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Potential Use of Fat Replacers for Development of Functional Food of Animal Origin

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Abstract

Fat replacers are the substances which provide the health benefits to the consumer by reducing the incidence of cardio-vascular diseases. Fat replacers may be either carbohydrates or protein based and used singly or in combination in the products. Today's consumer is very demanding and choosy for their nutritional requirements and mostly preferred the food items having low fat, low salt, fibre rich and antioxidative properties. So this review explained the importance of fat replacers in milk and meat products with their brief classification, present status and role.

Keywords: Fat replacer; Fat mimetics; Fat substitute; Low calorie fat; Meat products; Milk products.

Introduction

Fat is a very important ingredient contributing to the texture, flavor and overall perception of cookies. Fat shortens a dough by weakening its gluten network, resulting in the baked product being softer, breaking easily and having a more tender mouth feel. Fat can trap air during beating and mixing, producing a batter that consists of masses of tiny air bubbles trapped within droplets of fat (Zoulias et al., 2002). Fat also imparts richness and tenderness, improving flavor and mouth feel to processed meat products (Pareyt and Delcour, 2008). However, an excess of energy intake and the consequent high amount of fat (especially saturated fat) is associated with health disorders such as obesity, cancer, high blood cholesterol and coronary heart disease (Akoh, 1998). In fact, the total fat content should not be higher than 30 percent of the daily energy intake.

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Saturated fats should not be more than 10 percent and monounsaturated and polyunsaturated 20 percent of the total energy intake (USDA, 1999). Red meat like mutton, carabeef and beef contain more saturated fat than that of white meat like rabbit and chicken meat. Many meat based snack products are also now marketed with "fat free" slogans, (97-98% fat-free) and in fact, most have been low in fat since their early development. The flavor intensity, juiciness, and tenderness of meat products are directly correlated with fat content and that reducing fat content reduces overall acceptability (Brewer, 2012). Reducing the fat content of ground beef to 10% often results in a cooked product that is bland and dry with a hard, rubbery texture (Keeton, 1994; Youssef and Barbut, 2010). When the total fat content is reduced, optimizing the remaining fat content and cooking parameters to produce a good quality finished product are necessary to meet consumer expectations and ultimately result in consumption of lower fat, lower calorie products.

Fat replacers are substances of carbohydrate or protein nature which can imitate the functional and sensory properties of fat without increasing caloric intake (Lindsay, 2000). They need to be able to replicate all or some of the functional properties of fat in a fat-modified food. The fat in foods can be lowered by simple techniques such as dilution with water or substituting with ingredients such as fruit purees or with use of compounds developed by food technologists (Ruthig et al., 2001).

Fat replacer are those substances which take place of all or some of the fat in a food and give the food a same texture, taste, juiciness and mouthfeel to the original full- fat food. Fat provides some essential functions in the food like carry the fat soluble vitamins (A, D, E and K), act as a precursor of prostaglandin and it is the source of essential fatty acids linoleic and linolenic acids. Various health organizations have recommended lowering of daily intake of dietary fat to an average of 30% of total calories, consuming less than 300 mg of cholesterol per day and limiting saturated fat to less than 10% of total calories (Matulis et al., 1995).

The AHA (American Heart Association) recommends that those with elevated LDL cholesterol levels or cardiovascular disease restrict saturated fats to <7% of calories. To achieve a more healthful dietary pattern, current dietary guidelines recommend increasing intake of fruits, vegetables, and grains and modifying the type and amount of fat consumed (Krauss et al., 2000; Wylie-Rosett, 2002). The high intake of fat is highly associated with certain diseases like obesity, high blood cholesterol level, cancer and coronary heart disorders. But reduction of fat content leads to a firmer, rubbery, less replaced in food products by traditional techniques such as substituting water (Chronakis, 1997) or air for fat, using lean meats in frozen entrées (Hsu and Sun, 2005), skim milk instead of whole milk (Zalazar et al., 2002) in frozen desserts (Specter and Setser, 1994) and baking instead of frying (Haumann, 1986) for manufacturing or preparing snack foods.

Classification of fat replacer

Basically fat replacers are categorized into three categories:

1. Fat Mimetics
2. Fat Substitutes
3. Low Calorie fat

1. *Fat Mimetics*

Fat mimetics are defined as a partial replacement for fat by mimicking or imitating a particular function, but not all functions of fat in a food. They are commonly carbohydrate and protein based fat replacer.

- Carbohydrate based fat replacer included guar gum, polydextrose (litess), gum Arabic, xanthum gum, carrageenan, modified food starches, cellulose, oat fiber and wheat fiber. They all are non caloric sources.
- Protein based included simplesse, trailblazer, and zein protein.

In those the guar gum is extracted from leguminous seeds and xanthum gum by aerobic fermentation of *Xanthum campestris.* Carrageenan is extracted from red sea weed *Chondrus crispus* (Irish moss).

Simplesse is obtained from white egg protein and milk protein. Trailblazer is from white egg protein & serum protein mixed with xanthan gum.

2. *Fat Substitute*

They are basicly fat based fat replacer which have the properties of fat and oils but are not absorbed or metabolised by the body. They commonly included Olestra, Sorbestrin and Esterified propoxylated glycerol esters (EPGs).

a. *Olestra*

Olestra made from highly unsaturated fatty acids is liquid at room temperature; olestra made from highly saturated fatty acids is solid (Harrigan

and Breene, 1989). Olestra has a zero calorific value because it neither digested nor absorbed by the gastric or pancreatic enzymes. Due to no absorption it is totally excreted out the high cholesterol from the body and plays a main role in reducing the cholesterol level in hypercholestrimic patient. But there are some side effects of olestra in some people like it reduces the absorption of fat soluble vitamins in the body, produces abdominal cramps and loose stools. It is mainly used in the preparation of savory snacks such as potato and corn chips, cheese puffs and crackers and for frying of savory snacks (Akoh, 1998; Cooper et al., 1997; Peters et al., 1997]. Some people eating large amounts of olestra snacks may experience common gastrointestinal tract symptoms such as stomach discomfort or changes in stool consistency, similar to symptoms accompanying other dietary changes but these symptoms present no health risks (Akoh, 1998; Cooper et al., 1997]. As a result, the Food and Drug Administration (FDA) requires that food containing olestra be labeled with the statement: "This Product Contains Olestra".

b. *Sorbestrin*

Sorbestrin is the mixture of tri-, tetra-, and pentaesters of sorbitol and sorbitol anhydrides with fatty acids. The caloric value of sorbestrin is 1.5 kcal/g. It is commonly used in salad dressings, baked goods, and frying (Lucca and Tepper, 1994).

3. *Low Calorie Fat*

They generally included medium chain triglycerides (MCT), caprenin and Salatrim. The caloric value of them is slightly lower than 9 kcal/g.

a. *Caprenin*

Caprenin (caprocaprylobehenic triacylglyceride), (The Procter & Gamble Co.), is manufactured from glycerol by esterification with caprylic (C8:0), capric C10:0), and behenic (C22:0) fatty acids (Costin and Segal, 1999). behenic acid is only partially absorbed and capric and caprylic acids are more readily metabolized than other longer chain fatty acids, caprenin provides only 5 kcal/g (Akoh, 1998; Lucca and Tepper, 1994). Caprenin, in combination with polydextrose, was commercially available briefly in reduced-calorie and reduced- fat chocolate bars (Sandrou and Arvanitoyannis, 2000). Caprenin's functional properties are similar to those of cocoa butter (Lipp and Anklam, 1998). As a result, caprenin is suitable for use in soft candy and confectionery coatings (Lucca and Tepper, 1994).

b. *Salatrim*

Salatrim is a randomized triglyceride containing short and long chain fatty acids. The short chain fatty acids are acetic, propionic and butyric, while long chain fatty acids include stearic acid. The stearic acid and other long chain fatty acids are poorly absorbed. The calorific value of salatrim is about 5 kcal/g. It is commonly used in chocolate-flavored coatings, deposited chips, caramels and toffees, fillings and inclusions for confectionary, peanut spread and dairy products such as sour cream, frozen dairy desserts, and cheese (Lucca and Tepper, 1994; Kosmark, 1996).

Present status of fat replacers

Market for fat replacers will reach 280,100 MT with an annual growth rate of 6.03% predicted between 2011 and 2015. Meat industry is the largest recipients of fat replacers because low calorie and reduced-fat foods such as low-fat meat products are gaining huge popularity in these markets. The carbohydrate and protein based fat replacer continue lead the market of fat replacer that offer dietary and processing benefits to the consumers.

Role of fat replacer in meat and meat products

In case of red and white meat, the red meat contains more than 2.64 times of saturated fatty acids so the risk of certain type of disorders are mainly related with juicy product with dark color and more cost (Trout et al., 1992; Cavestany et al., 1994; Keeton, 1994; Paneras et al., 1996; Desmond et al., 1998; Kirchner et al., 2000). So for reducing the fat, use of fat replacer is a best option to maintain the quality and acceptability of products. The lot of work was done on the use of fat replacer in meat and meat products and in production of low fat meat products.

In the early 1990s, work on acceptable reduced and low-fat sausage systems used added water and carrageenan to low-fat sausages containing 8% fat without deleterious effects on lipid or color stability (Bradford et al., 1993). A year later, Osburn and Keeton (1994) developed acceptable low-fat prerigor pork sausages, containing 10% fat, with 10–20% konjac flour gel. Carrageenan was used in the preparation of low fat frankfurter (Foegeding and Ramsey, 1987) and in pork nuggets (Berry, 1994) as a fat replacer. Carrageenan in pork nuggets increasing cooking yield and in the preparation of meat patties carrageenan reduced the fat as well as calorie content of product. Some workers observed that guar gum increases the emulsion stability by providing thickening and gelling properties.

Barbut and Mittal (1996) found that in cooked low fat sausages, fat content decreased by 52–60% and moisture content decreased by 61-65% by use of carboxymethyl cellulose (CMC) as fat replacer.

Choi et al. (2012) used a Surimi like material (SLM- 20%) as a fat replacer in pork patties, obtained from longissimus dorsi muscle which reduced fat upto 1.76% as well as improving the organoleptic properties, tenderness and overall acceptability. The synthetic fat replacer olestra has also a role in meat industry as a frying medium for preparation of prebrowned meat items.

Berry (1997) used combination of sodium alignate and modified tapioca starch with 7 and 14 percent added water levels and observed increase in juiciness, tenderness and cooking yield of low-fat (<10%) beef patties. The role of sodium alginate as fat replacer was studied by Kumar et al. (2007) in the processing of low fat ground pork patties. Sodium alginate reduces the cholesterol content as well as calories and improved the shelf life of pork patties. Bhat et al. (2017) also reported that well accepted functional chicken cutlets could be prepared by incorporation of 3% mango peel powder without any adverse effect on sensory attributes.

Nisar et al. (2009) evaluated the efficacy of tapioca starch as a fat replacer in low fat buffalo meat patties and concluded that the low-fat buffalo meat patties incorporated with tapioca starch had higher cooking yield, better dimensional parameters and substantially higher scores for sensory attributes in comparison to the other low-fat buffalo meat patties and high-fat control patties. Ground poppy seeds upto 20% level was incorporated in meat burgers as a fat replacer which decreases saturated fatty acids as well as cholesterol content in meat burgers (Gök et al., 2011). Park et al. (2000) also observed the improvement in cooking yield, textural and sensory properties of low-fat pork patties (10%) with the incorporation of various hydrocolloids (Sodium alignate, Carboxy Methyl cellulose and Xanthan gum). The amorphous cellulose gel was used as fat replacer in fermented sausages which replaced the pork back fat and reduced the cholesterol content from sausages (Campagnol et al., 2012). Goswami et al. (2019) also reported significant ($p < 0.05$) increase in cooking yield of carabeef cookies incorporated with different levels of plum pulp powder as fat replacer.

Role of fat replacers in milk and milk products

Roland et al. (1999) examined the effects of individual fat replacers on the physical and sensory properties of fat-free ice cream. Ice creams (≤0.5% milk fat) were formulated with maltodextrin, milk protein concentrate, or polydextrose. The sensory analysis panel scored maltodextrin as best overall as a single fat replacer in fat-free ice cream. These results suggest the need for development of fat replacer blends to optimize quality of fat-free frozen desserts.

Two protein-based fat replacers (Simplesse® D100 and Dairy-Lo®) and two carbohydrate-based fat replacers (Stellar™ 100X and Novagel™ RCN-15) was used in the development of low fat mozzarella cheese. Distribution of the fat replacers within the cheese was influenced by the extent of microparticulation of the fat replacer, size of the fat replacer particles, and processing steps that caused an interaction between the fat replacer and the caseins in milk (McMahon et al., 1996).

The textural, melting and sensory properties of low-fat fresh kashar cheeses (70% fat reduction) produced by using two protein-based fat replacers (1.0% w/w Simplesse® D-100 and 1.0% w/w Dairy-Lo™) and one carbohydrate-based fat replacer (5.0% w/w Raftiline® HP) were examined during the storage period for 90 days. The results indicated that Simplesse® D-100 and Raftiline® HP can improve the texture and sensory properties of low-fat fresh kashar cheese (Koca and Metin, 2004). As per Anita et al. (2018), citrus fruits and their by products could be used as efficient fat replacers for development of different functional dairy as well as meat products.

Ohmes et al. (1998) demonstrated the importance of fat as flavor modifier and the importance of certain fat replacer as aids in improving texture and determined the relative effects of milk fat, nonfat milk solids, or each of three whey protein type fat replacers on the flavor and texture attributes of vanillin-flavored ice cream.

Conclusion

The demand of animal products is increased with a frequent rate and hugely among all age group consumers. The red meat is a good source of iron, zinc, phosphorus and other minerals with richest amount of various vitamins. But the red meat contains 2.64 times more saturated fat than white meat so there is greater risk of certain types of major diseases. Similarly the fat content of certain types of milk products is also very high from health point of view. The fat percent of cheese, ice-cream, whole milk, butter etc. is much higher that is mostly replaced by combination of one or two

or more fat replacers because no single fat replacer provides all the beneficial properties. These fat replacers improved the functional as well as sensory properties of milk and meat products and enhanced the shelf life.

The guidelines recommended that daily dietary fat intake should be less than 30% of calories and saturated fats to <10% of total energy intake. So for these dietary goals consumer are selected the food containing low fat like lean meat, poultry and fish, low fat or non fat dairy products, dressings, steamed products etc. for regulating the body cholesterol and fat. The diet is modified with the incorporation of fat replacers and certain functional ingredients for reducing the prevalence of various major diseases. Fat replacers are improved the sensory attributes like texture, flavor, aroma, color and appearance, mouth coating etc. as well as the perishability and functionality of products are also enhanced. Due to presence of so many valuable qualities in fat replacers, the market value for these fat replacers and low fat milk and meat products increase with a very fast rate among the younger generation.

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