Future Foods, Fats and Fads

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Introduction

Consumer demand for safety, good nutrition and especially good taste and texture are primary driving forces for new product development. Today, consumers are motivated to a very high degree for their foods to also deliver good health. This motivation has created an intense focus on fat and therein lies a major opportunity, as well as a challenge to the product developer.

All categories of foods have undergone an explosion of new low or no fat line extensions of the conventional or standard product (Figure 1). There has been intense development in the dairy category, whereby new dairy product introductions have but passed all other categories. A walk down the supermarket aisles will quickly convince the observer that there has been a flurry of activity in the development and marketing of fat reduced or "healthy" foods. This is true for bakery products as it is for other categories of food.

Figure 1.

Although many of the "healthy" foods on the shelves are relatively new, some have been on the market for some time. High fiber, calorie reduced breads have been marketed for 10 to 15 years and have become such a mainstay of sales of the baking industry that they are almost overlooked in the reviews of the developments of "healthy" bakery foods. You will note that I put the word "healthy" in quotes because some would argue that snack cakes, pies, cookies and pastries are not really "healthy" foods even if the calories have been reduced or fat/cholesterol removed. Perhaps a better term would be "healthier" since some negatively perceived components have been eliminated or reduced.

Federal Regulations

To obtain a perspective on altering fat composition, one should understand that dairy products is a category of foods that is highly regulated. Nearly all dairy products have a Standard of Identity, which generally has as its basis a minimal concentration of fat. To alter fat composition, particularly to decrease the fat composition of a standard dairy product, one is not allowed to use the usual or common name. Thus, whole new categories of standards need to be established or newly named to effectively translate the identity of the new product to the consumer.

For years, the cheese industry has balked at the restrictions that federal standards place on cheese production and marketing. For instance, minimal requirements for fat and moisture in the Standard of Identity for cheddar cheese do not allow labels to state "reduced fat cheddar cheese." In 1987, Kraft introduced a line of reduced fat cheeses to more fanfare than the company may have wanted. The Food and Drug Administration (FDA) did not act because the State of Wisconsin decided to take up the banner to oppose Kraft. Initially, Wisconsin officials withheld shipments but later quietly rescinded this action with a decision to allow the new products.

Other companies, most notably Dorman Roth Foods, have avoided confronting the standards by choosing other names and descriptions of their products. Dorman Roth, which has been selling "light" cheeses for several years, tiptoes around the issue by giving its products carefully chosen names like "Chedda Delite" and "Slim Jack".

There are a number of regulatory issues which must be considered in developing and marketing nutritionally modified food products. Federal regulations define reduced calorie foods as those products which have at least one-third less calories than the standard counterpart. The reduced calorie product must also not be nutritionally inferior. In some cases this will require

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the addition of vitamins and minerals to compensate for the reformulation. For example, if a baker normally purchases enriched flour and then replaces 2 to 30% of it in producing a high fiber, reduced calorie bread, additional nutrients will need to be added.

The Nutrition Labeling and Education Act of 1990 addresses the use of descriptors such as "lite" or "light" as part of the product name. The whole area of regulation is dynamic at the present time with this new Act and with FDA's food labeling initiatives.

Food labels and standards have been a matter of controversy for nearly a century. United States Department of Agriculture (USDA) personnel review every meat and poultry product label before it can be used and require an ingredient statement even if the product is covered by a Standard of Identity. In 1985, 143,000 labels were approved and 19,000 were disapproved. The FDA does not review labels nor does it require ingredient statements for standardized foods. Dietary cholesterol is present only in animal products. It is now widely accepted that a number of Americans should probably decrease their cholesterol intake. Current FDA regulations, however, are restrictive as to the inclusion of cholesterol information on product labels. The new proposed rules above would encourage the voluntary declaration of cholesterol and fatty acid contents on labeling to assist individuals in lowering their intake of these substances, should they so desire, as well as to assist those individuals who have been directed medically to modify their intake. Again, developing processing techniques for cholesterol removal would affect dairy products' labeling and standards, and, of course, consumer attitudes.

Proper market signals and information are just as important to consumers as they are to producers. Information on the label or as conveyed by Standards of Identity is a basic starting point for consumers wishing to exercise informed choice in the marketplace.

Processing Methods

The most basic and oldest processing method is cream separation. Ancient people are known to have used milk freely, and it is probable that they at times used cream that rose to the top of the milk that had been held for some time in containers, although there is little in ancient literature to suggest such use as common. It is well established that in early times, butter was produced by churning milk. Thus, in one of the oldest parts of the Bible occurs the statement, "surely the churning of milk bringeth forth butter." Separation of cream from milk is possible because of a difference in specific gravity between the fat and the liquid portion or serum. Whether separation is accomplished by gravity or centrifugal methods, the result is dependent upon this difference. An example of simply removing fat are products for an expanding market for all-dairy, sour cream alternative products with half the fat content of sour cream. The industry has responded, in some cases, by simply replacing the 18% butterfat cream ingredient in the manufacturing process with a 9% butterfat starting ingredient. Land O'Lakes, Inc. has pioneered this category with a dairy product that used proprietary processing in combination with cream, skim milk, and whey proteins to produce a product with less than half the butterfat content of traditional sour cream while still maintaining the taste and texture expected from a full-fat product.

The reduction or elimination of cholesterol is relatively simple in most bakery foods. Generally, it requires the replacement of animal fat with vegetable oils and the reduction or elimination of whole eggs.

The reduction or elimination of fat is somewhat more difficult in bakery products. However, a number of rather traditional ingredients have been shown to have fat-sparing or fat-like properties. These ingredients include modified starches, emulsifiers and gums. The replacement of the sensory properties of fat is more difficult in low moisture bakery foods like cookies and may explain why few fat reduced products are being marketed.

Fat reduction in meat products follows similar constraints as in formulated bakery products. Fat can be reduced and substituted for gums, emulsifiers and other vegetable proteins.

If one reviews the entire dairy case, basically all existing Standard of Identity dairy products technically can be produced in a lower fat alternative form. The next generation of fat substitutes, such as Simplesse™ or Olestra™, could offer the dairy industry even greater flexibility in product development. One excellent fat replacer that exists today and is a component of Simplesse™ is whey protein. Dairy proteins provide the opportunity to replace some of the fat in dairy products while still ensuring the product would qualify for the Real Seal®. The use of existing dairy proteins as ingredients that deliver functionality, nutritious protein, calcium, and a healthy image and that can be modified by new processing conditions will play an increasingly important role in future food products. Outside of the butter/margarine/spreads category, future fat replacers probably will have a minor impact on existing dairy products, because it is already possible to formulate dairy products into lower fat alternatives.

Several methods are currently being studied as a means of reducing fat and cholesterol in processed meats. Some are technically possible, but require regulatory changes before coming practically feasible.

A most promising method of reducing fat and cholesterol is through replacement of lean and fat meat with non-meat protein. In emulsified meats, addition of

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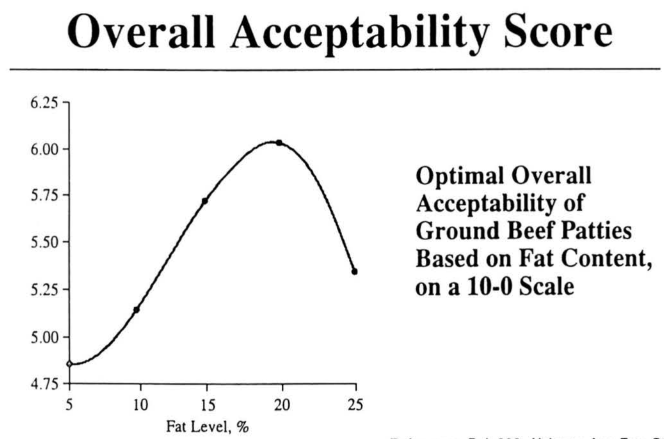
up to 3% of a non-meat protein enables the fat level of the emulsified meat to be reduced 10% or less. Huffman and Egbert at Auburn University performed extensive sensory evaluations finding that the fat level of 20% was broadly preferred (Figure 2). By substituting 0.125% carrageenan and 0.25% hydrolyzed vegetable soy protein (HVP) for 10% of the fat (90% lean), they could achieve equal preference to the full fat (80% lean) hamburger. With processed meat products at 30% fat, they could be reduced to 10% or less. Even the use of HVP alone or with other ingredients enables significant reduction in fat and cholesterol while minimizing palatability differences relative to the standard meat product.

Figure 2.



Reference: Bul. 606, Alabama Agr. Exp. Sta.

Fractionation

The art of fractional crystallization for the purification of fats on a commercial scale is a relatively recent innovation. Fractional crystallization is a thermo-mechanical separation process wherein component triacylglycerols of fats and oils are separated, usually as a mixture, by partial crystallization in a liquid phase. In the process, three successive stages are recognized: (1) cooling of liquid or melted triacylglycerols to produce nucleation, (2) growth of crystals to a size and shape that permit efficient separation, and (3) separation, isolation, and purification of resultant solid and liquid phases.

Several methods for the fractional crystallization of fats and oils currently are practiced on a commercial scale in combination with procedures and equipment to effect separation and isolation. Fractionation by thermal crystallization, steam stripping, short-path distillation, supercritical fluids, or crystallization can achieve fat alterations of significance to the dairy industry. Milk fat is a mixture of triacylglycerols of a range of molecular weights and degree of unsaturation, exhibiting a broad and variable range of melting points and other physical properties. Milk fat is an important component of most dairy products, but it has been consumed traditionally for the most part as butter.

Because the physical properties of milk fat influence the rheological properties of dairy products, especially butter, there has been considerable interest in the modification of milk fat by physical and chemical means. Economic fractionation of milk fat into oil and plastic fat fractions will facilitate an increased utilization of milk fat in many food applications such as chocolate, confectionery and bakery products, and in developing new convenient (spreadable) and dietetic (decreased cholesterol, fatty acid variable composition) butter or butterfat-containing products.

One industrial process in practice for the fractionation of milk fat is the Tirtiaux system, which is a semi-continuous bulk crystallization process. The Tirtiaux dry fractionation process enables one- and two-step fractionation of butteroil at any temperature ranging from 50°C to 2°C. The milk fat fractions thus obtained can either be used as such, or the fractions can be blended in several proportions for use as ingredients in various food fat formulations or for the use of preparing spreadable butter.

Fractionation by Steam Stripping or Deordorization

When margarine came into use as an economical substitute for butter, odorless and tasteless fats and oils became highly desirable. Carefully rendered bovine and porcine fats were relatively neutral in flavor. The flavor these fats possessed was sufficiently animal-like that at one time they were considered to be not too obtrusive as a butter substitute. Even today, some food processors use tallow as a frying fat, preferring the odor and flavor produced to that of a bland shortening. Vegetable fats, on the other hand, tend to have naturally strong flavors quite foreign to that of butter.

Steam deodorization is feasible because of the great differences in the volatility between the triacylglycerols and the substances that give oils and fats their flavors and odors. It is essentially a steam distillation whereby volative odoriferous and flavored substances are stripped from the relatively nonvolatile oil at temperatures below those damaging to the oil. The application of decreased pressure during the operation protects the hot oil from atmospheric oxidation, prevents undue hydrolysis of the oil by water, and greatly decreases the quantity of steam needed. However, the process results in a completely tasteless product.

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values were similar during the feeding trial. Blood ammonia values were about the same for the steers fed the 3 rations. Except for higher values on all steers for the initial samples, the values were similar during the experiment. These steers had been on pasture, and initial blood ammonia values averaged 0.72 mg/100 ml.

When larger amounts of urea were fed to the steers in Group 2, clinical signs of toxicosis were manifested. These were persistent belching (Fig. 4) and coughing, bloating, polyuria and kicking at their flanks as if there was abdominal pain. The urea fed steers would consume their allotted ration in 3 to 4 hours in contrast to 20 to 30 minutes for the steers fed the control or high soybean meal ration. When fed, these steers would eat as usual for about 10 minutes, then quit eating, shake their head, belch, cough, and manifest the clinical signs mentioned, especially bloating. In about 30 minutes, they would start eating again very slowly, nibbling and "nosing" the feed until they had it consumed in 3 or 4 hours. Two of the 4 steers fed the large amounts of urea were classified as chronic bloaters as they remained bloated several hours after they had been turned loose to exercise in a lot with all the steers. At times they were still bloated at their next feeding.

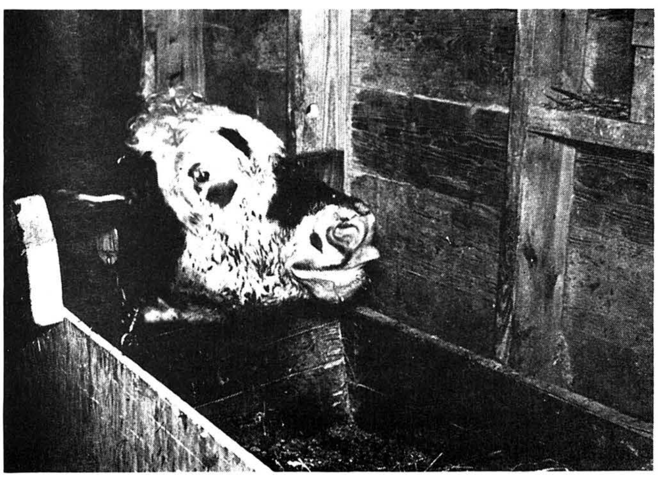

FIGURE 4. Belching and coughing in a bloated steer fed 450 gms urea/day in a high grain fattening ration.

At slaughter, the lateral-dorsal wall of the rumen of the 2 chronic bloaters was edematous with focal hemorrhagic areas. No other lesions were noted on gross or microscopic examination in any of the steers. Rib roasts were prepared from each steer, and on panel palatability tests there were no differences between the roasts from the urea fed steers and steers fed the other 2 rations. The carcasses all graded good to choice. These results were similar to previous studies in that no significant chronic injury could be demonstrated when urea was fed in large amounts for a period of time.[9] In the previous report, bloating was not a problem, and the same total amount of urea was fed. In this work the cattle were full-fed while in the earlier study they were fed limited amounts of feed. In pregnant cows, an experimentally produced toxicosis that was treated with acetic acid had no effect on pregnancy.[10]

Discussion

A variety of factors influence urea (ammonia) toxicosis, and these factors should be considered in interpretation of absolute values of blood ammonia and amounts that would be toxic. These include the amount consumed, adaptation, type of ration fed, and type of production. The most important single factor conducive to acute urea or ammonia toxicosis is a vigorous appetite in cattle not adapted to urea feeding. It is usually the cow or steer that is first to the feed and anxious to eat at the regular feeding time that is affected, and when allowed to the urea feed mixture it eats rapidly for 5 to 8 minutes. When the cattle are group fed, some dominant individuals will eat more than their share by pushing other cattle away. The palatability of urea and urea- containing rations varies and is unpredictable in cattle. In these acute trials and under practical conditions, some cattle came to a feed bunk and rapidly consumed a fatal amount of pure urea. In other instances, cattle would not eat a concentrated amount of urea even though it was mixed with molasses to "mask" the taste and feed had been withheld for 24 hours. When cattle consume a concentrated urea mixture slowly, they become sick and have mild signs of toxicosis such as belching, polyuria and bloating. They then quit eating and recover. Cattle, even mildly sick from an infectious or metabolic disease, will not usually eat a urea containing ration. The cattle feeder may observe that the steer that was so anxious to eat when fed is found dead near the feed bunk an hour or so,later. Ammonia, whether derived from the hydrolysis of urea or other compounds when present in small amounts in the blood circulatory system can be toxic to cattle. Blood ammonia increases of 1.0 mg/100 ml initiate clinical manifestations of toxicosis and increases of 2.0 to 3.0 mg/100 ml are usually fatal, having a toxic effect on the central nervous system. Thus it requires only a small amount of total ammonia to have deleterious effects on cattle health. The blood volume for cattle is given as 57 ml/kg body weight.[11] Thus, a 400 kg cow would have a blood volume of 22,800 ml. Theoretically, to increase the ammonia content of blood 2.0 mg/100 ml would require only 456 mg of ammonia to produce clinical signs of toxicosis and death. This amount of ammonia could be derived from 0.8 gm of urea. In previous reports it was concluded that the oral lethal dose of urea for cattle was about 0.5 gm/kg of body weight.[1,7] This amount was based on toxicity studies in sheep and in cattle when urea was given by drench, stomach tube or through a rumen fistula. Under field conditions, toxicosis occur under different conditions. In experimental methods of administration

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Figure 3.

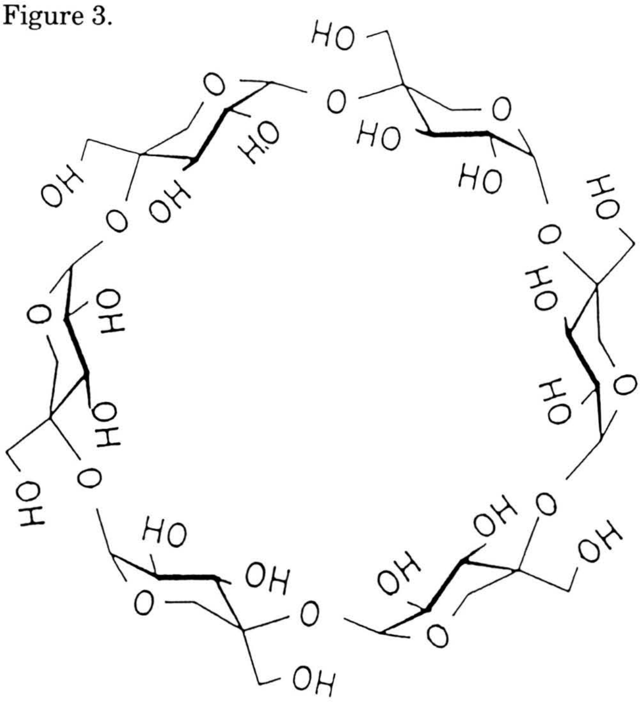

Fig. 1 Chemical structure of ß-cyclodextrin.

filtering of the insoluble dextrin from the substrate also removes the cholesterol.

A major shortcoming of an absorption process is the lack of general selectivity of similar components. For instance, many of the flavor and color components are removed from the milk fat and generally cannot be recovered efficiently.

Enzymatic Conversion

A hypothesis exists that the cholesterol reductase from *Eubacterium* species can be used to convert the cholesterol in fluid milk to products (primarily coprostanol and cholestanol) that are either poorly absorbed or completed unabsorbed in the human intestine and will, therefore, be excreted. Products from the chemical reduction of cholesterol are not carcinogenic. Conversation of cholesterol to chemically reduced and poorly absorbed compounds therefore should decrease the concerns of cholesterol-conscious people about consuming milk and other dairy products.

Currently, the work for extracting, purifying, and concentrating cholesterol reductase from species of *Eubacterium* is being performed by researches at Iowa State University. In addition to extraction of the cholesterol reductase, the University of Minnesota is working on genetically transferring the gene that provides the ability to specifically produce cholesterol reductase into a lactic dairy culture.

Fat Substitutes

Numerous fat substitutes have been developed, patented, advertised and marketed in the last few years. These substitutes can be categorized in three broad categories:

- Carbohydrate Based
- Protein Based
- Synthetic

The carbohydrate based substitutes are derivatives, modifications or pure form starch, polydextrose, dextrins, maltrins, cellulose gels, and oat fiber. Avicel™, the brand name for FMC's polydextrose, has been marketed for ten years as a bulking agent, but now also touted for its fat substitution properties. ConAgra licensed the USDA patented oat fiber substitute and is now marketing it under its trademarked name TrimChoice™. Other companies marketing a carbohydrate based substitute are Pfizer's Litesse™, Staley's Stellar™, and Hurcule's Slendid™.

Of the protein based fat substitutes, Nutrasweet's Simplesse™ has by far received the most public and industry attention. Simplesse™ comes both in a dry and wet form and it is either egg albumin or whey protein based, depending upon application. Kraft and Land O'Lakes have released only limited publicity on their protein based substitutes Trailblazer™ and Realean™, respectively.

For years there has been on and off publicity for Olestra™, Proctor & Gambles synthetic based fat substitute. Proctor & Gamble developed this "sucrose polyester" type substitute to have broad applications. When comparing to the carbohydrate and protein based substitutes, the synthetics have superior usage characteristics such as in frying applications, as well as in formulations. Other patented synthetics include EPG (Esterified propoxylated glycerol = Arco Patent), DDM (Dialkyl Dihexadecymalonate = Frito-Lay Patent), and TATCA (Trialkoxycarboxylylate = CPC Patent).

The main drawbacks for these synthetic fat substitutes are that they cause diarrhea and will absorb fat soluble nutrients (vitamins). The synthetics tend to lubricate the intestines, allowing rapid pass through of other food substances. Since these "polyesters" are not enzymatically digested, nor absorbed, they tend to carry out the fat soluble nutrients, thus potentially creating a deficiency situation.

Fiber

Back in the midst of the "1980's" the success of a food product virtually hinged on the word "fiber" or "oat bran". In fact, as recently as 1989, fiber had the same

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stature currently enjoyed by "low/no fat" claims. Today, although somewhat diminished in prestige, fiber is far from being a dead issue. This is because fiber has further proven functional properties of fat substitution, water binding and bulk building in fat reduced foods.

Still, not all fibers can achieve high fiber levels or low fat claims while maintaining traditional product quality in all food categories. Because taste and texture are paramount in creating a successful product, the fiber content of a particular food cannot be the only criteria for evaluation. Fortunately, current knowledge of fiber processing and purification combined with improved understanding of fiber's behavioral characteristics has made product designers better equipped to formulate successfully with fiber. The list of fiber sources is extensive and it includes cellulose products, hemicellulose, pectins, gums, lignin, and cereal brands. All can be modified to fit a particular food application.

Conclusion

If the dairy industry is to achieve any success in utilizing its abundant milk fat, technological modifications will have to be undertaken to improve milk fat's utility as a food ingredient of choice. In terms of surplus butterfat, it would be both practical and profitable to extract butter flavor and concentrate it. This product then could be used in pastries, cooking oils, breads, edible creams, and imitation dairy products.

Is the bakery category a "fad" market? Will these products endure and be relegated to a relatively small segment of the total market? Is the market going to grow? Will people substitute lower fat products for the standard? These questions can be answered through observance of trends as well as actual results in the marketplace. It is interesting to note that Kraft/General Foods grossed over $200 million in the first year of sales of their Entenmann's line of fat and cholesterol free bakery foods and has plans to expand the product line. A spokesperson for Sara Lee was quoted recently as forecasting that "healthy alternative bakery food could eventually represent 25 to 30% of frozen baked food sales". A spokesperson for VanDeKamp's Holland Dutch Baker was reported to have said that no fat/cholesterol sweet goods "may settle out long term at about 30 to 50% of an average company's sales". Of course these predictions assume that acceptable substitutions to the full fat product is developed and that there is no or a small decrease in sensory properties acceptable to the consumer.

Compared with other natural fats, milk fat has certain properties that offer a good starting point for developing new milk fat products: (1) multiple fatty acid, triacylglycerol, and vitamin composition (2) phospholipids and lipoproteins; (3) excellent taste and aroma; and (4) some special physical properties. The problem is the high price that decreases its competitiveness in relation to vegetable fats and oils.

Fractionation by crystallization, superfluids, or other technology are examples being applied commercially to milk fat to create favorably received new products. The essential purpose of milk fat application development is to adapt products to fit user purpose. Correctly performed crystallization, texturization, whipping, or other treatments offer numerous opportunities for improving the quality and applications of products based on milk fat.

Biotechnology offers new promise for the future. It creates opportunity to address issues (*e.g.*, saturation) not available using current technologies at potentially favorable costs and conditions.

Future Predictions

1. Trend to low fat will continue. This is not a fad.

2. Increase in medical/nutritional foods especially meeting nutritional needs of the aged.

3. There will be new preservatives and packaging technologies to be fresh appearing with longer shelf life.

4. The process of market segmentation will continue especially in the following areas:

   - Ethnic foods
   - Population groups, *i.e.*, spicier foods for aged
   - Gourmet foods
   - Natural foods
   - Food for Kids: Pizza, pancakes, yogurt
   - Mini sized products

5. Fewer product introductions

   - Less shelf space available
   - Cost of introduction
   - Low success rate

6. New technology to play a greater role

   - Ohmic for aseptic
   - Improved fat substitutes
   - Enzymology for flavor

7. Package improvements to meet environmental concerns, convenience and cost effectiveness.

8. Joint ventures, technology sharing, consolidations of technical skills, international alliances.

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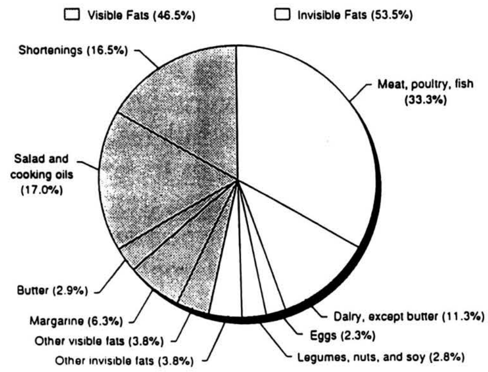
Figure 4

Distribution of U.S. Fat Consumption by Category



Source: Food and Fats and Oils 1988, *Institute of Shortening and Edible Oils.*

Table 2.

Trends in Weight Control

	1983	1985	1987	1988
Overweight Total	58	62	59	64
Within Rec. Range	23	21	24	21
Underweight	19	17	16	15

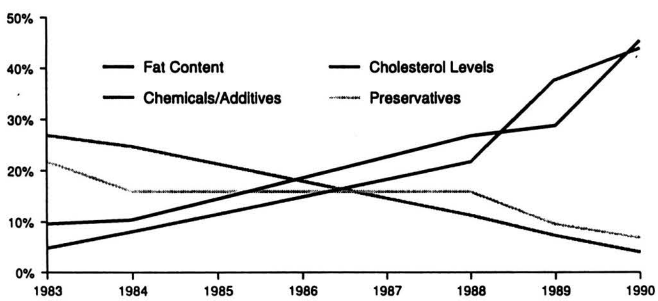
Reference: Metropolitan Life/Prevention Index, 1990

Table 1.

Rise in Concern Over Fats, Cholesterol

Latent Concern Over Chemicals?

What is it about the nutritional content of what you eat that concerns you and your family the most?



Reference: Hill and Knowlton

Table 3.

Abstaining in Moderation

	Given Up	Cut Back	Would Go Back
Ice Cream	4%	38%	13%
Sugar/Sweets	4%	55%	15%
Cheese/Dairy Products	2%	31%	9%
Red Meat	2%	53%	18%
Foods with Preservatives	2%	45%	3%

Reference: Wall Street Journal, 6/89

Table 4.

Shopper's Nutritional Concerns

	1983 (%)	1986 (%)	1987 (%)	1988 (%)	1989 (%)	1990 (%)
Fat Content	9	14	16	27	29	46
Cholesterol Content	5	13	14	22	28	44
Salt Content	-	-	22	26	25	30
Calorie Content	6	11	12	14	15	19
Sugar Content	-	-	16	20	15	-
Preservatives	-	-	14	16	-	-
Chemical Additives	-	-	13	14	-	-

Reference: Food Marketing Institute Survey - 1990

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