 2019)
Cake	Shortening	ethyl cellulose based oleogel with adipic acid	Cake flour batter	Viscosity decreases	(Adili et al., 2020)
Muffin	Full Fat	inulin and hydroxypropyl methylcellulose	Batter	Viscosity increases	(Ren et al., 2020)
Muffin	Shortening	candelilla wax + glycerol monostearate	Batter	Viscosity increases	(Jeong et al., 2021)
cookies	Shortening	oleogel using esterified rice flour with citric acid	Dough	Viscosity increases	(Kwon & Chang, 2022)
Cookies	Vegetable margarine	Psyllium	Wheat flour Dough	Viscosity decreases	(Belorio et al., 2019)
Filling cream cookies	Refined higher oleic sunflower oil	Monoglyceride oleogels	-	viscosity decreases.	(Palla et al., 2021)
Cookies	Shortening	Gum tragacanth oil/gels	Wheat flour	Viscosity increases	(Gharaie et al., 2019)

Effect of fat in bread, cake, cookies

Biscuits and cookies are the most widely consumed bakery goods in the world, **(Okpala & Okoli, 2013),** which is available in an unlimited number of sizes, shapes, textures, tenderness, color, and composition **(Sudha et al., 2007; Sumnu & Sahin, 2008)**. Fat and sugar are used in high proportions in the making of cookies and biscuits, whereas moisture is used in small amounts **(Sciarini et al., 2013).** The function of fat in biscuits and cookies is very important, which is responsible for the overall texture and tenderness of the final product which improves lubrication, mouthfeel, integrity of structure, heat transfer, incorporation of air, and longer shelf life **(O'Brien, 2004).** Fat used for the production of cookies should be solid and semi-solid at room temperature to the handling batter during manufacturing, which implying an increase in saturated fatty acid concentration **(Tarancón et al., 2013).** During the initial baking stage of cookies, a fat crystal has a structural function in retaining air at the end of the blending process. **(Sciarini et al., 2013).** To get an effective product, shortening must have plastic properties for example optimum solid-liquid index at dough mixing temperature. High solid fat index shortening has enough aeration and low index of solid fat possess the capacity to store air until it is mixed. Amount of fat is decreases which is added to biscuits and cookies is a good way to obtain a healthier and low-calorie fat **(Tarancón et al., 2013).**

All cake is the most consumed by consumers as a delicious product with distinct sensory characteristics. Cake batter consists of oil in water emulsion and some dry content such as sugar, flour, salt, yeast, and milk powder which are liquefy in the continuous aqueous phase **(Ronda et al., 2011)**. The absorption of air during whipping and the creation of bubbles during cooking give the cake its aerated structure **(Wilderjans et al., 2013).** If the viscosity of batter is low then the air trip leads to low volume expansion **(Vasso Psimouli & Oreopoulou, 2012)**. Role of fat in the preparation of the cake is very important from both a technological point as well as sensory point of view, many bakery goods required high amount of fat content to give define volume and better mouth feel. **(Saghafi et al., 2019).**

Bread is a flavorful and nutrient-dense item that continues to be the foundation of our daily diet. Bread is described as a food made mostly from flour, water, salt, and a leavening agent and generally baked. Fats are used in bread manufacturing to promote gas retention in the dough, resulting in increased volume and softness, as well as to lubricate, aerate, and aid heat transfer in the dough for a desired texture.

Fat Replacement

Different approaches to replacement

There are many ways to replace the fat in bakery products, the most common way

to replace the fat is to add some fat replacer during the preparation of the product. Such types of fat replacers are lipid-based fat replacers, protein-based fat replacers, and carbohydrate-based fat replacers. But nowadays novel ingredients are used as a fat replacer such as Gels, which are easy to make and give a better result. These gels are prepared with proteins, polysaccharides, and lipids. The gel which is used are Oleo gel, Hydrogel, and Emulsion gel.

Type of Fat Replacer

Fat replacers are used to replace the fat in some amount or all of the total fat such as saturated and trans-fat in food. In order to reduce fat, calories content, obesity, hypertension, type of diabetes, and cardiovascular diseases which are released by the consumption of food with high total, saturated and trans-fat **(Colla et al., 2018) (Yazar & Rosell, 2022).** Fat replacers are general categories in three on the basis of their composition: carbohydrate fat, lipid-based fat, and protein-based fat **(Gutiérrez-Luna, Astiasarán, et al., 2020).**

Carbohydrate-based Fat Replacer: Carbohydrate-based fat replacer is one of the largest groups among the fat replacer by imitating the function and sensory properties. All the components in the group are plant-based on polysaccharides including fibers (such as insulin, methylcellulose, cellulose, cereal bran, etc), modified starch/starch, maltodextrin, polydextrose, and gums including pectin, xanthan gum, guar gum, etc **(Vassiliki Psimouli & Oreopoulou, 2013).** The most common property of carbohydrate-based fat is it can form a gel-like matrix when it is heated in the water and show similar properties to a fat **(Serinyel & Öztürk, 2017)**. Modified starch and Native starch are considered fat replacers because of their size, shape, and fat globules which can provide a similar texture to fat **(Werlang et al., 2021).** Native starch has a limited function in the food system due to its pH, lack of thermal conductivity, structured fragility, strong retrogradation rate, and instability under stress. **(Ma et al., 2019; Werlang et al., 2021)**, and modified starch is also known as the water holding capacity in order to minimize syneresis and this syneresis of the starch gel is used to calculate the degree of starch retrogradation. On the other hand, the functionality of maltodextrins is slightly different from the native and modified because of the globular structure due to hydrolyzed product **(Chen et al., 2020).** Insulin is also considered a fat replacer due to its chain length which varies from 2 to 60 units and this long chain insulin is used to structure low-fat food because of its ability to shape microcrystals that interconnect with each other to cluster into a gel network and holding the high amount of water **(Rodríguez-García et al., 2012).** When insulin combines with water, it produces the same texture and mouthfeel as fat in baked food as well as in different foods.

Among all types of insulin as a fat replacer in bakery, Raftiline is one of the most used and shows successfully replaces 35% fat in sugar-free cookies. Cereal fibers used fat replacers which are water-insoluble polysaccharides when processed into small particles. They have the ability to absorb water and can swell to provide a similar and smooth mouthfeel just like fat **(Wekwete & Navder, 2008; Forker et al., 2012)**. Trimchoice-5 is the common fat replacer that is produced by oats bran, while vital and Z-trim are produced by corn fibers. These cereal-based fat replacers are commonly used in brownies and biscuits. Cellulose is also used in bakery products which strongly binds water and increases the viscosity of batter/dough, which affect the final volume, texture, and mouthfeel of the product **(Struck et al., 2016; Yazar & Rosell, 2022)**. The water absorption capacity of the cellulose is higher than the cereal fibers. Cellulose is subjected to physical and chemical modification before being used as a fat replacer. Cellulose such as MCC (Microcrystalline cellulose), CMC (Carboxymethyl cellulose), HPMC (Hydroxypropyl methylcellulose), and MC (Methylcellulose) is used as a fat replacer in the bakery product **(Wekwete & Navder, 2008; Peng & Yao, 2017)**. Among all carbohydrate-based fat replacers, Gums have the highest capability to bind water. It can replace the fat in the batter of the cake by increasing the viscosity of the batter preparation in mixing and cake volume in baking. Major gum is used as a fat replacer guar gum, locust bean gum, alginate, carrageenan, xanthan, and pectin **(Peng & Yao, 2017).**

Protein-based Fat Replacer: Protein-based fat replacers such as low molecular protein and modified molecular protein are used to provide fat-like functionality. It contributes the thickening-like ability i.e. rheological properties and by representing the similar size and shape like fat globules and emulsion drop in microparticulate **(Peng & Yao, 2017).** These type of fat replacers are classified into two types microparticulate protein and modified protein concentration. Microparticulate protein is produced by heating as well as blending the protein at the same time at a high temperature to form a sphere type particle having a diameter 1-1.5 which **(Mert & Demirkesen, 2016a)** provides fat like lubrication, structure, and creamy mouthfeel and it is not usually used in the baked product because it denatures, loses its structure at high temperature. Generally, microparticulate protein is derived from egg white or milk and whey protein. It shows both hydrophilic as well as hydrophobic properties and is not heat stable but can affect the final baked product. Modification of protein concentrates are generally produced from whey or milk by the process of controlled thermal denaturation like ultrafiltration and high hydrostatic pressure **(Lim et al., 2008; Borges et al., 2020)**. Whey protein such as Dairy-lo forms a gelling network when it is heated above the denaturation temperature and used in baked products, including cheesecake.

Lipid-based Fat Replacer: Surfactants/emulsifiers and low-calorie fats are two types of lipid-based fat replacers. Low-calorie fats and surfactants, or emulsifiers, are two types of lipid-based fat replacers **(Hasenhuettl, 2019)**. It was shown that a surfactant containing glycerol monostearate and polyglycerol esters of fatty acids increased batter viscosity, gave higher volume during baking by stabilising air bubbles, so the result shows in even gas cell distribution in the crumb of reduced-fat cakes.
Novel ways for structuring liquid oils as partial hydrogenated oil substitutes have been explored in the recent decade. These non-triglyceride alternatives, which include oleo gels [such as wax oleo gels and ethyl cellulose (EC) oleo gels] and structured emulsions **(Patel et al., 2020)**, were employed to replace trans- and saturated fat in food products **(Yazar & Rosell, 2022).** Oleo gels are use in cookies **(Onacik-Gür & Żbikowska, 2020; Li et al., 2021),** muffins **(Giacomozzi et al., 2018; Jeong et al., 2021),** cake **(Luo et al., 2019; Adili et al., 2020)** and many more.

Oleo gel

Oleo gel can be defined as a semi-solid or gel-like substance in which a high amount of liquid oil adds to it to create a structure and form a gelator. 3-Dimensional (3D) Structure is formed due to the nth number of 1- Dimensional (1D) structures combined together to create a single unit. These are the small molecular weight compound. In the gelation operation, the π-π bonding, Hydrogen bonding, van der wall forces, and electrostatic force of attraction take place, which helps the oil combine together and form the matrix. **(Patel et al., 2014; Mert & Demirkesen, 2016b; Singh et al., 2017).**
Nowadays, these techniques used to reduce fat are taking hype, demanding, and trending in the food and bakery industries. Oleo gel uses in various bakery products such as cookies, bread, sweet pan bread, pastry, muffins, and many more. The benefit of using oleo gels is not only that it reduces fat, but it can also improve the quality of the products used in different-different industries. It can reduce oil migration, provide a high melting point, good heat resistance, increase consistency and mouth feel characteristics, and minimize the oxidation and color of food products.

Oil Structuring Method: There is 4 type of method for structuring, which is shown in **(figure 1)** (i) Direct dispersion method:- It is considered as a traditional and commonly used method to prepare oleo gel. In this method, direct dispersion of liquid-based gelator (fatty acids, waxes, fatty alcohols, monoglycerides, etc.) in the liquid oil phase temperature beyond the melting point then cools naturally, resulting in the formation of a gel-like structure. Step of nucleation, matrix growth, a solid fat (TAGs, high melting triacyl-glycerol molecules) forms a network in which it is also involved in oil structuring liquid-based structure.

When applying this method, using mono component gels like wax easter and fatty acid increases gelation efficiency. **(Mert & Demirkesen, 2016a; Singh et al., 2017).** (ii) Indirect dispersion method:- The Polymer used for oil gelation through Direct dispersion, as it is well define defined and used in food. Still, most food polymers show limited dispersion. Polymer function is to form a structural framework in an aqueous solvent and form hydration to an extent from, strong molecular interaction with the solvent **(Martins et al., 2019).** The hydrated polymer coil from a physical crosslink at a specific concentration leads to the gelation of the water phase **(Patel & Dewettinck, 2016b).** (iii) Oil sorption method:- In sorption (absorption and adsorption) porous substance having a large specific surface area and other absorbent fillers are used to accumulate, and excess moisture\water is used to increase the consistency, texture and flow rate of the product **(Patel & Dewettinck, 2016b).** (iv) Structured biphasic system:- This system gives 'gel-like' behavior in three ways (i) Using biopolymer (proteins or polysaccharides), water continuous emulsion structure act as an emulsifier as well as a gelling agent such as yogurt, cheese, and other based desert, etc. (ii) highly concentrated water structured using continuous emulsion as a result of densely packed dispersed droplets at high packing fractions, such as sauce and mayonnaise etc. (iii) oil continuous emulsions structured using a crystalline network of fat particles such as margarine, spreads and butter **(Patel & Dewettinck, 2016; Luo et al., 2019; Demirkesen & Mert, 2020),** make cake using camellia oil-based oleo gels in which trans-fat is reduces by replacing shortening and shows a good sensory property. Ethyl cellulose based oleo gel with adipic acid **(Adili et al., 2020),** Oleo gel beeswax **(Oh et al., 2017),** candelilla wax/canola oil oleo gel **(Alvarez-Ramirez et al., 2020)** are replace by shortening to produce cake which shows good sensory and texture properties. Oleogel are one of the common fat replacers also used in various product such as muffins, cookies and biscuits.

Hydrocolloids/ Hydrogel

The substance has the ability to swell and hold a fraction of water in its structure but does not dissolve in water **(Gutiérrez-Luna, Astiasarán, et al., 2020).** Hydrogels are a network of polymer chains that are found in hydrocolloids, in which the dispersion medium is water **(Nishinari et al., 2000).** It is an intermediate substant have an aqueous phase between liquid and solid, possess elastic and viscous characteristics **(Banerjee & Bhattacharya, 2012)**. Hydrocolloids can divide into Gelling and thickener agents, depending upon molecular association. Hydrocolloids are derived from natural sources such as proteins and polysaccharides, which are used widely in the food industry. It performs various functions such as thickening, gelling aqueous dispersions, emulsions, stabilizing foams, and distributions, suspending the particulate materials and decreasing syneresis effect as well as an increase in retention of water **(Sutherland, 2006).**

Hydrogel is a hydrophilic cross-link polymer that is generally prepared by the hydrophilic monomer. The hydrogel can prepare either synthetic or natural polymer. A synthetic polymer is hydrophobic in nature and has a strong chemical bond, and its mechanical strength shows a low degradation rate and provides durability. Preparation of the hydrogel supplied based on natural polymer based on their suitable functional group **(Shantha & Harding, 2002)**. The general technique used to create a cross-linked polymer is used to prepare hydrogel. Copolymerization/ cross-link free radical polymerization is commonly used to train in which water-soluble linear polymers of both synthetic and natural are cross-linked to form a hydrogel in no. of ways (a) link the polymer chain with chemical reaction. (b) using an ionized reaction to generate the main chain as a free radical and combine to form a cross-link junction (c) by using physical interaction such as electrolysis, entanglement, and catalyst formation. Any technique can be used to create a gel, including solution, bulk, and suspension polymerization **(Ahmed, 2015).**

Hydrogel are used to prepare sweet bread, bread and cake by using chia seed **(Fernandes & Salas-Mellado, 2017),** replacing palm oil/sunflower oil **(Calligaris et al., 2013)** and chia seed gel respectively. Bread with 75% shows a better result as compared to 100%, dried chia seed are successfully replacing the fat in bread, Hydrogel is also used in the puff pastry with maltodextrin gel which shows no change is the specific volume, sweetness and saltiness of the food tended to be diminished, maltodextrin gel puff pastry was best evaluated then other fat replacer.

Emulgel

Emulgel is, also known as Emulsion gel, or gelling emulsion **(Lin et al., 2020)** in which both gel and emulsion droplets occur in this complex colloidal material.. This structure of emulsion gel is divided into two categories; emulsion-droplet aggregate gel and emulsion-droplet filled gel. In emulsion droplet aggregate gels, a network formed by the emulsion droplet aggregate and the matrix is disrupted in most of the cases, structural state of an emulsion droplet is the mixing of two different structures probably owning inhomogeneous distribution of emulsion droplets, and in emulsion-droplet filled gel is the continuous phase of protein and polysaccharide-based gel that form constant gel matrix that serves as the support of the emulsion gel with emulsion droplets are embedded in the gel matrix **(Cofrades et al., 2017; Corstens et al., 2017; Lin et al., 2020).** Preparation of emulsion gels generally includes two steps first step is to make the emulsion and turn the emulsion into a gel. In the recent decade, growing interest received in emulsion gel due to its advantages as compare to emulsion, such as improved storage stability, reduced oil movement, and oxygen difference within the system, and prolonged gastric release because of the protection of gel matrix **(Sato et al., 2014; Lin et al., 2020)** and the

practical application including overcoming the texture problem caused by the lipids particles in the food product and the effect on the fat, hardness and water holding capacity and play an essential role as a fat replacer **(Alejandre et al., 2016; Guo et al., 2017).** Re-emulsified soybean oil used to produce the steam buns **(Li et al., 2020)** produce the similar as compare to shortening and emulsified oil considered as a feasible fat replace, Inulin-based emulsion filled gel used to prepare shortbread cookies **(Paciulli et al., 2020)** increase in volume of cookies is observed and successfully remove the fat.

Table 2: Replacement in bread: Effect of replacement on dough/baking quality/ sensory characteristics

Product	Fat replacer	Sensory	Effect on baking characteristics	Reference
Bun	Oleogels replace Margarine	oleo gel and margarine shows almost same result	➢ no differences in the crumb structure, volume, height, and texture ➢ less porous ➢ harder ➢ no differences in texture	(Bascuas et al., 2021)
Steam buns	re-emulsified soybean oil	sensory acceptability decreased with increased oil replacement	➢ reduced hardness, chewiness ➢ increased springiness ➢ emulsified oil considered as a feasible fat replace	(K. Li et al., 2020)
Bread	Weissella cibaria	focaccia samples is more softer and replace 20% fat and accepted by consumer	➢ Reduced fat content ➢ Protein amount increases ➢ Reduced in glycemic index ➢ Texture quality increases ➢ Improved in sensory profile	(Bavaro et al., 2021)

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Sweet pan bread	Rice bran oil oleogel	-	➢ no differences show in the specific volume ➢ small bread volume ➢ Increases in bread hardness ➢ Wheat flour doughs show more viscous when oleogel in the blends increased	(Jung et al., 2020)
Bread	chia mucilage (CM)	average acceptance	➢ Water activity not increases ➢ No change in specific volume ➢ Colour is almost no change ➢ Sensory increases ➢ Hardness increases ➢ 70% fat replaced	(Fernandes & Salas-Mellado, 2017)
Sweet Bread	Hydrogel (HG)	-	➢ Firmness is high ➢ reasonable aerated structure. ➢ showed a number of small and large bubbles ➢ Sweet bread characteristic was improved	(Calligaris et al., 2013)

Bread is one of the most common bakery products used among consumers. Fat replacement in bread is done by various methods. Fat in bread plays an important role such as it helps to improve retention in the dough, lubrication in the preparation of dough, and enhances the baking quality such as it softening the bread and increasing the volume of the bread which has higher aeration, improves rheological behavior and help in heat transfer and desirable texture in the dough **(Rios et al., 2014).**

Buns are prepared by replacing oleo gel with margarine, in which sample of buns are prepared by using margarine, olive oleo gel, and sunflower oleo gel by baking and steam method. In the preparation, the result shows that fat plays an important role in forming air bubbles in which oleo gel is very effective. Baked buns are hard and dark whereas steam buns show white color and soft structure but the specific volume, height, and texture show significantly no change. Oleo gel gel has a less aerated structure and is harder as compared to margarine. The sensory of both oleo gel and margarine shows the same but oleo gel successfully plays the role of a fat replacer **(Bascuas et al., 2021).**

Bread prepared by Weissella cibaria (species of gram-positive bacteria) which is used as a fat replacer. The wheat flours show high water absorption, moisture content, and water holding capacity compared to traditional cereal flour and show a positive contribution to dough rheology with high strain value which may promote hardness, crumb, and shows reduction in metabolic activity. No browning reaction was shown and have and no modification in colour compared to the original product. Sensory shows an increase in the firm due to a 20% reduction in oil, an increase in the protein content, and fat content reduce to 20% and soften the reference product **(Bavaro et al., 2021)**.

An experiment is done to prepare sweet bread by using rice bran oleo gel and adding candelilla wax with wheat flour, the dough shows lower resistance when mixing with rice bran oleo gel and candelilla wax, their rheological properties become more viscous as the content of oleo gel increases viscosity of the dough is also increased and shows no difference in the texture of the bread such as similar specific volume, and controlled hardness. Content of oleo gel reduces the fat content and plays an important role as a fat replacement in bakery industries.

Studies shows that, hydrogel used to prepare bread with different concentrations of chia mucilage (CM) such as 10,25,50,75 and 100% reduces the fat content as well as calories by replacing vegetable oil. Dries chia mucilage (CM) at 50 degrees did not differ from control sample and shows a 37% reduction in fat content. Bread with 100% chia mucilage shows no change in water activities, specific volume, and colour parameter but the L* (brightness) decreases and increases in the hardness value. Sensory analysis shows very good results above the average acceptance value

significantly with no change in texture. Bread with 75% shows a better result as compared to 100%. Dried chia seed mucilage works very efficiently as a fat replacer in bread and is more acceptable from a sensory point of view **(Fernandes & Salas-Mellado, 2017).**

Sweetbread is prepared using Palm oil and sunflower with Hydrogel and Organogel. The study shows that the effect with the control sample is normal with both palm and sunflower oil and shows a better result with monoglyceride in Palm oil but not very effective in the sunflower oil. This effect is done by obtaining a magnetic resonance image (MRI) which shows that the bread which is formed by Hydrogel shows good results from the other sample. The firmness shown by the palm oil is higher than the sunflower oil but the specific volume in the sunflower oil is better than the palm oil. Monoglyceride reduces the oil network of crystal and hydrogel shows good baking characteristic and reduce fat by up to 80%.

Table 3: Replacement in cake/ muffins: Effect on replacement on batter / baking quality/ sensory characteristics

Product	Fat replacer	Sensory	Effect on baking characteristics	Reference
Cake	camellia oil-based oleogels	Sensory score decreases with increase in pectin content	➢ little harder compare to fat ➢ reduce trans fatty ➢ hardness and chewiness increase ➢ roughness increased	(Luo et al., 2019)
Cake	ethyl cellulose based oleogel with adipic acid	Higher score for colour and texture and overall acceptability	➢ thermal behavior improved ➢ crystallinity improved ➢ no adverse effect on texture ➢ EC2%/AA4% appropriate in bakery product	(Adili et al., 2020)
Cake	Psyllium	-	➢ greater bubbles ➢ lower specific volume ➢ cohesiveness increases slightly ➢ crust colour gets lighter ➢ no change in hardness	(Belorio et al., 2019)

Cake	candelilla wax and canola oil oleogel	-	➢ reduced the viscoelastic properties ➢ reduced the viscoelastic properties ➢ improve in textural properties ➢ improved cohesiveness ➢ lower hardness ➢ prevalence of human health illnesses associated with metabolic syndrome	(Alvarez-Ramirez et al., 2020)
Cake	Oleogel beeswax	-	➢ No difference in specific volume ➢ lowest hardness was observed ➢ low in saturated fat ➢ high in unsaturated fat without significant quality loss	(Oh et al., 2017)
Cake	Coffee silverskin and Water treated Coffee silverskin	No significant difference with control sample	➢ not able to alter fat ➢ Shows weight loss ➢ hardness and chewiness increased ➢ decrease in springiness and cohesiveness ➢ antioxidant activity increases ➢ Water treated Coffee silverskin use as fat substitute up to 30%	(Ateş & Elmacı, 2018)
Cake	Aloe Vera Leaf Gel Powder	Overall acceptable	➢ 4% Aloe Vera powder to improve its nutritional value ➢ No change in physical characteristics	(Singha et al., 2021)
Muffins	Monoglycerides Oleogels	-	➢ higher specific volume ➢ greater spreadability ➢ similar hardness value ➢ homogeneous crumb structures were reached. ➢ 50% re-spect to the Control muffin after 10 days of storage	(Giacomozzi et al., 2018)

Muffins	candelilla wax oleogels added with glycerol monostearate and β-carotene	-	➢ no difference show in specific volume ➢ no change total porosity ➢ greater specific gravity ➢ harder	(Jeong et al., 2021)
Muffins	oleogel with candelilla and sunflower oil	-	➢ increased nutritional value ➢ fat influenced the aeration in the cake ➢ effect the height ➢ hydrolytic and oxidative changes ➢ most promising alternative to profession recipe of gluten-free products	(Kupiec et al., 2021)
Muffins	hydrocolloids–protein and soy protein isolate	Both muffins show similar sensory score	➢ negative effect on hardness ➢ moisture content and water activity increases ➢ Increase in texture properties such as specific volume, height, springiness, cohesiveness, chewiness	(Azmoon et al., 2021)
Muffins	water, inulin, chia seeds, and hempseed	flaxseed oil samples were indistinguishable from the control overall acceptibility	➢ improved nutritional value ➢ reduce fat up to 78% ➢ increasing fiber and omega-3 FA content. ➢ Show no oxidation	(Gutiérrez-Luna, Ansorena, et al., 2020)
Muffins	inulin and hydroxypropyl methylcellulose	8% of insulin are widely accepted	➢ improvement shows in textural properties ➢ delay in retrogradation ➢ Batter shows better viscosity ➢ Hardness decreases	(Ren et al., 2020)
Muffins	HPMC oleogels	-	➢ Batter of muffins shows lower viscosity ➢ Decrease in shear-thinning behaviour ➢ Texture of muffins is soft and chewy nature	(Oh & Lee, 2018)

Cake and muffins are prepared with ingredients such as flour, sugar, fat, egg, and water. These all are mixed together and form a semi-liquid complex structure. Fat plays a very important role in the batter as well as in baking texture, moisture aeration structure, fluffiness, and volume their characteristic can be achieved **(Luo et al., 2019)** prepared cake prepared by using camellia oil-based oleo gels at constant tea olyphenol-palmitate 2.5% (m/v) with different concentrations of citrus pectin (1.5, 2.5, 3.5, 4.5 % (m/v)) by emulsion-templated method, result shows that concentration of citrus pectin effect the physical properties of emulsion, with increases in the stability and viscoelastic nature, This oleo gel display shows high gelling strength and good thixotropic recovery when concentration of citrus pectin is higher then 1.5%. When oleo gel replace by butter, this increase the viscosity of the batter which shows shear thinning behavior which means viscosity increases shear rate decreases. The concentration of citrus pectin increases the loss modulus (G″) & storage modulus (G′). The texture of the cake shows increase in the hardness, Springiness, gumminess, and chewiness but cohesiveness fluctuated as compared to the standard one. The overall quality score decreases with an increase in the concentration of citrus pectin percentage **(Luo et al., 2019).**

Ethyl cellulose-based oleo gel with adipic acid is used to prepare the cake. Morphological properties of oleo gel show irregular network and compactness. By the addition of adipic acid in ethyl cellulose improves the thermal behavior of the oleo gel. When it replaces with shortening, air bubbles are shown in the batter during mixing and oleo gel lower the viscosity of the batter. The hardness of cake increases by replacing 50% shortening and increasing firmness and chewiness. L* value decreases a* & b* value increases with the replacement of shortening by oleo gel increases **(Adili et al., 2020)**.

When candelilla wax/canola oleo gel is replaced by butter to prepare cake bread, viscoelastic properties are reduced with an increase in the concentration of the oleo gel, and reduced in stain amplitude with an increase in the concentration of candelilla wax/canola oleo gel, the flowability of batter is increased due to the oleo gel. The hardness of the cake decreases and specific volume increases and shows a positive effect on vitro starch. FTIR analysis shows reduced in the amorphous domain. Oleo gel is used to prepare sponge cake and balances with starch digestibility and texture analysis **(Alvarez-Ramirez et al., 2020)**.

An experiment was done on the cake to replace oil with psyllium with different proportion 25,50,75,100%(m/v). All batter shows no significant difference between the density, as the oil replacer increases the irregular batter in cake is shown, therefore decrease in the batter volume, there is no change in the hardness of the cake and slightly increase in cohesiveness. Oil formulation reduces lighter crust color is observed. 75% oil replacer shows high score in sensory analysis and it increases the consumer acceptability **(Belorio et al., 2019)**.

Study shows that cake prepared with beeswax shows a lower consistency index in shortening batter and flow index behavior shows higher with oleo gel, rheological properties indicate that viscoelastic behavior is higher whereas specific volume is lower in beeswax oleo gel. The texture of the cake has lower hardness and no change in cohesiveness. Beeswax successfully produces cake lower in saturated fat and higher in unsaturated fat effect the quality of baked cake **(Oh et al., 2017).**

When water is treated with coffee silver skin with the cake, it can reduced-fat up to 30%, increase the fiber content improve the nutrient value that is lower calories in food, and help to increase the antioxidation activities. Physical properties of the cake absorbed the increase in the specific volume, hardness, and chewiness but decrease in the springiness and cohesiveness value. L* shows lighter in color, and a* and b* value is decreased as compare to control sample, this water-treated coffee silver skin can use as a low calorie's food and as a fat replacer. **(Ateş & Elmacı, 2018).**

New studies show that aloevera leaf gel powder is used to prepare the cake. The powder is used and prepared by freeze-drying which increases the nutrition value. Physical properties such as hardness and chewiness increase but a decrease in the volume, specific volume, and baking loss when the percentage of aloevera leaf powder decreases, shows good antioxidant properties, total flavonoid, total polyphenol, and protein and shows high consumer acceptance **(Singha et al., 2021).**

Muffins are high in calories and popular for their sweet taste and soft texture **(Djali et al., 2020).** In a study oleo gel, hydrocolloid, and chia seed are used as the fat replacer in muffins which can have no effect on the rheological properties of batter and improve the physical quality as well as sensory of the muffins. Previously coco fiber, insulin etc are used as a fat replacer **(Zahn et al., 2010; Martínez-Cervera et al., 2011).**

Giacomozzi et al. (2018) prepared muffins using monoglycerides oleo gels by replacing margarine, which changes the rheological of batter and texture profile of the muffins. Monoglyceride gives a high oil binding capacities and elastic modulus. Hardness shows similar as compared to the margarine and obtains greater specific volume and greater spread ability homogenizes crumb structure and reduces oil migration up to 50% after 10 days. Oleo gel indicates oil loss in the sweet baked cake and shows a positive impact on quality and nutrient value, Sensory show an increase in shelf life than other baked cake .

A recent study shows that muffins prepared with candelilla wax added with glycerol monostearate and β-carotene oleo gel show an increase in the rheological properties such as gel strength, viscoelastic behavior, and no significant difference in specific volume, total porosity, have lower hardness and oxidation, it is used to develop muffins which are lower in saturated and trans-fatty acid level **(Jeong et al., 2021).**

When muffins is prepared by structuring with different waxes such as candelilla, sunflower, beeswax with rapeseed oil which shows similar physicochemical properties as compare to shortening, an increase in the nutrient value and aeration in the dough, temperature, and baking influence quality of lipid fraction. Result of shortening and sunflower wax confirm that least degree of hydrolytic and oxidation changes the examined extracted fat. Similar color of muffins is observed and shows a good alternative to produce gluten-free muffin. **(Kupiec et al., 2021)**.

A study with hydrocolloids–protein mixed with soy protein isolate in order to produce sugar free low fat muffins. The result shows that increase in the percentage of mixture of stabilizer shows positive effect on the final product as compare to oil, moisture content of the muffins shows 25.92 on the first day and 22.21 on the fifteenth day, water activity, specific volume, height, springiness, cohesiveness, chewiness is decreased from first to 15th day, and increase in the specific volume, height, springiness, cohesiveness, chewiness but negative in a* and b* color and lower the hardness of the muffins when a mixture of stabilizers **(Azmoon et al., 2021).**

The addition of a different amount of ingredient composed of water, insulin, chia seed improve the nutrient value and reduce 78% of fat content and omega-3 fatty acid because of increase in fiber content and hardness is significantly affected by the time and storage condition of muffins, hempseed oil is used to modified and show the difference on sensory properties and similar texture and no oxidation problem in the formulation **(Gutiérrez-Luna et al., 2020).**

Hydroxypropyl methylcellulose (HPMC) and insulin are evaluated in a low-fat muffin at 0.2 and 8 levels. Result indicated that both the fat replacer improve the texture properties of the muffins by delaying retrogradation. batter shows better viscosity and decrease in hardness of muffins when it is prepared with insulin but HPMC shows opposite effect. Adding a large amount on insulin up to 8% and small amount of HPMC (0.2%) low fat muffins can widely applied **(Ren et al., 2020).**

Table 4: Replacement in Cookies/Biscuits: Effect on replacement on Dough, batter /baking quality/sensory characteristics

Product	Fat replacer	Sensory	Effect on baking characteristics	Reference
Cookies	oleogel using esterified rice flour with citric acid	-	➢ Increase in content of unsaturated fat ➢ Cookies shows no effect appearance ➢ Improve Rheological properties ➢ Oil loss test reduce the oil which is done on the oleogel	(Kwon & Chang, 2022)
Cookies	chitosan-based oleogel	-	➢ Reduced in weight ➢ Show Similar hardness and crispiness ➢ Oil cookies shows highest colour difference	(Brito et al., 2022)
Cookies	Tomato seed flour	Decrease and increase in sensory attribute not effect acceptability	➢ Positive impact in nutritional profile ➢ Negative impact of physical characteristics ➢ Acceptable in terms of sensory characteristics	(Yashini et al., 2021)
Cookies	psyllium	-	➢ Diameter of cookies decreases ➢ Hardness of cookies increases ➢ Moisture content increases ➢ Increases in L* value	(Belorio et al., 2021)
Sandwich Cookies	Filling cream with monoglyceride oleogel	-	➢ Oil migration in Filling cream cookies is low ➢ Hardness increases ➢ increase in adhesiveness and cohesiveness ➢ adhesivity of the samples increases	(Palla et al., 2021)

Cookies	Oleogel with rice bran wax	Overall acceptability	➢ homogeneous porous structure ➢ ideal colour ➢ crispy texture ➢ excellent rheological properties ➢ showed lower cookie hardness	(S. Li et al., 2021)
Shotbread Cookies	Inulin-based emulsion filled gel	Average acceptablity	➢ Higher volume ➢ Harder texture ➢ High water availability ➢ Lower fat content ➢ Thermal and H-NMR parameter shows the presence of lipid and water	(Paciulli et al., 2020)
Cookies	Oleogel with 5% of monoacyloglicerol	Acceptable	➢ contribute to better aeration ➢ small diameter compare to comtrol sample ➢ Oil binding capacity is low ➢	(Onacik-Gür & Żbikowska, 2020)
Cookies	Wheat bran gel	Accepted by 79.5%	➢ Fat replacement to 30 to 50 % ➢ cookies possessed higher dietary fibre ➢ good reological properties	(Milićević et al., 2020)
Cookies	Gum tragacanth oil/gels	25 and 50/100g oil/gel shows acceptable sensory score	➢ Lower replacement level with shortening higher moduli ➢ Fat reduces up to 27-30% ➢ Acceptable sensory Softer texture during storage	(Gharaie et al., 2019)

Cookies	Oleogels + Candelilla wax (CDW) Blend of 70% Candelilla wax oleogel prepared at 6% and 30%	Overall acceptable	➢ softer products were obtained compared to liquid oil ➢ enhanced the cookie quality ➢ Blending increase the physical properties	(Mert & Demirkesen , 2016b)
Shortcrust biscuit	microcrystalli ne cellulose and psyllium	25% fat replace is accepted	➢ Replace 25% fat microcrystalline cellulose is recommended ➢ Weight if biscuit increases ➢ Thickness increases ➢ Volume decreases ➢ Hardness increaeses	(Zbikowska et al., 2018)
Shortbread Biscuits	Insulin and pectin gel	Overall acceptable	➢ Inulin higher than 10% can promote higher then 3-MCPD easter and decline during long day storage ➢ Pectin doesn't endogenous formation of 3-MCPDE ➢ Presence of acid can influence Glycidyl Esters	(Sadowska-Rociek & Cieślik, 2019)

The study indicates that in order to replace the fat oleo gel is prepared by the different concentrations of esterified rice flour with the addition of citric acid (ERCA). which is used as an emulsified coating material for oleo gels and emulsions. The Rheological test of oleo gel are done which shows that consistency index (K), storage modulus (G′), loss modulus (G″), apparent viscosity (ηa), and complex viscosity (η*) of emulsion increase with the increase in the concentration of the (ERCA) due to presence of hydrophobic carbonyl group, the thicker and denser layer are formed due to the new intermolecular and intramolecular hydrogen bond present between hydroxyl group.

This oleo gel is used to prepare cookies by replacing shortening with oleo gel and different concentrations of ERCA (0,5,10,15%) which shows the overall appearance of the cookies is not significantly different and increases the concentration of the unsaturated fat. Fat replacer cookies are produced without causing a decrease in the product quality **(Kwon & Chang, 2022).**

An experiment is done to indicate Psyllium as a fat replacer in the sugar snap cookies. Psyllium is used with different concentrations of water. The rheological properties of dough studies indicate that the paste of Psyllium and water decreases the storage modulus (G′) and loss modulus (G″), and increase the tg delta(G″/G′). Cookies that produce show a lower spread factor, smaller diameter, and harder texture. Eliminating fat and adding the water content change the dough rheology. This addition of paste is not a reversible change produced by fat and is necessary to add more water because of high water-retention capacity of Psyllium, and the cookies have a high moisture content, in order to reduce the water large baking time is taken and also important to consider that fat replacer which is better to use Psyllium and small amount of water as possible. In gluten-free cookies adding a large amount of water is not effective because during baking it evaporates. Wheat cookies, due to the formation of a gluten network and a large amount of water, decrease the characteristic of cookies, decrease in spread ratio, decrease the texture, and a large amount of moisture in the cookies. But the use of Psyllium paste replaces the fat content **(Belorio et al., 2021).**

A Study investigates that, the industrial by-product (Partially defatted tomato seed flour) can replace the fat of millet-based cookies, by replacing fat at different concentration levels such as 10, 20, 30, 40 % (w/w). The study indicates that PDTSF has high protein, carbohydrate, and ash contents, low energy values, and also exhibits outstanding functional properties. Cookies have a good effect on the nutritional profile while having a detrimental effect on physical features. Millet base cookies are acceptable at all levels of PDTSF even decreasing and increasing the sensory attributes and with the fat replacement. Cookies with 10, 20 % can preferable in terms of sensory and other quality characteristics. Cookies show good storage acceptability in terms of storage up to 30 days and their hardness in the HDPE pouch. It can used to replace fat for high-fat food products **(Yashini et al., 2021).**

In a recent experiment, Filling cream (FC) cookies are prepared by using monoglycerides oleo gel. FC is challenging because this fat cannot be directly placed with these lipid oil without any change in the final product. FC formulation with oleo gel shows viscoelastic moduli which does not differ with those commercial cream fill cookies. Oil binding capacity of FC decreases with increase in the oleo gel content. The amount of oleo gel concentration increases, it decreases the hardness but

increases in adhesiveness and cohesiveness of the cookies. When FC was used in the cookies, after 21 days of storage it was found that oli loss in the cookies was about 9 g/kg. Nutritional improvement due to use of oleo gel in FCs can reduce the trans-fatty acid and obtain a product with good quality with similar characteristics **(Palla et al., 2021).**

Li et al., (2021) prepare different type of oleogel with five gelators such as Hydroxypropyl Methylcellulose (HPMC), sodium stearyl lactate (SSL), monoacylglycerol (MAG), beeswax (BW), and rice bran wax (RBW). With the help of these oleogels, cookies are were prepared and were compare with each other. The noval oleogel of gelators MAG and RBW are demonstrate to be a healthy alternative of the shortening. The cookies of MAG and RBW shows similar porous structure, hardness, standard colour and crispy texture. Oleogel with MAG and RBW shows very good rheological properties same as similar to the shortening. compare to BW and RBW shows higher crystal content shows lower cookies hardness whereas SSL and MAG with no content result lower cookies hardness. The sensory score of the cookies prepared by RBW, MAG and shortening are 4.3, 3.9 and 4.1 respectively. This shows the best gelator for preparing cookies was shows by RBW.

Short bread cookies was prepare by **(Paciulli et al., 2020)** with different fat replacement is obtain (0,20,40 and 50%) using emulsion filled gels based on insulin and extra virgin olive oil and studies for 60 day storage. Increasing in the amount of emulsion filled gel in shortbread cookies shows that higher water availability, higher volume, harder texture, darker color and low-fat content, presence of insulin involve in Maillard reaction. The role of state of lipid and water on cookies are reflected by the thermal and H-NMR parameter. During storage, stable result shows by the cookies regarding rancidity, color and dimension, only little change in the texture, it become soft due to the retain in the moisture among the cookies component. Emulsion filled gel valuable ingredient to replace fat in the shortbread cookies.

Another research shows that the cookies which is prepared by high oleic rapeseed oil used to prepared oleo gel by using different wax such as (yellow and white beeswax, rice bran and canelilla) , monoacylo glicerols and ethyl celullose. Obtained oleo gels having different significant then palm oil in terms of texture and viscosity. The dough with oleo gel and oil shows less plastic nature compare to palm oil and similar to monoacyloglicerols. Oleo gels shows smallest density and ethyl celullose shows highest density. It was found that even oleo gel having small amount of liquid phase in biscuit matrix better than others and similar then palm oil **(Onacik-Gür & Żbikowska, 2020).**

Researcher **(Milićević et al., 2020)** prepare a cookies by using the by- product from grain processing industry that is wheat and oats. These wheat and oats used in the form of gel at different levels of 30%-50%. The fat replacement of cookies is

compared with the cookies having full fat. The fat reducer results in increase in the dough hardness and wheat oats result in decrease in water availability and fat content. Due to a lack of free water, the gluten network has not grown significantly. Decrease in the diameter of the cookies with increase in the fat replacers that is wheat and oats gels due to increasing in elasticity of the gel containing dough. Color shows in crease in the L* value and decrease in a* and b* in the both cases. Based on the result the fat substitution up tp 30% does not show any desired effect on cookies.

Gharaie et al., (2019) studies that gum tragacanth oil structuring agent used to prepare cookies with different composition (1.5, 1.7,1.9, 2.1 per 100g) with sesam oil with oil phase were utilized to prepare oil/gel as a fat subtitue in cookies dough. These oil and gels shows shear-thinning behavior. Based on the result 1.5 and 2.1 these oil / gel are selected for the replacing shortening at different level such as 25, 50, 75 and 100 per 100 g in the dough formulation, lower level of oil/gel such as 25 and 50 shows high elastic and loss moduli as compare to shortening where as the higher level of oil/ fat content result lower value. Cookies sample prepared with oil/gel contain 1.5/100g gums retain softer structure during storage. Over all result shows, 50/100 g of shortening with oil/gels containing 1.5 /100 g of gums tragacanth may be the alternative for the healthier product.

Zbikowska et al., (2018) reduces the fat content in shortcrust biscuits by using gels and without gels or powder of microcrystalline cellulose (MCC), the biscuit is also enriched with psyllium. The replacing between 25% to 75% was proven to effect physical and sensory characteristics. Replacement of 25% fat with powder of MCC is most effective. Product is highly graded as a part of sensory evolution and shows optimum physical properties, by the adding of psyllium contain MCC with 2-5% increase its hardness and reduces the sensory properties. After comparing the result of different composition of fat replacing 25% of fat with MCC may recommended in shortcrust biscuits.

New solution to reduce the fat content was found by **(Sadowska-Rociek & Cieślik, 2019)** by using inulin and pectin gels in different proportion 10-40% in classic shortbread biscuit change the of 3-monochloropropane-1,2-diol ester (3-MCPDE) and glycidyl ester (GE) levels. Experiment shows that endogenous is formulation of 3-MCPDE when the insulin is higher than 10% due to higher amount of maillard product formed in the biscuits, but after two month the level is decreases as compare to the shortening. Pectin did not explain such phenomenon due to presence of bound water in gel. Glycidyl easter were decompose during baking and storage, by adding in pectin gel which cases low stability of Glycidyl esters resulting in occurring galacturonic acid in pectin.

Conclusion

Fat are very important in bakery product gives better structure and good mouthfeel, due to presence of triglycerides it can cause various disease such as cardiovascular and various chronic disease due to presence of trans fat, so it is important to remove the fat from bakery product. Now a day, novel ingredient used to remove the fat such as oleo gel, emulsion gel and hydrogel. These fat replacer shows similar characteristic as compare to traditional fat (Shortening and margarine) used in bakery and shows approximate similar baking characteristic and remove the fat successfully and make the product healthy and effective.

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