1 Current trends in the consumption of fats and foods

1.1 INTRODUCTION

One of the major changes in the way Americans have consumed foods over the past 30 years has been an appreciable increase in the number of meals eaten outside the home and in the total per capita calories ingested. Factors such as convenience, increase in the number of two-earner households, and higher incomes have contributed to this phenomenon (Stewart *et al*., 2004). The convenience of eating out and use of already prepared home meal replacements has also resulted in taking away control over what food ingredients will go into a meal, including types of fats, carbohydrates, and proteins. This trend appears to be being followed by the rest of the developed countries.

Consumer spending continued to grow by 18% at full-service restaurants and by 6% for fast food in the 2000s. The total food expenditure away from the home amounted to US $641 billion in 2011, as opposed to $263 billion spent in 1992 (USDA-ERS, 2013a), with the average American household spending approximately 10% of its income on food and about 43% of the food dollar was spent on food away from the home.

Fast-food restaurants, restaurant take-out, and supermarkets are playing an important role in the increased use of home meal replacements by American households. These foods are designed to be easy to eat, simple to prepare or reheat for consumption at home. It is estimated that eight out of ten meals eaten at home were not necessarily homemade. As previously mentioned, this convenience and novelty of products that eating out and home meal replacements brings to the consumer has also taken away control over what ingredients are being consumed, especially with regards to critical ingredients such as the fats that are used.

The US consumer, on the other hand, is becoming increasingly aware of healthier food options, especially when it comes to fats and oils. For example, the consumer is starting to focus more on foods that are made with whole grains, are rich in fiber,

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and which contain healthier types of fat. Sales of whole grain bread and other baked goods increased 20% from 2005 to 2008. However, despite the population being increasingly conscious about their health, problems related to issues such as obesity and diabetes continue to increase in western countries. In the United States nearly 65% of the adult population were considered overweight in 2000, up from 46% in 1980; 32% were considered obese (Flegal *et al*., 2002).

1.2 PRODUCTION TRENDS OF FATS AND OILS

The world production of edible oils has increased dramatically since the early 1990s. This is mainly due to population growth and an increasing demand for vegetable protein for animal and human use. The production of fats and oils worldwide increased from 72 million metric tons in 1991 to more than 146 million in 2011. The major vegetable oils used in foods are soybean, palm, rapeseed, sunflower, peanut, cottonseed, palm kernel, and coconut. Table 1.1 shows outputs for these oils since 1991. Palm oil has now overtaken soybean as the major oil, and together with soybean oil accounts for over 55% of the total vegetable oil produced in the world. The United States, Brazil, Argentina, and China account for over 70% of the world's output. Soybeans continue to be the largest and fastest growing oilseed crop worldwide with a production of 256 million metric tons in 2012 (USDA-ERS, 2013b). The major oils consumed in the US are listed in Table 1.2.

The type of vegetable oil, specifically the fatty acid composition, usually determines the application and nutritional value of oil or fats. Fatty acids in oils usually have chain lengths of between 18 and 16 carbons with different levels of unsaturation. The most common fatty acids found in oilseeds are linoleic, oleic, linolenic stearic, and palmitic acids. Table 1.3 lists the fatty acid composition of the major vegetable oils (Hernandez, 2005). Most naturally occurring fats have a cis geometric configuration. Catalyzed reactions such as hydrogenation will rearrange this shape into a trans geometry. The position of fatty acids in the glycerol backbone also follows a natural pattern for most vegetable oils. A fatty acid found at carbon 2 is usually unsaturated, whereas the fatty acids positioned at carbons 1 and 3 can be

Table 1.1 World production of fats and oils (millions of tons).

	1991/92	**1996/97**	**2001/02**	**2011/12**
Palm	13.01	17.64	25.42	50.57
Soybean	17.47	20.53	28.85	42.03
Sunflower	7.32	8.61	7.61	14.07
Cottonseed	3.64	3.70	3.82	5.38
Peanut	3.59	4.38	4.88	5.17
Coconut	3.09	3.69	3.23	3.69
Palm Kernel	1.74	2.22	3.12	5.88

Source: Compiled using data taken from United States Department of Agriculture – Economic Research Service, 2013.

Table 1.2 Edible fats and oils: US disappearance (millions of pounds).

	1991	1996	2001	2010	2011
Soybean	12 248	14 267	16 833	16 794	17 600
Canola	801	1 134	1 493	3 704	4249
Palm	223	297	471	2 108	2 525
Corn	1 202	1 244	1 363	1 670	1 620
Tallow, edible	1 197	1 218	1 488	1 902	1 910
Coconut	910	1 111	1 119	1 073	1 155
Lard	885	571	663	788	783
Cottonseed	1 088	1 012	780	599	620
Palm kernel	344	363	369	622	778
Olive	216	321	470	633	650
Sunflower	396	207	401	535	395
Peanut	179	194	260	226	203

Source: Compiled using data taken from United States Department of Agriculture – Economic Research Service, 2013.

either saturated or unsaturated. The unsaturated fatty acids in vegetable oils determine the degree of susceptibility to oxidation. The low relative oxidation rate of oleic acid is a driving force in the development of high oleic genetically modified oils (GMO) either by natural breeding or genetic modification of some of the major oilseeds, that is, sunflower, canola, soy, and peanut. The oxidative stability of some edible oils is improved through the use of partial hydrogenation. However, the use of hydrogenated oils is decreasing due to the excessive generation of trans fatty acids by this process (Jung and Min, 2005).

Fats and oils are present in most foods and they are a required component of every diet. They are also the primary components of products such as margarines, shortenings, butterfat, fried foods, mayonnaises, salad dressings, baked products, infant formulas, and snack and confectionary products. The major application of oils in cooking includes frying, where they function as a heat transfer medium and contribute flavor and texture to foods. More highly saturated oils are preferred

Table 1.3 Fatty acid composition (%) of some edible oils.

Fatty acid	Soybean	Canola	Corn	Sunflower	Olive	Palm
Lauric (C12:0)	0.1	–	–	0.5	–	0.4
Myristic (C14:0)	0.2	–	–	0.1	–	1.1
Palmitic, (C16:0)	10.7	3.7	12.3	6.4	13.5	43.8
Stearic, (C18:0)	3.9	2.1	1.9	4.5	2.2	4.4
Oleic, (C18:1)	22.8	66.9	27.7	22.1	75.1	39.1
Linoleic, (C18:2)	50.8	16.9	56.1	65.6	5.8	10.2
Linolenic, (C18:3)	6.8	7.9	1.0	0.5	0.6	—

Source: Compiled using data taken from United States Department of Agriculture – Economic Research Service, 2013.

as frying and cooking oils because they are less prone to oxidative, thermal or hydrolytic breakdown. Where little or no heating is required, vegetable oils are used as ingredients in foods such as pourable salad dressings and mayonnaises. In the case of margarines and shortenings, fats and oils are required to be solid at refrigerator and room temperatures. Partially hydrogenated oils and palm-based products are commonly used for this application.

Saturated fatty acids are derived from animal sources of foods, including whole milk, cream, butter, cheese, and fatty meats such as pork and beef. They are also found in oils such as coconut, palm, and palm kernel oil, which have relatively high amounts of saturated fatty acids.

One current trend is to consider fats more closely from the nutritional viewpoint. As a result, the vegetable oil industry is currently going through a process of diversification and finding new applications for vegetable oils with novel fatty acid contents. New developments include the naturally bred and genetically modified oilseeds. As mentioned previously, food processors manufacture fats and oils that are shelf stable, and for baking and frying tend to use the more stable fats high in saturates and trans fatty acids. Some of these fats, especially those more saturated and high in trans acids, may cause cardiovascular disease. Hence, manufacturers have started to switch to healthier, more polyunsaturated oils, in their manufacturing practices (Jung and Min, 2005).

As mentioned, highly stable oils are being developed to replace hydrogenated oils that are high in trans fat. Most of the conventional oils now have a high oleic content version, that is, soybean, sunflower, and rapeseed oils have a version that is high in oleic (up to 90%). With new regulations requiring more detailed nutritional labeling of foods and a consumer increasingly aware of nutritional aspects of foods, manufacturers are reformulating many food products to minimize undesired components such as saturated and trans fats.

1.3 FAT CONSUMPTION TRENDS

Fats and oils also play an essential role in the processing, quality, and organoleptic and texture properties of food products (Hernandez, 2005). This increasing knowledge of the functional and structural properties of fats and oils has allowed for the development new more stable and more functional food products. Lipids are a major source of storage energy, important precursors in the body's metabolic processes, and are essential components of cell membranes and other biological structures. Lipids also play important roles in the absorption of fat-soluble nutrients, such as fat-soluble vitamins and other dietary and medical supplements.

The general consumption of fats, along with carbohydrates, has steadily increased in the United States in the last 30 years, as shown in Figure 1.1, and, as mentioned before, has contributed to the dramatic increase in obesity in the United States. Excessive and unhealthy calories as well as sedentary behaviors have also been associated with the primary causes of deaths attributable to obesity (Flegal *et al.,*

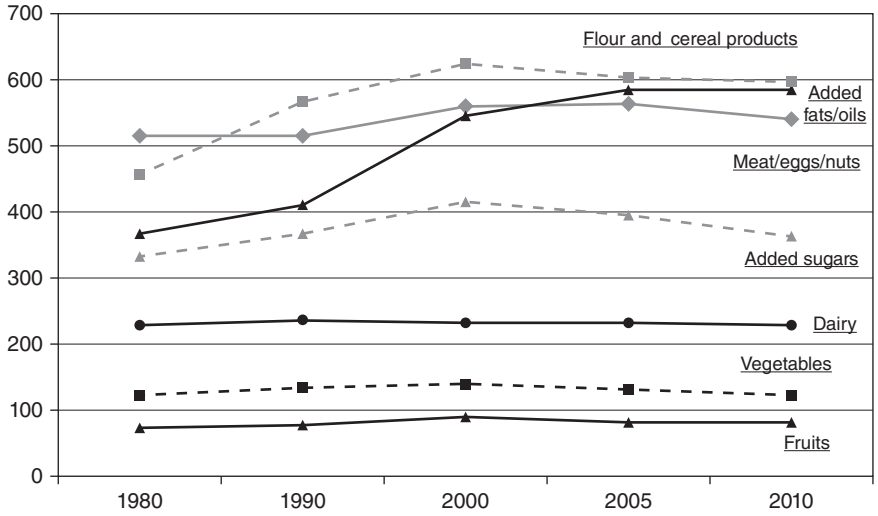

Figure 1.1 US daily per capita calories (food availability, adjusted for spoilage and other waste). Compiled using data taken from United States Department of Agriculture – Economic Research Service, 2013.

2004). Mean energy intake in kilocalories has increased sharply since 1980, especially from carbohydrates and fats. However, the mean percentage of kilocalories from fat has decreased as a percentage of the total calories. Average daily per capita calories from the US food availability, adjusted for spoilage and other waste, in 1980 was reported at 2112 with an increase to 2534 in 2010 (USDA-ERS, 2013c).

The consumption of added fats, which include cooking/salad oils, shortenings, spreads, and butter, cooking oils and shortenings in the US doubled from early 1900s to the end of the 20th century. The main growth in fats consumption has been in salad and cooking oils (see Figure 1.1), while the consumption of table spreads declined. Consumption of margarines has also declined to levels slightly lower than those of butter. Table 1.3 shows the fatty acid composition of the main oils consumed globally.

1.4 FATS AND NUTRIENTS

Lipid nutritional supplements were in use even before the term nutraceutical was coined. Omega-3 oils are one of the most widely consumed health supplements. Products such as fish oils, shark cartilage, shark liver oil, and vitamins have been on the market since the beginning of the 20th century. There is now a better understanding of the biological properties of lipids in general and the application of new functional foods and dietary supplements has extended to areas such as disease prevention, transdermal carriers and other cosmeceutical applications (Shahidi and Senanayake, 2006).

The importance of essential fatty acids (omega-3 and omega-6) in the daily diet is now well recognized and new fortified foods and dietary supplements of omega-3 products are considered one of the fastest growing markets. Marine oils are the main source of long chain omega-3s and fish (Kris-Etherton *et al*., 2000). Vegetable oils such as soybean and flaxseed oils contain high amounts of the short chain α-linolenic acid. Fish oils provide a mixture of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), and fatty fish are the major dietary sources of EPA and DHA. Smaller amounts are also present in meat and eggs.

Official health institutions in many countries have issued dietary guidelines on the intake of nutrients to assist the consumer and health professionals in determining diets for all segments of the population – men, women, and children. In the United States, the Institutes of Medicine of the National Academies (2005) have issued a report on Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids. This report now also includes Acceptable Macronutrient Distribution Ranges for fiber and essential fatty acids omega-3 and omega-6. For essential fats only adequate intakes (AI) are reported, including only short chain omega-3 as α-linolenic acid and omega-6 as linoleic acid. RDAs are defined in the report as average daily intake levels sufficient to meet the nutrient requirements of nearly all (97–98%) healthy individuals in a particular life stage and gender group. AI is defined as the recommended average daily intake level based on observed or experimentally determined approximations or estimates of nutrient intake by a group (or groups) of apparently healthy people that are assumed to be adequate and can be used when an RDA (recommended dietary allowance) cannot be determined. The previous recommendation was to keep fat below 30% of the total calories, now it is suggested that between 20 and 35% of calories are in the form of fat. It is generally recommended that at least 15–20% of an adult's calories be in the form of fat and for infants this should be at least 30–40%.

The Institutes of Medicine recommend a total daily fat intake of between 20 and 35% of total calories (IOM, 2010). It also recommends that saturated fat make up less than 10% of the total fat consumed and the rest be consumed as monounsaturated and polyunsaturated fats.

The AMDR (Acceptable Macronutrient Distribution Ranges) recommendations for carbohydrate are estimated to be 45–65% of energy for adults. They also established Estimated Energy Requirements (EER) at four levels of energy expenditure: Sedentary, Low Active, Active, and Very Active, assigning Physical Activity Coefficients (PA) depending on the age and gender of the individual.

Also, for the first time, the *Dietary Guidelines* have specific recommendations for whole grain consumption separate from those for refined grains, encouraging all Americans over 2-years old to eat at least three 1 oz equivalent servings of whole grains each day, or roughly half of their recommended 5–10 daily servings of grains, depending on calorific needs. The goal of this new recommendation is to improve Americans' health by raising awareness of whole grains and their role in nutritious diets.

1.5 DIETARY FAT INTAKE TRENDS

In general it is recognized that in the US diet the percentage of energy from carbohydrates increased and the percentage of energy from fat and protein decreased during the period from 1971 to 2000, and that the prevalence of obesity is due to an increase in caloric intake, mostly from an increase in the intake of carbohydrates and fats. The reduction in the percentage of energy from fat resulted not from a significant decrease in total fat intake but rather from an increase in carbohydrate intake, resulting in an increase in total energy intake (Austin *et al*., 2011).

Americans typically consume 71.6 g of added fats and oils per person per day; of that, 59.6 g come from vegetable fats and oils, 9.2 g come from animal fats (including butter, margarine, and shortening), and 2.7 g come from dairy fat. This estimate does not include dietary fats that occur naturally in foods, such as in dairy products and meats. Added fats and oils account for about 32% of the total calories for a 2000 calories-per-day diet (Wells and Buzby, 2008). It is estimated that the average intake for monounsaturated, polyunsaturated, and saturated fat is 29.2 g (12% of total calories), 16.4 g (7% of total calories), and 26.3 g (11% of total calories), respectively. The amount of saturated fat is appreciably higher than that recommended by *US Dietary Guidelines* (Grotto and Zied, 2010). On the other hand it has also been suggested that the use of dietary guidelines may alter behavior and this changes could have positive or negative effects. As an example, it has been pointed out that the Dietary Guideline Advisory Committee recommendation to lower fat consumption, advised in the 1995 guidelines, may be partly responsible for the trend towards food products that are lower in fat, which were widely marketed in the late 1990s. However, this may have lead people to believe that, provided their fat intake is low, their diet will be entirely healthy. This in turn could result in an over consumption of total calories in the form of carbohydrates, resulting in the adverse metabolic consequences of high-carbohydrate diets that can trigger the onset of obesity (Marantz *et al*., 2008). As mentioned before, the increase in calorie consumption and obesity has also been attributed to the creation of a social environment that promotes overeating and sedentary lifestyle (Woolf and Nestle, 2008).

Regarding the intake of essential fats, polyunsaturated fatty acids, such as *n*-6 (linoleic acid), have been estimated to be from approximately 12–17 g/d for men and 9–11 g/d for women. Polyunsaturated fatty acids have been reported to contribute approximately 5–7% of the total energy intake in diets of adults (Allison *et al*., 1999; Fischer *et al*., 1985). There are other *n*-6 polyunsaturated fatty acids present in small amounts in the diet, such as arachidonic acid, which is commonly found in animal fats. About 50% of monounsaturated fatty acids are also provided by animal products, primarily meat fat (Jonnalagadda *et al*., 1995). The consumption of essential fatty acid omega-3, as linolenic acids, has been estimated for men and women to be in the range 1.3–1.8 g/d and 1.0–1.2 g/d, respectively. Intake of omega-3 fatty acids has been reported as 0.7% of total caloric intake. (For all adults, the median intakes

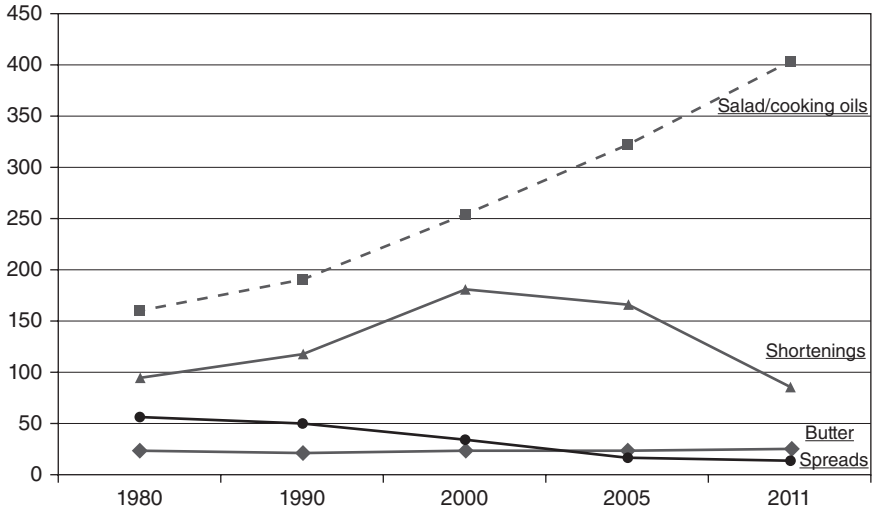

Figure 1.2 Per capita calories from added fats in the US. Compiled using data taken from United States Department of Agriculture – Economic Research Service, 2013.

of EPA and DHA ranged from 0.004 to 0.007 and 0.052 to 0.093 g/d, respectively. The median intake of DHA ranged from 0.066 to 0.093 g/d for men and from 0.052 to 0.069 g/d for women. Docosapentaenoic acid provided only 0.001–0.005 g/d (Kris-Etherton *et al*., 2000).

Trans fats have received a great deal of attention in the United States in the last several years because of reported deleterious health effects. The current trend in the industry is to replace trans fat rich partially hydrogenated frying oils with a more stable non-hydrogenated oil, such as high in oleic sunflower, canola, and safflower oil. Partially hydrogenated solid fats used in baking are being replaced by higher melting, and higher in saturates, solid fats such as palm oil. This is reflected by the higher amounts of imported palm oil imported into the United States in recent years (See Table 1.2). Before the trend to eliminate or decrease trans fats from fried and baked products, data showed that in the United States average trans fatty acid intakes varied between 1.5 and 2.2% of energy (Ascherio *et al*., 1998) or 5.2% of total dietary fat (Lemaitre *et al*., 1998). Figure 1.2 reflects also these changes; the current consumption of spreads has fallen below butter due mainly to the higher health awareness by the consumer. The consumption of shortenings, widely found in baked goods has also decreased sharply.

Snacks are also considered an appreciable source of calories, including calories from fat. It has been shown that Americans are consuming a higher percentage of total daily calories from snacks than ever before. Between 1977 and 1978 and 2003 and 2006 consumption of calories from snacks increased from an estimated 18 to 24%, respectively. It was reported that 98% of children snack, with an estimated 27% of their total daily calorie intake coming from snack foods (Piernas and Popkin, 2010). Foods with high SSS (sensory-specific satiety) have been suggested to help

in maintaining body weight. It has been shown that daily overconsumption of snacks can result in a significant reduction in SSS and could lead to a higher energy intake (Tey *et al*., 2012).

1.6 TRENDS IN HEALTHY FATS AND FOODS

Owing to the combination of growing obesity in the general population, aging of the baby boomer generation, and increasing health awareness, there has been an appreciable growth in the last 20 years in the consumption of dietary supplements as well as in the introduction of several types of diets and nutrition regimes.

It is generally recognized that the increase in obesity has resulted in the growing incidences of cases of metabolic syndrome globally and in the United States. Metabolic syndrome is characterized by a set of risk factors that include: abdominal obesity, atherogenic dyslipidemia, elevated blood pressure, insulin resistance or glucose intolerance, a prothrombotic state (the presence of high fibrinogen or plasminogen activator inhibitor in the blood) and a pro-inflammatory state. It is estimated that over 50 million Americans have metabolic syndrome. It is also estimated that people in the United States spend more than to $2 billion per year on weight-loss programs (Flegal *et al*., 2002). As suggested before, the most important contributing factors to the obesity epidemic are sedentary lifestyle and calorie intake increase for all segments of the population. The increase in calorie intake, as already mentioned, exacerbated by an increasing number of meals eaten away from home, has also resulted in an increased population submitting to a dietary or weight reduction regime. It is estimated that over 45 million Americans diet each year. (Stewart *et al*., 2004). Many diets include, in one form or another, some of the basic nine inter-related recommendations from the *Dietary Guidelines for Americans* regarding individual nutrients and food components (DRI, 2005), which are as follows. (1) The consumption of adequate amounts of nutrients from a variety of nutrient-dense foods and beverages. Limit the intake of saturated and trans fats, cholesterol, added sugars, salt, and alcohol. (2) To maintain body weight in a healthy range, balance calories from foods and beverages with calories expended, to prevent gradual weight gain over time. (3) Practice regular physical activity and reduce sedentary activities to promote health, psychological well being, and a healthy body weight. (4) Encourage consumption of particular food groups such as whole grain foods, fruits and vegetables. (5) Recommendations of consumption of specific fats to help maintain balance diet and healthy weight. (6) Choose fiber-rich fruits, vegetables, and whole grains often and avoid consumption of simple sugars. (7) Consume less than 2300 mg (approximately 1 teaspoon of salt) of sodium per day. (8) Take measures of hygiene to avoid microbial food-borne illness. (9) Avoid excessive consumption of alcoholic beverages.

There is still some controversy as to whether diets higher in fats or carbohydrate contribute to furthering the onset of obesity. For example, it has been reported that when men and women are fed isocaloric diets containing 20, 40, or 60% fat,

there was no difference in total daily energy expenditure (Hill *et al*., 1991). Similar observations were reported for individuals who consumed diets containing 10, 40, or 70% fat, where no change in body weight was observed (Leibel *et al*., 1992), and for men fed diets containing 9–79% fat (Shetty *et al*., 1994).

One of the major challenges for food producers is to design products that conform to dietary guidelines. As mentioned, convenience is one of the major drivers for consumer's food purchases. Meals eaten at home, made from scratch are increasingly being replaced by already prepared products. Ready-to-eat and ready-to-cook have replaced made from scratch meals. Some of the more popular items include single-serve items such as a meal in a cup. New foods with exotic and ethnic flavors have been introduced into the market as well, based on innovations from cuisines from around the world.

Convenience also applies in the way foods are prepared at home. It has been reported that 50% of consumers use their microwave to prepare meals (IFT, 2013). Sales of ready-to-eat and eat-on-the-go meals continue to grow. Ready-to-eat cereals have been around for a long time. The average American consumes over 72 frozen meals each year (Gust, 2011). This is also reflected by the size of the ready-to-eat cereals market of more than $5 billion in the United States. This trend is reflected by supermarket chains devoting the second largest amount of their space to prepared foods. They also reported that the highest percentage of prepared foods sold fall in the ready-to-cook and frozen-food categories. The types of prepared foods fall into the categories of: Ready-to-Heat 30.83%, Ready-to-Eat 40.83%, Ready-to-Cook 18.00%, and Frozen 16.00%.

Besides convenience, health has become one of the most important drivers for the global food industry. One of the fastest growing trends in consumer attitudes toward foods is shopping for healthier choices, the consumer tends to look not just for convenience but also for foods with specific health claims (Sloan, 2012). This has also been an important factor for the growth of the supplement industry. The consumer looks for products that might help them maintain a healthy diet and also have weight management benefits. For example, sales of products low in calories have increased 6% to over $11 billion in the United States (Lempert, 2007). In 2011, the functional food and beverage market reached $93 billion, registering a growth rate of 6% from 2007 to 2011.

The general consumer has learned to look for foods with healthier connotations such as no trans fats, reduced fat, and low salt content. The general consumer is now also learning to look for fortified foods and beverages that include products which deliver specific health benefits, such as added nutrient claims, for example vitamins, calcium, and fiber. The market for functional foods sales has passed $31 billion, up 10%; and US healthy beverage sales have been estimated at well over $17 billion (in 2006).

Seventeen of the top 24 fastest-growing food categories have been reported to be driven by a desire for wellbeing, risk reduction or weight control (ACNielsen, 2007). It is reported that 56% of adults in the US used nutritional supplements in 2006. Essential omega-3 fats are considered one of the top and fastest growing

Table 1.4 Top health problems in the US and major supplements areas.

Top health problems[1]	**Major food supplements areas**
Heart disease	Heart/cardiovascular health
Cancer	Cognitive
Respiratory diseases	Visual
Stroke	Energy/mood
Alzheimer's disease	Bone/joint
Diabetes	Gut/digestive
Kidney disease	Weight management
Pneumonia and Influenza	Immune function

[1] Murphy *et al.*, 2012

supplements, followed by antioxidants, folic acid, vitamin B6, B12, DHA, potassium and magnesium.

Table 1.4 shows the top health problems for Americans and the top areas of health supplements sales. Heart disease is at the top. Six out of ten adults link omega-3s to heart health, for example, cholesterol lowering and heart attack prevention (Sloan, 2006). Fish oil and omega-3 products were one of the leading products in the entire supplement industry in 2012, with annual gains in excess of 20% for the past five years.

More specifically with respect to cooking fats and oils, olive oil ranked high as a food item that consumers used increasingly for health reasons, right behind vegetables, fruits, and whole grains (Health Focus, **?**). One-third of shoppers used more olive oil and 25% used more low-fat products, over the last eight years use of olive oil rose 11%, while low-fat products usage fell 29%. For example nine out of ten adults in the United States believe that olive oil is the healthiest oil, followed by soybean, sunflower, and canola. Food products such as mayonnaise and margarine spreads, made with canola oil and flax seed oils, have been introduced into the market, which include in the label omega-3 and its health benefits. Fish oil is still considered the main source of essential fatty acids and is one of the fastest areas of growth in the supplements market representing over 65% of the omega-3 supplement market sector.

1.7 FUTURE TRENDS

The production and consumption of foods has gone through very important changes in the last 100 years, with more dramatic transformations taking place in the last 30 years. Major evolution in technologies in growing and harvesting of crops, automatization and modern distribution methods has allowed for the mass production and ready access to staple foods. Genetic modification techniques has allowed for the

development of higher yielding essential crops such as soybeans, corn, and wheat. Advances in food preservation and general knowledge of nutrition has also allowed for the development of more convenient and safer foods.

Table 1.5 shows a time line for the evolution of food products introduced into the market aimed at an increasingly larger and diverse population demanding larger volumes of foods as well as more convenient ways of preparation and consumption. As food, volume, and variety became more abundant, combined with a growing economy, food companies become more sophisticated, not just in production techniques but in also in marketing and innovation. Table 1.5 also shows how the food trends have shifted in the last few years to address not just factors of convenience and indulgence but also health.

In response to an aging and better-informed population that demands health, wholesomeness, and convenience in their foods, the food industry has introduced a growing number of innovative products such as better-for you, multi-claim prepared home meal replacements. These new products are designed to help meet a combination of health needs such as heart health, increased vitality, digestive health, weight management, anti-aging, and immunity boosting. The food industry top opportunities in the functional foods market are considered to be: (1) anti-aging (mental, cognitive, visual and joint health; (2) heart/cardiovascular health; (3) energy/mood enhancing; (4) bone health; (5) gut/digestive health; (6) immune function; (7)weight management; (8) beauty (nail, hair and skin health)(Food Product Design, 2011). Food products introduced into the market include ingredients that actively protect the heart, such as plant sterols, soy, whole grain, and teas. Lead categories in the heart health trend are snacks, bakery and cereals, dairy, oils and fats.

Examples of functional foods currently sold in the market include cereals fortified with fiber, minerals, and vitamins. New dairy products such as milk, cheeses, spreads, and soya milk fortified with omega-3 fatty acids have also been introduced. Beside omega-3, consumers also are becoming aware of other healthier oils and in addition avoid other products such as saturated and trans fats.

The major future trends in foods that have been widely recognized include three important characteristics: health, convenience, and premium/indulgence. Also four additional properties with regards to the ingredients have been associated with these trends: (1) healthy and functional fats; (2) "free-from" products, that is, trans, low salt, and so on; (3) products for personalized diets; and (4) new flavors from ethnic/fusion cuisines (Lewis, 2006). Also, a factor that is increasing in importance is the addition of ingredients with bioactive properties to regular foods.

Another emerging trend is the increasing concerns from the consumer about environmental and social impact of ingredients used in prepared foods. There is a growing trend by consumers to support safer and environmentally benign technologies in harvesting of ingredients and the manufacture of food products, for example, products such as palm oil that in some cases may involve deforestation, or tuna that is caught by methods that do not harm dolphins and protect the marine ecosystem. More recently, as the consumption of fish products is on the increase, more fisheries are required to be certified as sustainable.

Table 1.5 Time line in food products and trends.

1876	Heinz Tomato Ketchup is first introduced
1889	Aunt Jemima Pancake flour mix was introduced
1893	Coca-Cola trademark is registered
1893	Cream of Wheat was developed by Nabisco Foods
1896	H.J. Heinz, introduces "57 varieties" of canned sauces, pickles, and preserves
1897	Campbell's Soup introduces condensed soup
1899	Carnation began producing evaporated milk
1899	David Wesson introduced refined and deodorized cotton seed oil
1900	Hershey's chocolate bar is introduced
1904	Quaker markets first puffed cereal
1906	Kellogg's introduces Toasted Corn Flakes
1906	Food and Drug Act and the Meat Inspection Act were passed
1911	P&G introduced Crisco, partially hydrogenated cottonseed oil as a vegetable oil shortening
1912	Oreos cookies are introduced by Nabisco, bestselling cookie of the 20th century
1912	Hellman's mayonnaise is introduced
1912	A&P opened chain of grocery stores with standardized lay out and cash and carry format
1920	Birdseye introduces deep-frozen food
1921	White Castle opened first chain of hamburger shops
1924	Iodine fortification of salt was initiated in the US
1925	Frigidaire introduces first all-steel mechanical home refrigerator
1927	USDA's Bureau of Chemistry became the Food, Drug, and Insecticide Administration
1928	Velveeta is introduced by Kraft
1930	Wonder Bread markets first automatically sliced bread
1932	Fritos corn chips are introduced
1935	Howard Johnsons begins chain of franchised restaurants
1937	Kraft Macaroni and Cheese Dinner are first introduced
1937	Hormel Foods introduced Spam
1937	McDonald brothers opened first drive-in fast food restauran
1941	First Recommended Daily Allowances are published by US Food and Nutrition Board
1942	Danone yogurt is introduced
1943	US Food and Nutrition Board required that thiamin, niacin, riboflavin, and iron be added to white flour
1946	General Foods introduced Maxwell House instant coffee
1946	Chef Boyardee canned pasta dishes are introduced
1948	Pace Foods introduces first mass produced salsa
1951	Swanson produces first frozen meals, pot pies
1954	Swanson makes first frozen TV dinner
1954	Ray Kroc buys McDonalds, starts nationwide fast-food chain
1956	USDA publishes "Basic Four" food guide
1967	Amana introduced counter top microwave oven
1970	Quaker Oats introduced 100% Natural granola
1974	FDA approved aspartame use in carbonated beverages and in dry products
1980	USDA and DHHS publish first *Dietary Guidelines for Americans*
1981	Stouffer's Lean Cuisine frozen dinners are introduced
1982	Coca-Cola introduces Diet Coke

(*Continued*)

Table 1.5 (*Continued*)

1985	Jenny Craig Diet weight management and nutrition system is introduced in the US
1990	FDA introduces the Nutrition Labeling and Education Act
1992	USDA releases "Food Guide Pyramid" recommending lower fat consumption
1994	FDA introduces the Dietary Supplement Health and Education Act
1996	Herbicide-tolerant and pest resistant transgenic crops: soybean, corn, canola received marketing approval
1999	48% of US food dollars is spent away from home
2002	USDA and DHHS publish new *Dietary Guidelines for Americans* including essential fats and fiber intake recommendations
2004	FDA approves Lovaza (omega-3 ethyl ester concentrates) for hypertriglyceridemia
2006	FDA requires mandatory labeling of trans fats in foods
2006	New York becomes the first city in the US to ban artificial *trans* fats in restaurant foods
2007	Sales of functional foods and beverages in the US is estimated at more than $20 billion
2010	US sales of organic food and beverages grew to $26.7 billion from $1 billion in 1990
2010	It is estimated that 35.7% of US adults are obese, up from 21.5% in 1999
2011	USDA replaces food pyramid with My Plate, it includes 5 basic food groups and a web site for personal tracking of calorie intake and physical activity
2011	US annual sales of omega-3 in foods and supplements surpasses $5 billion
2012	FDA issued proposed regulations on calorie labeling on menus and menu boards in chain restaurants, retail food establishments, and vending machines

It is generally acknowledged that some major health concerns that affect the western diet, such as obesity, heart disease, stroke, cancer, and diabetes, can be positively influenced, directly or indirectly, by a healthy diet. As the lines between dietary supplements and functional foods become blurred, one the most critical challenges for the food industry will be to develop products that satisfy the demands of a better informed population. This will include the delivery of functional ingredients through foods that are not just more nutritious but also health promoting. Healthy fats and oils as well as other new lipid bioactive agents will play a key role in the design of effective dietary systems.

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