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Uses and Nutritional Impact of Fat Reduction Ingredients

For more than a decade, Americans have heard a consistent message to reduce the amount of fat they eat. A host of government reports and recommendations including the Surgeon General's *Nutrition and Health* report, the National Academy of Science's *Diet and Health* report, *Healthy People 2000: National Health Promotion and Disease Prevention Objectives*, and the Dietary Guidelines for Americans agree with advice from health organizations such as the American Heart Association and the American Cancer Society to reduce the amount of dietary fat. To help reduce the risk of chronic disease such as coronary heart disease and some types of cancer, Americans should consume less than 30 percent of calories from fat. No more than one-third of fat calories should come from saturated fat.

Data from Phase 1 (1994-1996) of the most recent National Health and Nutrition Examination Survey (NHANES III) appear to indicate that Americans may have moved closer to meeting this goal. Average fat intake is estimated to be approximately 34 percent of calories, down from approximately 36 percent in 1976-1980[1]. Intake of saturated fat has decreased to approximately 12 percent of energy intake in the population.

A closer look at these data, however, suggests that the news is not so positive. Average absolute fat intake has increased from 81 to 83 grams per day. Average total caloric intake has increased even more, from 1,989 to 2,153 calories per day. On the basis of these data, the reported drop in the percentage of calories from fat appears to be the result of the intake of more calories instead of a reduction in absolute fat intake. Reducing the percentage of calories from fat by increasing caloric intake is not recommended because of the link between excess calories and obesity, another risk factor for chronic disease. Americans have reduced the percentage of calories that come from fat in our diets, but we are not eating less fat.

It has also been suggested that dietary intakes were more accurately measured in NHANES III than in previous surveys and that Americans' fat and caloric intakes have actually changed very little over time. Regardless of the reason, however, the fact remains that most Americans would benefit from reducing their fat intake. To help Americans reduce their amount of dietary fat, in 1990 *Healthy People 2000* called upon food manufacturers to double the availability of lower-fat food products by the year 2000 [2]. That goal was quickly met. On average, more than 1,000 new lower-fat and fat-free products have been introduced annually since 1990. Similar to food products in general, not all of these new products succeed in the marketplace [3].

Many of these products are the result of the innovative use of both standard and more recently developed food ingredients whose attributes replace the specific attributes of fat. This IFIC Review provides a detailed look at these ingredients: what they are, how they work, how they are approved for use in the U.S. food supply, and the role of lower-fat foods in a healthful diet.

The Function of Fat in Foods

The fat in foods plays a key role in determining texture and taste, which affect a food's acceptability. For example, fat helps provide the smooth texture of a salad dressing, the creamy mouth feel of ice cream or chocolate, the moist, tender texture of a cake, and the rich flavor of cheese.

Reducing the fat in foods while preserving taste and texture has been a major challenge. By using ingredients that mimic the functions of fat in foods or by using modified fats that are only partially digested and absorbed or not absorbed at all, manufacturers have begun to master this challenge. Because fat serves different functions, the task has called for a variety of strategies and ingredients.

Types of Fat Reduction Ingredients

The content of fat in some foods may be reduced by removal, as in the production of low-fat or fat-free (skim) milk or in the trimming of fat from meats. In general, however, fat plays an integral role in foods. Simply removing it can detract from the palatability and acceptability of a food.

Some ingredients that replace fats are combinations of common food constituents (water, carbohydrate, or protein) that achieve the desired texture and taste in a reduced-fat product.

In fact, achieving fat reduction can be the result of the use of several ingredients and processing techniques in combination or the use of a single ingredient used as a one-for-one substitute for fat, as is the case with the fat replacer olestra.

Types of Fat Reduction Ingredients

Type of Ingredient	Ingredient
Carbohydrate based	carrageenan, cellulose, gelatin, gellan gum, gels, guar gum, maltodextrins, polydextrose, starches, xanthan gum, modified dietary fibers
Protein based	whey protein concentrate
Fat based	Caprenin, Salatrim, mono-and diglycerides, olestra

Table 1

Fat reduction ingredients may be classified into three categories: carbohydrate based, protein based, and fat based. Table 1 provides a list of fat reduction ingredients divided according to this classification. The following discussion provides an overview of each category.

Carbohydrate-Based Ingredients. Various carbohydrates are used in reduced-fat food products to produce the texture that fat normally provides. Historically, carbohydrates such as starches and gums were commonly used in foods as thickening agents to supply texture. Today, carbohydrates continue to play key roles as thickeners, bulking agents, moisturizers, and stabilizers in foods including lower-fat and fat-free baked goods, cheeses, frozen desserts, gravies, processed meats, puddings, salad dressings, sauces, sour cream, and yogurt.

The modified food starches maltodextrins and dextrins absorb water, thereby forming gels that mimic the texture and mouth feel of fat. Polydextrose, a glucose polymer, acts as a bulking agent to replace some of the volume lost when fat or sugar is removed from a food. It also helps keep food moist. Gums provide a creamy mouth feel and help stabilize emulsions as in pourable salad dressings and low-fat spoonable dressings. Cellulose gel is a purified form of cellulose ground into microparticles that supply mouth feel and flow properties similar to those of fat for products such as frozen desserts, sauces, and salad dressings. Algins such as sodium alginate and calcium alginate can also be used as part of a fat reduction process. None of these carbohydrate-based fat reduction ingredients can replace the oils used to fry foods.

Compared with traditional fats, which contain 9 calories per gram, carbohydrate-based ingredients provide 0 to 4 calories per gram, depending on the ingredient. Because it is a carbohydrate, dry maltodextrin provides 4 calories per gram. When it is hydrated, however, its caloric density drops to 1 to 2 calories per gram of the finished product. Other carbohydrates, such as cellulose and xanthan gum, are digested by bacteria in the lower intestine and contribute negligible calories.

Protein-Based Ingredients. Some protein based ingredients are made through processes that give certain fat-like textural properties to proteins. Proteins are heated and blended at high speed to

produce tiny protein particles that feel creamy to the tongue. This is called *microparticulation*. In addition to simulating the mouth feel of fat, protein-based ingredients can also help to stabilize emulsions in sauces, spreads, and salad dressings to help retain moisture in foods. Sources for protein-based ingredients include soy, whey, and egg white.

Protein-based fat reduction ingredients can be used in a variety of products including cheese, butter, mayonnaise, salad dressings, frozen dairy desserts, sour cream, and baked goods. Like carbohydrate-based ingredients, they cannot be used as substitutes for oils used for deep-frying. These ingredients are fully absorbed, and their caloric contributions range from 1 to 4 calories per gram, depending on the degree to which they are hydrated.

Fat-Based Ingredients. Some fat-based ingredients are actually fats tailored to contribute fewer calories and less available fat to the body. Others are structurally modified to provide no calories or fat.

As with other fat reduction ingredients, fat-based ingredients are highly versatile and can be used in a wide variety of foods including baked goods, cheese, chocolate, confections, margarine, salted snacks, sour cream, and spreads. In addition, some may be used to fry foods. Because these ingredients are made from fats, they have the same physical properties as fats, including taste, texture, and mouth feel. The caloric values of fat-based ingredients vary. Some fat-based ingredients such as olestra are not absorbed and thus contribute no calories. Others such as Caprenin and Salatrim contain higher proportions of long-chain fatty acids, which are only partially absorbed and short-chain fatty acids, which contain fewer calories per gram. The latter ingredients contribute approximately 5 calories per gram to the diet.

Digestive Effects

At expected usage levels, fat reduction ingredients are without digestive side effects [4,5,6,7]. However, like fiber and many other foods that we eat and that are not fully absorbed by the body, consumption of large amounts of fat-based and some carbohydrate-based ingredients may lead to common, temporary digestive effects. These effects result from the added bulk of these ingredients in the digestive system.

Approving Fat Reduction Ingredients for Use in Foods

Most of the ingredients currently used to modify the fat contents of foods are not new to the food supply. Before new ingredients can be used in food they must either be self-affirmed to be generally recognized as safe (GRAS) or approved for such use by the Food and Drug Administration (FDA) under a Food Additive Petition. The procedures used to gain approval for the use of an ingredient in the food supply are designed to ensure the safety of foods for consumers of all ages.

The majority of fat reduction ingredients currently used are considered to be GRAS. A substance that is GRAS is defined as one that is generally recognized by scientific experts to be safe for specific uses on the basis of an extensive history of use or on the basis of published scientific evidence. Sugar, salt, and many other common food ingredients are GRAS.

Affirmation of an ingredient as GRAS is obtained through a new petition to FDA. GRAS status may also be obtained by convening an independent panel of experts qualified to evaluate the substance's safety for its intended use. GRAS petitions for the use of Salatrim and Caprenin are currently under review by FDA. In the future there may be a modification to the process.

GRAS affirmations and Food Additive Petitions identify specific intended uses for the food ingredient. For a new ingredient, FDA may elect to allow only limited use of the ingredient in the production of a single food category such as savory snacks or ice cream. A petition may include a wide range of uses, but each use must be specified and evaluated. If further uses in other food categories are desired at a later time, manufacturers may need to file additional petitions.

On the Food Additive Petitions that manufacturers use to seek approval for use of new ingredients from FDA, manufacturers must provide extensive safety and scientific data regarding the intended uses of the ingredient. Once approval is given for its use in the food supply, FDA may allocate Acceptable Daily Intakes or recommended limits on

intake of the ingredient. Food labeling requirements may also be specified. Postmarketing surveillance or monitoring of the usage of the ingredient may also be instituted. To illustrate, recently, two ingredients, polydextrose and olestra, received approval through the Food Additive Petition process. Polydextrose was approved for use in 11 different food categories. Olestra (brand name Olean®), a fat-based fat reduction ingredient, received FDA approval for use in savory snacks and their flavors and fillings.

Role of Reduced-Fat Foods in a Healthful Diet

The advice to reduce the amount of dietary fat represents a cornerstone of existing dietary guidelines designed to promote health and well-being. Foods with lower fat contents can help consumers implement this advice as part of an overall healthful eating plan based on the consumption of a variety of foods in moderate amounts. Reduced-fat, low-fat, and fat-free foods expand the choices from which consumers may select to achieve a diet containing moderate levels of fat.

In its position paper on fat replacement ingredients, The American Dietetic Association (ADA) cites the potential of lower-fat foods to help Americans moderate their fat intake [8]. These options can help consumers achieve a lower-fat diet while preserving basic food selection patterns. This strategy may help decrease the degree of change necessary to accomplish dietary objectives. Many experts believe that behavioral change may be more sustained when required modifications are perceived to be small and gradual.

The American Diabetes Association's position statement, "The Role of Fat Replacers in Diabetes Medical Nutrition Therapy," states that the availability of ingredients referred to as fat replacers has enabled the creation of many reduced-calorie, light, fat-free, non-fat or low-fat foods to meet the consumer demand for good-tasting lower-fat foods [9].

Taste often influences food choices more than nutrition [10]. Consumption of good-tasting, fat-modified foods is among the most easily adopted and maintained strategies for following a lower-fat diet [11]. It has also been speculated that the use of lower-fat products that satisfy consumer tastes may help prevent the feelings of deprivation that may act as a barrier to the long-term maintenance of a lower-fat diet [12].

Experience with low-calorie sweeteners points to the role of intent or motivation in successfully changing eating behavior through the use of modified foods. Consumption of good-tasting foods reduced in calories with the use of the low-calorie sweetener aspartame may enhance compliance with modified diets as part of an overall plan to manage weight [13]. Similarly, consumption of lower-fat foods can be a part of an overall strategy to make small changes to reduce the amount of fat in the diet.

Food intake involves an interplay of sensory factors, the amount or volume of food consumed, and other physiological and psychological responses [14]. The presence of fat in food affects the flavor and hence affects sensory factors and initiates physiological reactions. Both of these phenomena influence the amount of food that a person consumes.

There has been considerable controversy regarding whether consumers will compensate for fat and

How Fat Replacers Can Help Reduce Fat and Calorie Intake

This sample menu shows the fat and calorie difference foods that contain fat replacers can make. Be savvy and sensible. Keep in mind that portion size still counts.

Regular Lunch

	Calories	**Fat** (grams)
2 slices bread	130	2
1 oz American cheese	105	9
2 oz bologna	180	17
1 tbs. mayonnaise	100	11
Banana	105	0
2 chocolate cookies *(30 grams)*	140	6
	760	45

Fat- Replaced Lunch

	Calories	**Fat** (grams)
2 slices bread	130	2
1 oz reduced-fat cheese product	75	4
2 oz fat-free bologna	40	0
1 tbs. low-fat mayonnaise/ dressing	25	1
Banana	105	0
2 reduced-fat chocolate cookies *(30 grams)*	120	3
	495	10

calories when consuming fat-modified foods. *Compensation theory* is the term used to describe eating behaviors that offset or provide a substitution for lost fat calories. Significant attention has also been given to the theory that consumers associate "fat-free" with "calorie-free" and thus may overindulge in high-calorie foods. This does not seem to be supported by the research.

Predictive Research

Several analyses indicate that the use of products with modified fat contents could help Americans achieve dietary fat recommendations. Lyle et al. calculated that average fat intake could be reduced to 30 percent of total calories, with accompanying decreases in saturated fat intake, if equal amounts of fat-free alternatives were substituted for seven food categories (cottage cheese, cream cheese, sour cream, salad dressings, frozen desserts, processed cheeses, and commercial sweet baked goods) [15]. Likewise, another analysis indicates that the use of Simplesse® in all potential applications could achieve positive results, for example, a decrease in energy from fat from 34 to 32 percent of total calories [16].

Using computer analysis, researchers at the University of Toronto predicted the impact of noncaloric fat replacers on fat intake among consumers who compensate by eating more food [17]. The model predicted that there would still be a net reduction in average daily fat intake, even though total caloric intake remained the same. This implies that among a population that has lower motivation to reduce fat or caloric intake, the use of fat-modified foods could have the positive effect of reducing the overall percentage of calories from fat.

The potential impact on caloric consumption depends on the situation. Lyle et al. calculated that caloric intake could be decreased by approximately 800 calories per week if fat-free foods in the seven food categories (listed previously) were substituted in equal amounts for full-fat versions of these foods [15].

Clinical Research

Numerous clinical studies suggest that lower-fat foods can facilitate a significant reduction of fat intake and, for some consumers, caloric intake. In a study of 29 children ages 2 to 5 (who regulate calories well), subjects compensated almost entirely for reduced energy intakes [18]. Studies of normal-weight young men (individuals who also regulate caloric intake well) showed that when fat was covertly reduced to 20 percent of calories, energy compensation occurred, although it was not complete compensation, nor was it fat specific [19]. Both the children and young men compensated by eating a variety of foods, so most of the caloric compensation came from proteins and carbohydrates, resulting in a net reduction in the percentage of calories from fat.

Covert studies of individuals who do not regulate calories well found that when foods with fat replacers are used in place of full-fat foods, there was a resulting decrease in the proportion of calories from fat as well as the total number of calories consumed [20,21,22,23,24]. This indicates that for people who need to manage their weight, fat replacers may be a useful mechanism in controlling the intake of both fat and calories.

It is unclear whether knowledge about a food's fat content can influence eating behavior. In one study, over a 24-hour period, women who knew that they consumed a low-fat food at breakfast ate more food at a later meal than those who knew that they consumed a higher-fat food at breakfast [25]. However, a longer, 10-day study looking at fat-free food consumed as a snack found that knowledge of the fat content had no meaningful effect on the amount of the snack consumed [26]. This study showed that across time, all groups consumed significantly fewer calories and less fat from their snacks when they ate fat-free snacks than when they ate regular snacks. Another study that examined the behavioral aspects of compliance with a low-fat diet among two groups totaling 44 women found that the women who were allowed to use products with fat reduction ingredients reported feeling less deprived because of the wider range of food from which they had to choose [11].

Free-Living Studies

Free living studies provide additional perspective on how fat-modified products influence fat and caloric intake. A prospective 10-week trial of 49 normal-weight free-living adults who purchased, prepared, and consumed their own foods at home

found that those who used reduced-fat foods in place of full-fat foods lowered their overall fat intakes. Caloric intake remained the same. Not surprisingly, body weight did not change in either the reduced-fat group or the control group because subjects in both groups were of normal weight [27].

In a 6-month study that tracked 217 free-living, nonobese men and women who received either reduced-fat or full-fat products, the subjects in the reduced-fat group consumed fewer calories and did not gain weight. However, the full-fat group showed both an increase in caloric intake and weight gain [28]. In a similar 3-month trial, the study subjects consumed a full-fat diet and gained weight, whereas those who consumed foods made with a fat replacer did not [29].

Population Studies

Research to date is very suggestive that fat modified products play a positive role in helping consumers improve their diets. Analysis of data from the 1995 *Continuing Survey of Food Intake by Individuals* (CSFII) show that adults who used fat-modified foods consumed less fat as well as less energy. In fact, those persons who obtained less than 30 percent of calories from fat consumed more fat-modified products than those who obtained more than 30 percent of calories from fat [30, 31]. Importantly, the CSFII data suggest that the more fat reduction strategies people use (consumption of reduced fat products, leaner meat, or lower-fat milk) the higher the nutritional adequacy or nutrient density of their diet [32]. Furthermore, portion size did not differ between people who use reduced-fat products and people who use a full-fat alternative. Further short- and long-term studies with free-living populations will help clarify the effects of fat-modified foods on the intake of fat and calories.

Reading the Label

The Food and Drug Administration and the U.S. Department of Agriculture have set specific regulations on allowable product descriptions [33]. The following claims are defined for one serving:

Fat Free . . . . . less than 0.5 gram fat
Low Fat. . . . . 3 grams or less of fat
Reduced or Less Fat. . . at least 25% less fat*
Light. . . . . . one-third fewer calories
or 50% less fat*

**Compared with a standard serving size of a traditional food.*

Conclusion

The advice to reduce the amount of dietary fat represents a cornerstone of existing dietary guidelines designed to promote health and well-being. As part of a balanced eating plan that features recommended amounts of grains, vegetables, fruits, milk, meat, and meat alternatives, fat-modified foods can be useful tools in helping to implement this advice. Products lower in fat expand the food choices from which consumers may select to help bring diets in line with dietary guidelines.

To characterize fat replacers as a magic formula for weight loss is to misrepresent their optimal role. Such unrealistic expectations have fueled criticism of fat replacers' impact on the American diet. In fact, fat replacers contribute to a healthy eating plan by helping to create and sustain energy balance and by broadening the scope of food choices consistent with reduced fat intake. Fat replacers can help manage calories—both in weight loss and in weight maintenance efforts—and are just one aspect of a healthful plan that includes physical activity as well as increased consumption of fruits and vegetables.

Clearly, there is a role for individual responsibility in the appropriate use of reduced-fat, low-fat, and fat-free foods in a healthful diet. Additionally, health professionals can play a key role in helping consumers understand how to use lower-fat foods to help achieve dietary recommendations for fat intake within a well-balanced diet that features recommended amounts of a variety of foods and that matches individual caloric needs.

It is still too early to tell what the impact of fat-modified foods will be on the U.S. population. At this time, not enough Americans use them consistently and as one-to-one substitutes for full-fat foods to see a meaningful impact across the population. As more and better fat-modified products enter the market, their taste, cost, and convenience will determine how much they shape Americans' everyday eating habits.

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Myths and Facts about Dietary Fat and Lower-Fat Foods

As with any popular topic, there are a lot of myths about dietary fat and lower-fat foods. Test yourself to see if you know the facts about these common beliefs.

- ***Myth:*** *Americans have successfully cut the amount of fat in their diets.*
  Fact: We're not actually eating less fat, but surveys do indicate we have reduced the percent of calories that come from fat in our diets. That's because calorie intake has increased while fat intake has remained the same. To meet dietary goals, we still need to cut back on fat.

- ***Myth:*** *Reduced-fat foods are always low in fat.*
  Fact: These foods are lower in fat than their full-fat counterparts, but that doesn't necessarily mean they are "low-fat." To know the facts, read the nutrition label and compare the fat content of two similar products.

- ***Myth:*** *Fat-free and lower-fat foods are the solution to obesity.*
  Fact: These foods can help manage the amount of fat and calories we eat, but successfully losing and maintaining weight depends on using more calories than are consumed. To lose weight, you need to take in less energy (eat fewer calories) and expend more energy (burn calories) through physical activity. The most effective way to keep lost weight off is to stay active. When using lower-fat and fat-free products to help manage weight, eat a well-balanced diet that includes plenty of fiber. Fiber adds volume without adding calories and can help produce a feeling of fullness after a meal. Eat plenty of whole grain foods, vegetables and fruits for a fiber-rich diet.

- ***Myth:*** *Americans are getting fatter because they are overeating fat-free and low-fat foods.*
  Fact: Obesity occurs when more calories are consumed than used. Lower-fat, lower-calorie foods can help cut total calorie intake when used as part of a well-balanced and calorie controlled diet. Further, no scientific data implicate overconsumption of low-fat foods as the cause of consumers' weight gain. Studies show that people who use these products eat about the same amount as those eating regular products. Other research shows that people who consume fat- and calorie-reduced foods have a more nutritious diet than those who do not. Increased physical activity also plays an important role in weight maintenance. In addition to burning calories, increased activity benefits overall health in many ways such as disease prevention and stress reduction.

- ***Myth:*** *Low-fat always means low calorie.*
  Fact: Reducing the amount of fat in food doesn't necessarily mean the food is low in calories. While a product may be lower in fat, the calorie content may or may not be reduced compared to regular products. The Nutrition Facts panel on the label is the key to finding out the fat and calorie content of foods. Eat lower-fat foods in moderation just as you would a full-fat, full-calorie product.

- ***Myth:*** *Fat-free means taste-free.*
  Fact: Today's fat-free and low-fat products have greatly improved, although many of the first fat-free products on the market did not meet taste expectations. If certain fat-free products don't satisfy your taste buds, try low-fat versions. Slight adjustments can add up, and just a little fat can go a long way in adding both flavor and texture to a food. Think of skim milk versus 1% milk.

- ***Myth:*** *Not all calories are created equal.*
  Fact: A calorie is a calorie whether from carbohydrate, protein or fat. What is important is that your total calorie intake is balanced by calories used. However, research shows if you're eating excess fat calories, the calories from dietary fat are more easily converted to body fat. It's also important for both overall health and weight maintenance to balance your intake of protein, carbohydrate and fat.

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