THE TRANS FATS DILEMMA

AND NATURAL PALM OIL

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The information contained in this book is based upon review of research as published in professional journals, books and other media or as supplied to the author by various experts. Every effort has been made to provide the most complete, current and accurate information possible. It is the belief of the author that both the hydrogenated food industry and the palm oil industry want to do their best to protect the health of the public. When new research changes the way we look at certain components of the diet, manufacturers find themselves in a dilemma and I am sure they will try to find healthful solutions.

The author is not responsible for opinions expressed in the interviews. The responsibility for results of studies on trans fatty acids and palm oil reported in this book is that of the studies' investigators and not the book's author or publisher.

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Dedication

To my wife Monica who has inspired me
for many years to search for the ultimate diet.

"Nothing in life is to be feared. It is only to be understood."
—Marie Curie
Scientist, 1887–1934

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Preface

After an overview of fats (Part One), this book looks into the role of partially hydrogenated fats, also called trans fats, in health and good nutrition (Part Two). These fats are very useful to the food industry and to many restaurants, but some researchers have raised questions on the use of excessive amounts of these fats. Recently the FDA issued regulations that will require the listing of trans fat content on the nutrition labels of foods in 2006. Some manufacturers already list them. We need to give credit to the hydrogenated food industry that for many years was told that their fats were very healthy and that margarines based on this type of fat were a good choice for better health. On this basis, that industry grew and hydrogenated fats became common. Today, this industry that we believe is concerned about the health of people finds itself in what we call the trans fat dilemma as the food industry begins to think about decreasing the use of these fats.

Many food companies have decided to lower the content of these fats, combine them with other fats or replace them totally or partially with other oils, such as natural palm fruit oil. Natural palm fruit oil is an oil that contains about 50 percent saturated fat and 50 percent unsaturated, as well as some precious nutrients.

In Part Three, this book describes natural palm fruit oil, an ancient tropical oil which is balanced in saturated and unsaturated fats. This balance makes palm fruit oil useful for the food industry and bakeries when their products need an oil that becomes solid at higher temperatures than other vegetable oils. The oil of the pulp of the *fruit* of the oil palm has been confused with the oil of the *kernel* of the oil palm, the latter being a very saturated oil with a different type of saturated fat.

Both partially hydrogenated fats and palm oils have been the topic of many studies to help find their place in a healthy diet, yet controversy about these fats still exists, even among the experts.

This is an easy-to-read book for everyone, with as little scientific jargon as possible. It is not a detailed review of all the studies on partially hydrogenated fats and palm oils, but rather an overview of the key results of the research on their effects on health.

Gene A Spiller
Los Altos, California
December 2003

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Introduction
A SENSE OF WONDER

I feel a sense of wonder when I think or write about plant foods. We all know that plant foods are, or should be, the foundation of our diet. In real foods—the plant foods from nature that people in various regions of the world have consumed for centuries—there is something mystical that transcends any scientific or medical knowledge of the goodness of these foods.

When I began to plan this book on one of the great oils nature gave us—the oil of the fruit of the oil palm—just as when I have written about nuts, olives and their oil, or grapes and raisins, I felt this sense of wonder rekindled and revitalized, as if driven by a mystic force. As I began to write this book, I became fascinated by the idea of looking at another widely used fat, the kind of trans fats produced by partial hydrogenation of liquid vegetable oils.

For millennia, most of the food we ate, either raw or cooked, was what you might call natural food. Sometimes it was fermented, like wine or yogurt, or leavened, like bread. Some foods were prepared by removing their hard shell—as we do with nuts—or the seed of olives. But the sense of the wonderful things nature put in these foods was and is still there.

When we think about fats and oils, we realize that, for centuries, many seeds and the pulp of fruits have been primary sources of oils for cooking and preparing foods. In Mediterranean countries, the pulp of the olive was pressed and made into a precious oil long before the time of Christ, "…until I come and take you away to a land like your own land, a land of grain and new wine, a land of bread and vineyards, a land of olive trees and honey, that you may live and not die." (2 Kings 18:32). Today, olive oil remains an important part of a healthy Mediterranean diet.

Just like the olive tree in Italy, Greece and other Mediterranean countries, for centuries African palm trees supplied many basic foods, from the dates of the date palm (*Phoenix dactylifera*) in North Africa to oils from the oil palm (*Elaesis guineensis*) in tropical Africa. The palm tree inspires us with a sense of wonder, whether we look at a date palm in a dry desert or at an oil palm in a tropical, rainy region.

There are many other palm trees. We are all familiar with coconuts from the coconut palm (*Cocos nucifera*, "nucifera" meaning "bearing nuts"), a palm that has traveled from tropical islands in the Pacific Ocean to many other tropical regions and one that supplied energy and nutrients to the local people for millennia.

Palms are hardy, beautiful trees that grow all over the world. Some do not give us food. Common on the Mediterranean coast is the *Camaerops humilis*, a dwarf, bushy palm that supplies the raw material for ropes, hats and other woven products. Its popular name, the palm of Saint Peter—palma di San Pietro in Italy—was probably given because it had some kind of sacred aura. In the southern California desert of North America, we find the *Washingtonian filifera*, the only California native palm and the palm that gave its name to the city of Palm Springs.

Let's now focus on some of the palms that bear edible fruits and oils.

The fruit of the date palm, rich in natural sugars, was considered sacred by the Arabs. It was and is a great source of energy. The fruit of the coconut palm has supplied both drink and oils for the inhabitants of tropical Pacific islands. Its shredded pulp is widely used today in cooking.

This book focuses on the fascinating story of the oil from the pulp of the fruit of the oil palm (*Elaesis guineensis)*. Today this fruit comes from tropical Africa, South America and Asia, where it prospers with the frequent rains and year-round warmth of these continents. For millennia this oil has supplied a precious, deeply orange oil from its pulp. Its orange color comes from carotenes, which for centuries have prevented eye problems, including blindness, in children in Africa and other countries. We know today that carotenes—which take their name from carrots—have additional health benefits.

Palm oil is rich in many other valuable nutrients, such as tocopherols and tocotrienols, which are part of the vitamin E family. Palm oil contains a balance of saturated and unsaturated fats, making it great for baking when a semi-liquid oil is desirable. Natural palm oil is an integral part of a healthy tropical diet in Africa and Southeast Asia, just as olive oil is a part of a healthy diet in the Mediterranean region.

As the date palm migrated to the deserts of southern California and Arizona in North America from its native North African deserts, so did the oil palm. It migrated from tropical Africa to many tropical regions, such as Brazil, Malaysia and Southeast Asia.

Other seeds and pulps were found by ancient people to bear precious oils or fats, such as sesame seeds and almonds from the Middle East and the avocado from Peru. Entire books can be written about each one of these foods supplying great plant oils.

Oils of different plants have different characteristics due to the relative amount of various types of fat in the oil. Each has a special use in preparing foods, as we will see later.

In this book we will learn about partially hydrogenated fats to understand better what they are, how they are made and what researchers think of these fats that are so widespread in the American food supply. These fats are sometimes called *trans fats* because of what happens to the structure of their molecules after partial hydrogenation. Trans fats have been in the news in recent times, sometimes in a dramatic way, such as the lawsuit filed against a major cookie manufacturer by a San Francisco lawyer. This suit was later withdrawn. In July, 2003, the Food and Drug Administration in Washington, DC issued new regulations that will require trans fats to be listed on prepared food packages in the nutrition panel just as saturated fats are listed now. Many food manufacturers find trans fats very "functional," which means they can do a nice job of supplying texture and stability to baked goods and other processed foods.

There is no doubt that today there is a dilemma about trans fats or, more precisely, partially hydrogenated fats. While trans fats are very functional for the food industry, they lack the many valuable nutrients of natural fats, such as the health-protective antioxidants, and they do not have the unsaturated fractions typical of most natural plant oils. These fats may even have some unique properties of their own with regard to their effect on blood cholesterol when consumed in large amounts, a point much debated in the medical field. Let's not forget that these fats were considered for many years a healthy substitute for such fats as butter.

By no means do we have the final answer on trans fats and how much we should or should not consume. We know they have different health effects when consumed together with enough unsaturated fats, just like saturated fats.

Many food and ingredient manufacturers have been working to meet the demands of consumers to reduce the amount of partially hydrogenated fats in food products. After reading this book you will realize that it may be wise to limit the intake of trans fats. If you do consume them, you should combine them with other oils that supply unsaturated fats, just as you need to do when consuming saturated fats. And, after reading this book, you will realize how natural palm oil was and is nature's gift to the tropical and warm climates and why palm oil can be great if you decide to decrease the use of trans fats in various products like baked products and other prepared foods.

In Part Three, many researchers express their opinions. Again, you will see that there are a wide variety of differing opinions about trans fats. No doubt, the challenge of trans fats rests with more research and with the producers of hydrogenated fats.

Finally, in the Epilogue, we'll review all that we have learned about partially hydrogenated fats and palm oil. We will be reminded of a key point in health and in disease prevention: no food lives in isolation in an ivory tower. The best possible food must be part of the best possible diet.

Gene A Spiller
Los Altos, California
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PART ONE
UNDERSTANDING FATS

CHAPTER ONE

Untangling the Fat Maze

No natural "bad" fats?

Could it be that nature has created some edible fats that are bad for us? Is it, perhaps, that in our sincere desire to improve nutrition, we falsely believe that there are bad natural fats? Take the much maligned saturated fats, often referred to as "bad fats." How unwise nature would have been if these fats were bad for us, as there is practically no natural food from either plants or animals that is totally free of saturated fats. Here, as with the other fats we will discuss in this book, we need to see every fat, natural or synthetic, as part of the entire diet and the amount consumed. With this premise in mind, let's learn more about each type of fat…

Always look at the whole diet and at the history of nutrition.

No food or nutrient lives an isolated life of its own: not fats, proteins, carbohydrates, fiber, vitamins, minerals or any other nutrients. When foods are modified by drastic means, such as hydrogenation, which we will discuss later, we have to be somewhat more cautious about their place in our diet, as this is not what nature gives us.

We need to remember another key fact—natural foods have many well-known nutrients, but frequently we discover a new valuable compound that earlier was thought to be just a color or a flavoring agent. Many antioxidants and fiber belong in this category and only in the last few years have been recognized as beneficial compounds.

The secret life of the fat molecule.

Before looking into the oil of the oil palm or into partially hydrogenated fats, we need to understand fats better. Let's look inside fat molecules.

It is amazing how minor changes in the basic structure of the fat molecule can make such a major difference in the way they affect our body and our health. This is one time in this book that we need to get into some basic science, so that later on we may be set free to enjoy the romance, the history and the pros and cons of natural and synthetic fats.

Fat molecules are chains of carbon atoms of various lengths, with many atoms linked (or bonded) in many ways. The way the atoms are linked to each other, and the number of atoms in the chain, make a great deal of difference in their effect on our bodies. By adding or removing some of the links of the chain, or by inserting different links, or by twisting the chain around in some way, the fat molecule and its effect on our body changes.

When all the bonds in the fat are such that you cannot insert much else in the bond—it is full already, and hard to break—the fat is called saturated.

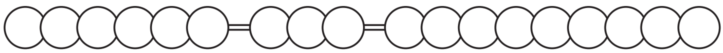
Saturated fat molecule with 18 carbons

But, this chain, sometimes with 14, 16, 18 or 20 carbons, can change in a major way if we just insert one or two or three unsaturated bonds. Chemists call these unsaturated bonds in a fat molecule *double bonds*.

Inserting one double bond makes the fat monounsaturated (*mono* means one); inserting more than one makes it polyunsaturated (*poly* means many).

Monounsaturated fat molecule with 18 carbons and one double bond

As we go along, sometimes we'll refer to the monounsaturated fats as the *monos* and the polyunsaturated fats as the *polys*. Look at this figure…



Polyunsaturated fat molecule with 18 carbons and two double bonds

Saturated fats

Some saturated fat exists in most of the fats we consume, no matter whether they come from animals or plants. The question arises about the amount of saturated fats compared to unsaturated fats, and the type of fatty acids contained in them.

Certain types of saturated fats, either from plants or animal foods, when consumed in sufficient amounts, raise blood cholesterol. In addition, fat from animal products such as beef contain cholesterol.

Oils, such as palm oil from the *pulp of the fruit* of the palm, have about 50 percent saturated and 50 percent unsaturated fat. From the same palm tree, the oil from the *kernel* (the seed) has much more saturated fat and less unsaturated fat (see chart on page 62).

Palm oil is high in palmitic acid, with 16 carbons, while the saturated fats in palm kernel oil (and in coconut oils) are mainly lauric acid (12 carbons) and myristic acid (14 carbons). The two shorter saturated fats (those with fewer carbons) may be more powerful in raising blood cholesterol than palmitic acid. Stearic acid, the key saturated fat (18 carbons) in chocolate, has been known for years not to raise blood cholesterol, reminding us that talking about saturated fats in general is a poor way to understand the effect of fats on health.

Natural monounsaturated fats

Natural monounsaturated fats are the basic fats of the healthy Mediterranean diets of southern Italy, Greece, the Middle East and North Africa. When monounsaturated fats replace saturated fats in the diet, they lower blood cholesterol. These mono fats do not promote harmful oxidation (oxygen in a special hyperactive state that causes damage) in the arteries of the heart (the coronary arteries) and other arteries. Such oxidation makes the bad cholesterol worse.

Partially hydrogenated monounsaturated fats

Partially hydrogenated fats are mono fats. In the hydrogenation process, the molecule changes shape and some double bonds are changed to saturated bonds. Partially hydrogenated fats are made from good, unsaturated vegetable oils. By adding hydrogen to the molecule under special chemical conditions, lots of things happen—the fat becomes solid and the shape of the molecule changes, some of the hydrogens move around and that is why they are called *trans* fats. This change makes these fats act differently than their sister fats, the naturally occurring *cis* fats, like the ones we find in olive oil, avocado oil, palm oil, almond oil and many other natural oils. A catalyst and pressure are usually used to make the reaction possible and fast, and the hydrogenation process is very drastic.

Many popular prepared foods contain trans fats, including pastries, breads, cookies, doughnuts, cereals and potato chips. They are used by some restaurants in preparing French fries. There is no doubt that trans fats are very "functional" fats in prepared foods and they are great for large-scale food preparation. Another advantage in commercial food preparation is that trans fats are very stable and have a long shelf life, making it possible for foods to have a longer "shelf life" at the supermarket.

Natural trans fats

Some trans fats are found in natural foods and, thus, are not partially hydrogenated fats. In this book, when we talk about trans fats, unless we specifically say otherwise, we refer to the trans fats purposely made by partial hydrogenation of vegetable oils. Sources of natural trans fats are usually animal products like meats and dairy products.

Polyunsaturated fats

In polyunsaturated fats, the molecule has more unsaturated bonds—at least two, sometimes more. There are many kinds of poly fats with two or more of these bonds. Poly fats are essential to health; they are the raw material for the synthesis of key compounds in the body, such as prostaglandins, which control many body functions.

Fractionated fats

Some commercial fats are called fractionated fats, as they are "fractions" of the original oil with special characteristics that may be useful in food preparation. The fractionation process is different from hydrogenation.

Cholesterol

There is basically no cholesterol in plant foods. Cholesterol is found mostly in animal foods, such as meat, poultry, egg yolks and dairy products. Some organ meats, like liver, are very high in cholesterol, as the liver is a key place for the synthesis, or production, of cholesterol.

We do not need to eat cholesterol, as our bodies make it "on demand." In healthy people with normal blood cholesterol, consumption of limited amounts of cholesterol in foods just tells the liver to make less cholesterol so the result is an unchanged level in the blood. Cholesterol plays many key roles in the human body and is essential to normal functioning. Plant fats, whether natural ones like olive or palm oil, or synthetic ones like partially hydrogenated fats, do not contain any significant amount of cholesterol.

Although we may perceive cholesterol as some kind of evil substance, let's remember that cholesterol is essential to health and plays a key role in the structure of the body. It is the precursor of many vital substances we synthesize, such as some vital hormones. A cholesterol-free body cannot exist! And there is even a good cholesterol in the blood!

Recently we've learned that when cholesterol in the blood is damaged by oxygen, it becomes the true "bad cholesterol."

Kinds of cholesterol and fat in our blood

To understand the effects of any food on our blood cholesterol we need to go a step further. We need to understand lipoproteins and some key scientific terms.

- *Lipoproteins* are many large particles (or globules) composed of fats, proteins and related compounds that contain cholesterol and carry it around in the blood. There are many of them with many different fractions. The two most commonly used in determining healthy cholesterol levels are the LDL and the HDL lipoproteins.
- *Total blood cholesterol* is the sum of the cholesterol in all types of lipoproteins. To be very precise we should say plasma or serum cholesterol, as the plasma or serum are, with minor modifications, the blood after the cells—like red cells and white cells—have been removed. In this book we talk about blood cholesterol to keep things simple.
- *LDL,* short for low-density lipoprotein, is a globule that carries cholesterol in the blood. Cholesterol in this form is considered more damaging and causes bad deposits in the arteries (plaques) which slowly narrow the openings of the blood vessels. That is why LDL is often called *bad cholesterol.*
- *HDL*, short for high-density lipoprotein, is also a globule that carries cholesterol in the blood. But when cholesterol is in this form, it is considered to be protective and good. It is often called *good cholesterol.* You do not want to lower this lipoprotein level.
- **Lp(a),** sometimes called “Lp little a,” is a special lipoprotein and an indicator of heart disease risk. You do not want to raise this indicator level.
- *Triglycerides,* that may be found in lipoproteins and sometimes free in the blood, are simply fats. They come mostly from fat in the diet or from carbohydrates eaten in excess of the body’s need.

We also need to understand what is meant by coronary heart disease.

- *Coronary heart disease*, sometimes abbreviated as CHD, is a common form of heart disease in which the coronary arteries feeding the heart muscle oxygen and nutrients become clogged with cholesterol deposits and may eventually become blocked.

Never forget the total diet!

Whether you deal with fats or any other components in the diet, never forget the total composition of your dietary intake. With fats, consider the amount of total fat and the types of fats in the diet, and the relative amounts of saturated, monounsaturated, polyunsaturated and partially hydrogenated fats.

Test Your Fat I.Q.

Everyone seems to oversimplify the effects of fats. Test your fat I.Q. after reading these statements that we have all heard or read so often. Mark either True (T) or False (F).

1. *Only fats and cholesterol in food affect the level of our blood cholesterol.*
2. *For a healthy person, too little fat can be just as bad as too much.*
3. *Too little fat can lower our good blood cholesterol.*
4. *Trans fatty acids are common in many American prepared foods, but natural trans fats are present often in meats, dairy products and other animal products.*
5. *Typical trans fats made by hydrogenation are monounsaturated fats that usually have been produced by partial hydrogenation of good polyunsaturated fats like soybean oil.*

See answers on the next page.

Answers to the quiz on the previous page.

1. False
2. True
3. True
4. True
5. True

Part Two

THE PARTIALLY HYDROGENATED FATS STORY

CHAPTER TWO

The Partially Hydrogenated Fats Dilemma

History of fat hydrogenation

At the beginning of the twentieth century, British chemist William Normann invented the process of fat hydrogenation. By using what chemists call a "catalyst," Normann made it possible to modify a liquid polyunsaturated fat to a monounsaturated fat that was solid at room temperature. The new fat was much more solid than the original liquid polyunsaturated fat and had great potential for the food industry, since these fats could be produced and used on a large scale and did not quickly spoil.

Rather than totally hydrogenate the liquid unsaturated oil, only partial hydrogenation became the process of choice, and the key product produced by the hydrogenation process retained a double bond. While at first sight this sounds great, the molecule was also twisted around. The good, original fatty acid, the one called *cis*, became a *trans*, and it was later discovered that it had a different effect on the body.

More and more products were developed that used these vegetable fats in place of fat from animal sources, such as butter, lard from pork or tallow from beef. This very inexpensive, cholesterol-free fat made its way into the food industry during the twentieth century.

For many years, margarines based on trans fats were considered great for our heart and much healthier than butter. People who wanted to avoid animal fat in their diet thought margarine was wonderful. After all, it did not contain any cholesterol and it was unsaturated.

So, margarines could now replace butter and many health professionals felt that this was a great cholesterol-free, solid fat that you could spread on your toast. I remember a July day in 1985 when an Australian dietitian phoned me at my office telling me about the key role margarines based on hydrogenated fat could play in a healthy diet and how she recommended them to her patients. It is important to remember that some margarines contain both trans fats and unsaturated fats—the latter alters the effect of trans fats on blood cholesterol in a beneficial way. Here, as with many other foods, we need to be reminded that one approach is trans fat or saturated fat by itself and another approach is the same fat in the presence of sufficient unsaturated fats. No doubt we need "pure" research on food components, but just as importantly, we need to study these components together with a proper diet. In the case of fats that may raise blood cholesterol, such as trans fats or saturated fats, we need to study them together with mono and poly fats.

Research and thinking on trans fats and health before 1990

In the period preceding the 1960s, scientists believed that partially hydrogenated vegetable oils were a better choice to replace animals fats when a solid fat was needed, as these fats were free from the cholesterol present in animal fats such as butter, lard from pork and tallow from beef.

Some early human studies on the effect of hydrogenated fats on blood cholesterol in the early 1960s showed that hydrogenated fats resulted in lower cholesterol when compared with butter. One of these studies compared the effects of margarine and butter and also reported a lowering of HDL, the good cholesterol, by margarine.

In the late 1960s and early 1970s, concerns began to be raised with new research. Some animal studies showed that partially hydrogenated fats interfered with some key changes in the body, such as the changes of linoleic and linolenic acids to other fatty acids that are precursors of prostaglandins, compounds that regulate many chemical reactions in the body.

Until the late 1980s, many of the human studies on trans fats that followed showed that they raised total blood cholesterol with some exceptions, like the study of Dr. Mattson and co-workers in the 1970s that showed no effect. Mattson found that over a four-week period a group receiving the hydrogenated fats showed no change in plasma cholesterol or triglycerides, compared to the subjects consuming the fats that were not hydrogenated.

The conclusion reached as a result of the study was that partially hydrogenated fats increased total blood cholesterol, compared to the polyunsaturated oils that were used to produce them. This conclusion was explained as the effect of hydrogenation, which reduced the number of double bonds in the structure of the molecule. Using these fats appeared to many food manufacturers to be a good choice, as here we had a cholesterol-free vegetable fat, rather than an animal fat with cholesterol, still a mono fat and a less costly fat.

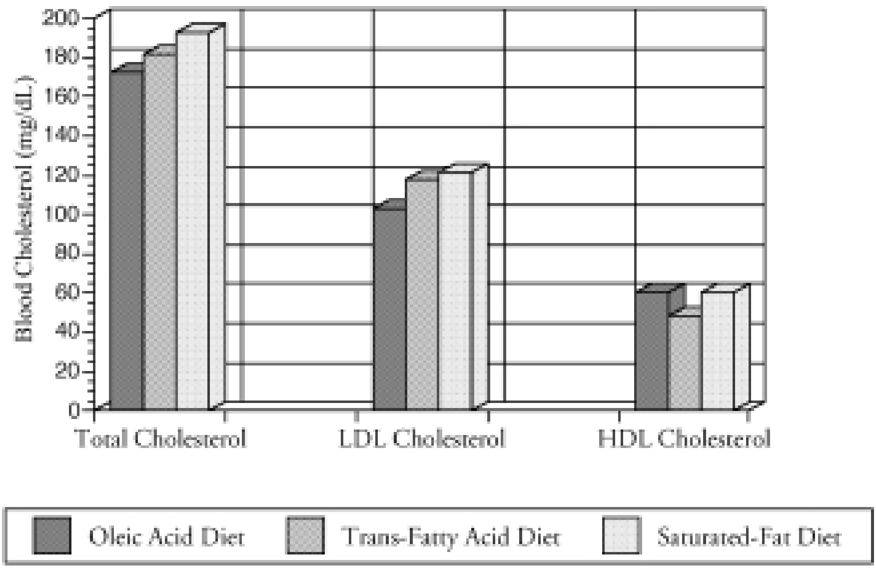
This conclusion became well accepted until the 1990s, when this view was challenged by the study of Drs. Mensink and Katan.

The 1990 Mensink–Katan study

In 1990, a study published by Dutch researchers shocked the nutrition world and made headlines in major American newspapers. Drs. Mensink and Katan and other Dutch researchers published a paper in a scientific journal that showed that trans fats raised the bad LDL cholesterol and lowered the good HDL cholesterol when consumed at a sufficient level. The lowering of the HDL cholesterol made trans fats worse than a typical saturated fat. Lp(a), one of the indicators in the blood of heart disease risk, was also raised.

It is important to note that, in this study, relatively large amounts of trans fats were tested—probably more than most people would normally consume.

Results of the 1990 Mensink-Katan Study



As we look at this chart of the results of the 1990 Mensink-Katan study on the relative effects of oleic acid (a monounsaturated fat), trans fats and saturated fats, we see that both trans fats and saturated fats raise LDL cholesterol and total cholesterol; but trans fats lower HDL cholesterol, while saturated fat does not. When looking at total cholesterol, it appears that saturated fats raise total blood cholesterol more than do trans fats. In reality, this is because trans fats lower HDL cholesterol, which is not a desirable effect. When HDL cholesterol goes down, it appears that the effect on total cholesterol is less.

Studies in the 1990s

Before going any further to review what research said in the 1990s about trans fats, let's stress that we do not have the final answer on the effect on blood lipoproteins of saturated fats—which are probably different depending on the specific saturated fats, as we will see later. And, we do not have the final answer on trans fats or the differences between these two types of fat.

Meanwhile let us look at some of the key studies of the 1990s.

Following the Mensink-Katan study, the effects of trans fats on cardiovascular health have been studied extensively in human experimental and population studies in many countries. You will find an extensive list of studies published over many years in scientific and medical journals in the References section (page 123).

An important follow-up study by Dr. Katan and co-workers in 1992 combined the results from this study with the earlier Mensink-Katan study, and concluded that the increase in LDL cholesterol was directly proportional to the amount of trans fatty acids consumed. It is crucial to note that these authors recognized that the amount of trans fats consumed was higher than that in the average U.S. diet. But some people, if they ate large amounts of baked products high in partially hydrogenated fats or products fried in such fats, could consume this amount.

These authors did not support the elimination of trans fats from the food supply. Rather, they encouraged the replacement of hard margarines with trans-fat-free soft margarines and suggested limiting the use of trans fats in baked goods and other products.

Reviewing the studies that followed in the early 1990s, researchers usually seemed to find a lowering of HDL cholesterol with large amounts of hydrogenated fats, as well as a higher LDL cholesterol and total blood cholesterol, while saturated fats raised LDL cholesterol, but did not lower HDL cholesterol. Again, the large amount of trans fats consumed in these studies must be remembered.

In 1996, a review by Drs. Khosla and Hayes concluded that dietary trans fatty acids negatively impact plasma lipids in humans. In this article, the authors critically review nine studies from 1990 to 1995 of the effect of dietary trans fats on plasma lipids in humans. The authors concluded that there was substantial evidence to implicate trans fatty acids as a potential risk factor of heart disease, and that the justification for continuing the indiscriminant practice of chemically hydrogenating vegetable oils could be questioned. Again, large amounts of trans fats were consumed in most studies.

Studies in the early 2000s

In 2001, Drs. de Roos, Katan and co-workers found that consumption of a solid fat that is rich in lauric acid, a saturated fat with 12 bonds, high in palm kernel (seed) and coconut oil, resulted in a more favorable serum lipid profile in healthy men and women than did consumption of a solid fat rich in trans fatty acids. Again, even though the amount of trans fats was high in this experiment, the authors concluded that the replacement of trans fats with solid, tropical fats rich in lauric acids appeared to be prudent.

In another study published in the same year by Dr. Lichtenstein and co-workers on the impact of partially hydrogenated fat on HDL cholesterol, the authors focused on the effect on HDL cholesterol of butter, compared to soft margarine and stick margarine. They found that both margarines resulted in significantly lower HDL cholesterol than did butter, although the difference was greatest with stick margarine, with about seven percent lower HDL cholesterol. There was no truly significant difference in HDL cholesterol between the two margarines.

In 2000, Dr. Katan, one of the researchers who published the key 1990 paper on partially hydrogenated fats, reviewed the research on trans fatty acids and plasma lipoproteins. His paper illustrated the research on trans fatty acids in the past ten years, talked about the situation in Europe and addressed the question of replacing hydrogenated fats with other fats. He reviewed the effects of trans fats on the LDL and HDL cholesterol levels and their ratios and on the risk for coronary heart disease from nine studies conducted around the world during the ten-year period. Dr. Katan concluded that the results of these studies, when placed on a chart, showed a good correlation that relates the intake of trans fats to the elevation of the LDL/HDL cholesterol ratio.

In 2001, Drs. Hu, Manson and Willett reviewed types of dietary fat and the risk of coronary heart disease. They found that studies of large groups of people, such as in the classic Seven Countries Study by the great epidemiologist Dr. Ancel Keys, showed a strong positive correlation of twenty-five-year death rates from disease of the coronary arteries of the heart (coronary heart disease) with intakes of saturated fats and trans fats. And, in The Nurses' Health Study of over 80,082 women (a powerful study with a large group of subjects and repeated assessment of diets), these authors found a weakly positive association between saturated fat intake and risk of coronary heart disease, but a significant and strongly positive association with intake of trans fatty acids.

In 2002, Dr. Katz found that a high content of trans fats in the membrane of human red blood cells may be involved in arrhythmias (irregular heartbeat) and sudden cardiac death.

In 2003, Dr. Jean-François Mauger and co-workers, in the collaborative Three-Countries Study from three major centers—Laval University in Quebec, Canada, Tufts University in Boston and the National Public Health Institute in Helsinki, Finland—found that dietary hydrogenated fats caused a deleterious increase in small, dense LDL particles. In 2001, in the Quebec Cardiovascular Study, Dr. A. C. St. Pierre and co-workers had previously found that these dense, small LDL particles were related to what they called "… a marked increase in the risk of cardiovascular disease."

The trans fats dilemma

Whether partially hydrogenated fats in small quantities are harmful to health because they increase the risk for heart disease has been much debated in the scientific research community in recent years and is yet to be resolved.

As it is well accepted that elevated total blood cholesterol and elevated LDL cholesterol are associated with increased risk for heart disease, many researchers felt it was important to confirm and clarify the results of the Mensink-Katan study. We know also that there is an association between low levels of HDL cholesterol and heart disease and the fact that hydrogenated fats lowered HDL cholesterol was an additional stimulus to do more research.

Researchers now agree that dietary trans fats increase LDL cholesterol compared to the non-hydrogenated native oil that was used to make the trans fats. This increase is about the same as that observed with saturated fatty acids. But now there is substantial evidence that, unlike saturated fatty acids, trans fats at high levels decrease serum HDL cholesterol levels compared to both non-hydrogenated oils and saturated fat.

As the ratio of LDL cholesterol to HDL cholesterol is considered by many people to be a better indicator of heart disease risk than total cholesterol or LDL cholesterol alone, the risk of heart disease could be increased if we lowered HDL cholesterol while raising LDL cholesterol.

Many researchers have criticized the studies showing these effects, including the original Mensink-Katan study, as the study subjects consumed large amounts of trans fats, beyond what is probably the typical intake for most people. The evidence on the effects of trans fats on HDL cholesterol is not unquestioned. Critics have objected to the amounts of trans fats used in many of the human studies, about one-and-a-half to two times the estimated "average" trans fats' intake in the United States (about 2 to 4 percent of total calorie intake).

And, not less important, as we will mention in this book over and over again, are the amounts and types of other fats: saturated fat, type of saturated fat, unsaturated fat and type of unsaturated fat, as well as the total amount of fat in the diet.

Notwithstanding these criticisms, for sections of the population consuming higher intakes of trans fats than the estimated "average," the effects of trans fats can have negative consequences on their health.

Major studies observing the usual diet of groups of free-living people, called "epidemiological studies," are in line with those done in research centers where the volunteers' diets are controlled and modified to see the effect of specific changes in the diet. At least one large-scale study in both men and women has shown a direct relationship between the intake of trans fats and incidence of heart disease. By their nature, epidemiological studies cannot establish a direct link between diet and disease risk and are certainly not without flaws, since it is not possible to eliminate all confounding factors that could affect heart disease risk. But the fact remains that the epidemiological observations point in the same direction as the data collected from studies where diets are modified, and these two approaches combined lend some credence to a causal link between *high* intakes of trans fats and heart disease.

Many food manufacturers in Europe and in Canada removed trans fats from most of their margarines between 1995 and 1996. In the Netherlands, margarine manufacturers also started listing the amount of trans fats contained in their products. Trans-fats-free or low-trans-fats margarines have also appeared in the United States market. Still, the major source of trans fats is not margarines, but vegetable shortening and fats used for frying and baking, both at home and in the food manufacturing and fast food industries.

Two points can be made in favor of the need for replacing at least part of the trans fats in the food supply. First, there are segments of the population with high intakes of trans fats (about 10 percent of calories), close to the average intake of saturated fat (about 13 percent of calories). Secondly, the presence of trans fats in food products is pervasive. Not only are they in those products that we are already recommending that people limit in their diet, such as fried foods and sugary baked goods, they appear in products that the average consumer considers "healthy," such as whole wheat breads and cereals, instant oatmeal, etc. And it will not be mandatory for food producers to list trans fats on nutrition labels in the U.S. until 2006, although some manufacturers already list trans fats voluntarily on their nutrition labels, together with saturated and total fat content.

Recently, Dr. Katan, one of the authors of the 1990 study and still an active researcher in this field, stated that the effort to replace trans fats with more healthy fats is worthwhile because it can have a marked impact on coronary heart disease risk. He maintains that this is because it requires no effort from the consumer (although it would require a major effort from the food manufacturer). He notes that the largest consumers of foods rich in trans fatty acids are often the poor, the young and the less educated, who have the least healthy lifestyles and are difficult to reach through nutrition education efforts.

Dr. Kritchevky of the Wistar Institute in Philadelphia, a well-known researcher of fats in health and disease, advises that we need to look at the entire diet. He states that the effect of trans fats, just as that of saturated fat, depends a great deal on the other components of the diet, and especially on the amount of other kinds of fats. (Read his comments on this topic in Chapter Nine after you have learned more about palm oil in the next part of this book.)

In July 2003, the Food and Drug Administration moves in

Considering that saturated fat and total fats are listed on food nutrition labels, the Food and Drug Administration (FDA) in the United States felt that trans fats should be listed as well. As part of a news release by the FDA Press Office that made headlines in American newspapers on Wednesday, July 9, 2003, Department of Health and Human Services Secretary Tommy G. Thompson announced that food labels will be required in 2006 to list the amount of trans fatty acids, or trans fat, to give consumers better information when choosing their foods.

The new requirement through the FDA means that manufacturers of most conventional foods and some dietary supplements will have to list the trans fat content of the product in the Nutrition Facts panel, in addition to the information about the product's overall fat content and saturated fat content.

"We are empowering Americans to make healthier choices about the foods they eat," Secretary Thompson said. "By putting trans fat information on food labels, we are making it possible for consumers to make better educated choices to lower their intake of these unhealthy fats and cholesterol. It's just one more way we're helping consumers lead healthier lives."

The new information is the first significant change on the Nutrition Facts panel since it was established in 1993. It will give consumers a more complete picture of the fat content in foods—allowing them to choose foods low in trans fats, saturated fat and cholesterol, all of which, if consumed in large amounts by people who don't consume enough unsaturated fats, could be associated with an increased risk of heart disease. Reducing the intake of trans fats and saturated fats is recommended by the Federal Dietary Guidelines for Americans.

"Our choices about our diets are choices about our health, and those choices should be based on the best available scientific information. This label change means that trans fat can no longer lurk, hidden, in our food choices," said Mark B. McClellan, M.D., Ph.D., commissioner of the FDA. "Americans will now be armed with better information to reduce their intake of saturated fat, trans fat and cholesterol—which could significantly lower the risk of heart disease, the leading cause of death in America today."

Reactions to the FDA decision on trans fats labeling

The action of the FDA prompted major headlines on the first pages of many of America's newspapers. In *USA Today*, the headline of the article by Nancy Hellmich and Bruce Horovitz read, "Food Labels Will Have to Reveal the Worst Kind of Fat." Kim Severson of the *San Francisco Chronicle*, in "Trans Fat to Appear on Food Labels," reports that Stephanie Childs of the Grocery Manufacturers Association says that the Association wants to make sure consumers aren't overemphasizing any one nutrient, which is the proper way to look at any food components. Margo Wottan, director of nutrition policy for the Center for Science in the Public Interest, pointed out that, "…while this is a good step, trans fat labeling is not going to take care of restaurant food."

Dr. Willett of Harvard's School of Public Health was quoted by

Marian Burros in her front-page article in *The New York Times*, "F.D.A. Announces Label Requirements for Artery-Clogger." Dr. Willett, commenting on the FDA regulations, emphasized that, "…This is only the first step. The big gap is fast-food and casual restaurants."

Some major food companies move away from hydrogenated fats

Even before the July 2003 press release, the negative publicity about trans fats has resulted in many major food manufacturers dropping their trans fats' content altogether or cutting the amounts used. Even if small amounts have not been proven to be harmful to the heart, there is concern that the sum of the trans fats from many foods may result in levels that could have some of the impact that Drs. Mensink and Katan had described in their 1990 paper. This concerned many researchers, like Dr. Willett at Harvard (see interview in Chapter Nine).

It is also important to consider the total amount of trans fats plus saturated fats in foods and in the total diet and the type of saturated fat present. The *type* of saturated fat, such as palmitic, lauric or myristic acid, is now totally missing from food labels.

Food manufacturers look for solution

Some major food manufacturers are already listing trans fats on their nutrition labels or plan to in the near future, even though they are not yet required to do so by the new government regulations.

One major producer of snack foods, for example, not only lists trans fats' content as "0"on the nutrition labels for some of their chip products, but also states as a footnote to the trans fat content that trans fat intake should be as low as possible. Yet even a zero trans fat listing allows for the presence of partially hydrogenated fat of up to 0.5 percent of the calories in a product. This additional information on products' Nutrition Facts panels allows purchasers to make informed choices, keeping to a minimum the amount of trans fats consumed from the sum of all the trans-fat-containing foods they might eat.

At the same time, the food industry is now searching for ways to partially or totally replace trans fats. *Baking and Milling News,* a weekly publication for the food industry, in a review article entitled "Replacing trans fats" (August 19, 2003), includes the points of view of various manufacturers that range from totally hydrogenating fat (this would make the fat a saturated fat), to reintroducing palm oil, which is the oil of choice in many countries with its balance of monounsaturated and saturated fats—an option that we will discuss in Part Three of this book. Many companies are looking into other options. According to *Baking and Milling News*, surveys show the concern of consumers regarding trans fats and it appears that most people seem to understand that partially hydrogenated fats listed on the label equals presence of trans fats in the product.

Baking Management, a major baking industry magazine, ran a long article by Sharon Gerdes in the Ingredient Spotlight section of the September 2003 issue, "Reformulating Trans-Fat Filled Bakery Goods." The article talks about the problems that confront wholesale bakers in deciding whether or not to reformulate their bakery foods that contain trans fats to reduce or eliminate them. Consumers are already demanding trans-fats-free products, and by 2006, wholesale bakers will be required to list trans-fat content on their product's Nutrition Facts panel to comply with new FDA regulations. Anticipating enactment of the recently announced ruling, ingredient suppliers have been developing special oils and shortenings to provide wholesale bakers with alternatives to trans fats.

Trans fats' content of foods

As we look at the trans fats' content in selected foods from USDA data collected from 1989 to 1993, we see the large variation in content for the same food. More data can be found on the USDA web site (www.USDA.gov).

Trans Fatty Acid Content of Selected Foods (USDA data, 1989–1993)

ID	Food Description	Total Trans FA grams/100 grams	Trans FA percent of total FA
BABY FOOD			
1	Vegetable beef dinner, brand a (no added fat)	0.12	4.71
2	Vegetable beef dinner, brand b (no added fat)	0.15	5.55
BAKED PRODUCTS			
3	Biscuits, buttermilk, dry mix, brand a	3.18	22.85
4	Biscuits, plain, refrigerated dough, higher fat (11 to 26 percent)	4.06	36.46
5	Bread crumbs, dry, grated, plain	0.07	1.54
6	Bread, cracked wheat, commercially prepared	0.99	19.98
7	Bread, rye, commercially prepared	0.14	4.82
8	Bread, white, commercially prepared, brand a	0.71	15.61
9	Bread, white, commercially prepared, brand a	0.11	9.24
10	Bread, white, commercially prepared, brand b	1.39	25.46
11	Bread, white, commercially prepared, buttertop, brand b	0.82	21.02
12	Cake, pound, commercially prepared, cholesterol-free, brand a	5.43	28.13
13	Cake, pound, commercially prepared, fat-free, brand b	0.4	28.27
14	Cake, yellow, commercially prepared, w/ chocolate frosting, brand a	3.21	17.32
15	Cake, pound, dry mix, regular, brand a	1.06	12.11
16	Cake, cheesecake, commercially prepared, plain, brand a	0.56	3.88
17	Cookies, chocolate chip, commercially prepared, regular, higher fat (18 to 28 percent), brand a	5.84	24.31
18	Cookies, chocolate chip, commercially prepared, regular, higher fat (18 to 28 percent), brand b	4	18.74
19	Cookies, chocolate chip, commercially prepared, regular, higher fat (18 to 28 percent), brand c	9.04	36.28
20	Cookies, chocolate sandwich w/ crème filling, brand a	4.87	23.57
21	Cookies, chocolate sandwich w/ crème filling, brand a	6.28	33.48
22	Cookies, vanilla sandwich w/ crème filling, brand a	7.09	37.65
23	Cookies, vanilla wafers, lower fat (12 t o 17 percent), brand a	4.25	32.08
24	Crackers, sandwich-type w/peanut butter filling, brand e	3.01	10.03
25	Crackers, cheese, regular, brand c	7.43	25.81
26	Crackers, saltine, regular, brand a	1.51	11.63
27	Crackers, saltine, regular, brand a	3.96	39.92
28	Crackers, saltine, regular, brand b	3	28.74
29	Crackers, standard snack-type, regular, brand a	5.87	25.24

ID	Food Description	Total Trans FA grams/100 grams	Trans FA percent of total FA
BAKED PRODUCTS *(continued)*			
30	Crackers, standard snack-type, regular, brand a	8.41	39.74
31	Crackers, standard snack-type, regular, brand b	5.87	31.03
32	Crackers, standard snack-type, regular, brand c	8.34	38.15
33	Crackers, standard snack-type, regular, brand d	8.18	39.62
34	Crackers, standard snack-type, regular, store brand	8.18	39.52
35	Danish Pastry, pecan, brand a	2.13	8.45
36	Doughnuts, cake-type, plain, sugared or glazed, brand a	6.91	29.22
37	Doughnuts, cake-type, plain, sugared or glazed, brand b	4.44	21.23
38	Doughnuts, cake-type, plain, sugared or glazed, brand c	2.01	13.63
39	Doughnuts, cake-type, plain, sugared or glazed, brand d	0.54	3.81
40	Doughnuts, cake-type, plain, sugared or glazed, store brand	4.45	24.75
41	Doughnuts, yeast-leavened, plain, glazed, brand a	6.3	31.17
42	Doughnuts, yeast-leavened, plain, glazed, brand b	0.65	2.25
43	Doughnuts, yeast-leavened, plain, glazed, brand c	2.45	13.3
44	Doughnuts, yeast-leavened, plain, glazed, store brand	2.09	6.79
45	Muffins, corn, dry mix, brand a	3.55	31.85
46	Rolls, dinner, plain, brand a	0.33	6.45
47	Rolls, dinner, plain, store brand	0.25	5.87
48	Rolls, hamburger or hotdog, plain, brand a	0.09	2.15
49	Rolls, hamburger or hotdog, plain, brand b	1.29	25.63
50	Snack cakes, crème-filled, sponge, light, brand a	0.68	21.62
51	Sweet rolls, cinnamon, brand a	2.36	14.31
52	Taco shells, baked, brand a	7.98	31.54
53	Tortillas, ready-to-bake-or-fry, wheat flour, brand a(no added fat)	1.06	16.61
54	Breakfast cereal, ready-to-eat, corn and oat, sweetened (no added fat)	0.34	19.64
55	Breakfast cereal, ready-to-eat, corn and oat, sweetened, w/fruit-flavored pieces	1.24	40.32
56	Breakfast cereal, ready-to-eat, corn flakes	0.15	12.97
57	Breakfast cereal, ready-to-eat, crisp rice, sweetened, fruit-flavored	0.84	34.58
58	Breakfast cereal, ready-to-eat, wheat and bran flakes, dried fruit and oat clusters	0.19	4.15
59	Breakfast cereal, ready-to-eat, wheat and bran flakes, raisins and nuts	0.87	15.26
DAIRY PRODUCTS			
60	Cheese food, American, pasteurized process, brand a (no added fat)	0.77	3.46
61	Cheese food, American, pasteurized process, brand c (no added fat)	0.64	2.69
62	Cheese spread, pasteurized process, brand a (no added fat)	0.48	2.41

ID	Food Description	Total Trans FA grams/100 grams	Trans FA percent of total FA
DAIRY PRODUCTS *(continued)*			
63	Cheese spread, pasteurized process, brand d (no added fat)	0.65	3.22
64	Cheese, American, pasteurized process, brand a (no added fat)	0.74	2.64
65	Cheese, American, pasteurized process, brand b (no added fat)	0.71	2.46
66	Cheese, cheddar, brand a	0.87	2.54
67	Milk, whole, composite, April	0.09	2.94
68	Milk, whole, composite, January	0.09	2.79
69	Milk, whole, composite, July	0.1	3.39
70	Milk, whole, composite, November	0.07	2.7
71	Yogurt, lowfat, plain, brand a (no added fat)	0.03	2.08
72	Yogurt, lowfat, plain, brand b (no added fat)	0.02	2.39
FAST FOODS			
73	Milk shake, chocolate, lowfat, brand a	0.01	3.18
74	Milk shake, chocolate, lowfat, brand b	0.06	3.57
75	Milk shake, vanilla, lowfat, brand a	0.01	4.85
76	Milk shake, vanilla, lowfat, brand b	0.07	3.03
77	Potatoes, French fried, brand a	1	7.25
78	Potatoes, French fried, brand a	3.04	23.94
79	Potatoes, French fried, brand a	5.22	32.51
80	Potatoes, French fried, brand b	1.21	11.37
81	Potatoes, French fried, brand d	3.3	20.99
82	Potatoes, French fried, brand e	2.15	14.05
83	Potatoes, French fried, brand f	4.96	34.16
FATS AND OILS			
84	Lard, brand a	1.56	1.64
85	Lard, brand b	1.28	1.33
86	Lard, brand c	0.38	0.41
87	Margarine, stick, brand a	17.32	27.58
88	Margarine, stick, brand a	25.06	31.86
89	Margarine, stick, brand b	22.58	29.42
90	Margarine, stick, brand c	20.13	25.69
91	Margarine, stick, brand d	13.02	20.14
92	Margarine, stick, brand e	24.1	31.22
93	Margarine, stick, brand f	17.83	23.71
94	Margarine, stick, brand j	21.11	26.64
95	Margarine, stick, brand k	17.08	21.92
96	Margarine, stick, brand l	16.2	21.37

ID	Food Description	Total Trans FA grams/100 grams	Trans FA percent of total FA
FATS AND OILS *(continued)*			
97	Margarine, tub, brand a	11.3	17.52
98	Margarine, tub, brand a	11.29	16.86
99	Margarine, tub, brand a	4.05	10.55
100	Margarine, tub, brand b	8.12	10.61
101	Margarine, tub, brand c	8.06	14.91
102	Margarine, tub, brand c	3.05	7.91
103	Margarine, tub, brand d	4.84	11.57
104	Margarine, tub, brand i	10.23	13.2
105	Mayonnaise, brand a	3.4	4.46
106	Mayonnaise, brand b	0.23	0.3
107	Salad dressing, French, brand a	0.27	0.72
108	Salad dressing, French, brand b	0.21	0.56
109	Salad dressing, Italian, brand a	0.54	1.39
110	Salad dressing, Italian, brand c	0.25	0.49
111	Salad dressing, Italian, reduced calorie, brand a	0.19	0.91
112	Salad dressing, ranch, brand a	3.71	8.95
113	Salad dressing, ranch, reduced calorie, brand b	0.3	13.8
114	Salad dressing, ranch, reduced calorie, brand d	2.83	12.54
115	Shortening, brand a	21.26	22.24
116	Shortening, brand a	12.98	13.99
117	Shortening, brand a	12.01	12.59
118	Shortening, brand a	17.15	18.03
119	Shortening, brand b	20.58	21.52
120	Shortening, brand c	10.68	11.17
121	Shortening, brand d	21.72	22.72
122	Shortening, brand e	18.94	19.81
123	Shortening, brand e	17.42	18.22
124	Shortening, brand f	14.01	14.66
125	Shortening, brand g	32.55	34.05
126	Shortening, brand h	25.86	27.08
127	Shortening, butter flavored, brand a	20.84	21.8
128	Spread, brand a	25.78	33.58
129	Spread, brand b	22.47	32.05
130	Spread, brand c	2.79	15
131	Spread, brand d	17.62	22.14
132	Spread, brand e	9.09	13.56

ID	Food Description	Total Trans FA grams/100 grams	Trans FA percent of total FA
FATS AND OILS *(continued)*			
133	Spread, extra light, brand f	5.66	15.24
134	Spread, light, brand d	9.09	17.95
135	Vegetable oil, brand a	0.22	0.23
136	Vegetable oil, brand c	0.48	0.5
137	Vegetable oil, brand d	0.16	0.17
138	Vegetable oil, brand e	0.09	0.09
MEAT			
139	Beef, ground, 20.8 percent fat, cooked, broiled (no added fat)	0.7	4.48
140	Beef, ground, 20.8 percent fat, raw (no added fat)	0.79	4.25
141	Beef, ground, 22.1 percent fat, cooked, broiled (no added fat)	1.04	5.71
142	Beef, ground, 22.1 percent fat, raw (no added fat)	0.93	4.74
POULTRY			
143	Chicken, broiler, composite, fat, raw (no added fat)	0.75	1.15
144	Chicken, broiler, composite, fat, skin, raw (no added fat)	0.37	1.2
145	Turkey, breast meat, raw (no added fat)	0.04	2.3
146	Turkey, burger, plain, cooked (no added fat)	0.56	3.76
147	Turkey, burger, seasoned, cooked (no added fat)	0.52	3.5
148	Turkey, composite, skin (no added fat)	1.28	3.5
149	Turkey, composite, visible fat (no added fat)	2.54	3.94
150	Turkey, dark meat, raw (no added fat)	0.14	3.2
151	Turkey, ground, brand a, raw (no added fat)	0.17	2.55
152	Turkey, ground, brand b, raw (no added fat)	0.32	5.15
153	Turkey, ground, brand c, raw (no added fat)	0.26	3.1
154	Turkey, ground, brand d, raw (no added fat)	0.19	3.76
155	Turkey, ground, brand e, raw (no added fat)	0.43	4.66
156	Turkey, ground, brand f, raw (no added fat)	0.15	2
157	Turkey, ground, brand g, raw (no added fat)	0.46	4.9
158	Turkey, ground, brand h, raw (no added fat)	0.4	5.19
159	Turkey, ground, brand i, raw (no added fat)	0.17	2.3
160	Turkey, ground, dark meat, raw (no added fat)	0.16	2.15
SAUSAGES AND LUNCHEON MEATS			
161	Bologna, beef, brand a (no added fat)	1.52	5.48
162	Bologna, beef, brand b (no added fat)	1.07	4.85
163	Bologna, pork and beef, brand a (no added fat)	0.16	0.56
164	Bologna, pork and beef, brand b (no added fat)	0.21	0.78

ID	Food Description	Total Trans FA grams/100 grams	Trans FA percent of total FA
SAUSAGES AND LUNCHEON MEATS *(continued)*			
165	Frankfurter, beef, brand a (no added fat)	0.99	3.71
166	Frankfurter, beef, brand b (no added fat)	1.4	4.44
167	Frankfurter, beef, pork and veal (no added fat)	1.01	3.97
168	Frankfurter, beef, pork and beef (no added fat)	0.18	0.7
169	Kielbasa, beef, cured (no added fat)	1.27	4.55
170	Link sausage, pork, raw (no added fat)	0.09	0.35
171	Pepperoni, pork and beef (no added fat)	0.36	0.93
172	Pork sausage, fresh, raw (no added fat)	0.11	0.41
SNACKS			
173	Granola bar, chewy, chocolate chip, brand a	1.96	17.88
174	Popcorn, microwave-popped, brand a	7.65	31.74
175	Popcorn, microwave-popped, brand b	7.4	32.33
176	Popcorn, microwave-popped, low fat, brand b	3.16	30.37
177	Popcorn, oil-popped, brand a	12.37	35.24
178	Popcorn, oil-popped, brand b	6	26.89
179	Pork rinds, brand a (no added fat)	0.25	0.81
180	Pork rinds, brand b (no added fat)	0.58	1.66
181	Pork rinds, brand c (no added fat)	0.18	0.55
182	Potato chips, brand a	0.15	0.5
183	Potato chips, brand a	10.64	29.71
184	Potato chips, brand a	0	0
185	Potato chips, brand b	0.31	0.9
186	Potato chips, brand b	0	0
187	Potato chips, brand c	0.06	0.2
188	Potato chips, brand c	0.12	0.4
189	Potato chips, brand c	3.95	10.54
190	Potato chips, brand d	2.11	5.79
191	Potato chips, brand e	3.7	11.54
192	Potato chips, store brand	0.14	0.45
193	Potato chips, store brand	0.1	0.33
194	Tortilla chips, brand a	4.12	17.48
SOUPS			
195	Bouillon cubes, beef, brand a	0.33	7.44
196	Bouillon cubes, beef, brand b	3.2	16.7
197	Bouillon cubes, beef, store bulk	0.22	34.49

ID	Food Description	Total Trans FA grams/100 grams	Trans FA percent of total FA
SOUPS *(continued)*			
198	Bouillon cubes, chicken, brand a	0.05	1.08
199	Bouillon cubes, chicken, brand b	3.85	18.04
200	Bouillon cubes, chicken, store bulk	0.33	41.86
SWEETS			
201	Candies, milk chocolate coated cookie bar w/caramel	6.92	29.1
202	Candies, milk chocolate coated nougat w/caramel bar, brand a	1.6	9.29
203	Candies, milk chocolate, brand a	0.1	0.31
204	Frostings, chocolate, creamy, ready-to-eat, brand a	3.56	19.91
205	Frostings, chocolate, creamy, ready-to-eat, brand b	3.44	19.72
206	Frostings, chocolate, creamy, ready-to-eat, brand c	3.47	20.01
207	Frostings, marble, creamy, ready-to-eat, brand a	3.62	22.32
208	Frostings, vanilla, creamy, ready-to-eat, brand a	3.65	23.54
209	Frostings, vanilla, creamy, ready-to-eat, brand b	4.04	24.74
210	Frozen desserts, ice cream, vanilla, brand a	0.44	3.76
211	Frozen desserts, ice cream, vanilla, brand b	0.39	4.14
VEGETABLES			
212	Potatoes, French-fried, frozen, unprepared, brand a	3.38	37.29
213	Potatoes, French-fried, frozen, unprepared, brand a	2.48	36.19
214	Potatoes, French-fried, frozen, unprepared, brand b	1.72	37.37

Daily intake of trans fats

Using food intake data from the 1989-through-1991 period, the mean trans fats consumption has been estimated to be 7.4 percent of total fat intake, and 2.6 percent of total calorie intake. A recent study pointed out that large errors in the estimates of the trans fats intake of individuals and, potentially, groups, can arise from the great variability in trans fats' content of foods within a category. For example, looking at crackers we find 1 to 13 grams of trans fats in 100 grams (about 3 ounces) of crackers in 17 brands. Estimates for the same diet could range from 1.4 to 25.4 grams a day.

Some recent statistics show that cakes, cookies, crackers, bread and baked foods in general probably supply about 40 percent of the intake of trans fats and margarines supply about 17 percent. Another fairly large amount of trans fats, about 21 percent according to some statistics, comes from animal products such as dairy products and meats. These are not partially hydrogenated fats.

Barbara Quinn, in the *Monterey Herald Tribune*, points out that some research actually shows that conjugated linoleic acid, a trans fat that occurs naturally in beef and dairy foods, shows promise as a cancer-fighting substance and may even help people on weight-loss diets stay lean.

Trans fats added to grain-based foods supply a high percentage of the trans fats in the American diet. *Milling and Baking News* noted in one of their articles that trans fats are now a major issue in grain-based foods.

Another source of trans fats for some people who frequently eat fast foods is French fries, since some fast food restaurants use these fats for frying.

As some people may eat a large amount of trans fats and others little or none, and as the type of food chosen varies greatly, consumption data has to be used only as a simplified overview of trans fat consumption.

Position of the American Heart Association

The American Heart Association in their 2000 issue of their journal *Circulation* states that the future inclusion of trans-fatty-acid content on food labels, as well as the increasing availability of trans-fatty-acid-free products, will aid consumers in reducing current intake. They further state that this will help to achieve a total intake of cholesterol-raising fatty acids not to exceed 10 percent of energy (calories). *Note that this statement was issued before the 2003 U.S. Food and Drug Administration regulation on listing trans fats on labels in 2006.*

The dilemma of partially hydrogenated fats

We have a dilemma, which, among other things, means we do not have the final answer yet. When reviewing all the key publications on partially hydrogenated fats or trans fats and after listening to interviews with various researchers, it appears that:

1. Most studies seem to agree that LARGE AMOUNTS of partially hydrogenated fats raise LDL cholesterol and lower HDL cholesterol. Some saturated fats raise LDL cholesterol, but do not lower HDL. The varying effect of different saturated fats on blood cholesterol will be discussed in Part Three.
2. SMALL AMOUNTS of partially hydrogenated fats probably have little or no effect on blood cholesterol or lipoproteins, but the degree of the effect may depend on the balance of the diet, such as the amount of saturated and unsaturated fat present. We need to learn more about how, according to recent research, they affect in a negative way two other indicators of heart disease risk, Lp(a) and LDL particle size.
3. The amount of trans fats consumed daily in the United States varies tremendously from person to person. Trans fats are so common in processed foods that the average consumer does not know how much he or she is consuming.
4. Trans fats have no cholesterol.
5. Trans fats have no trace compounds that may be beneficial to health.
6. Trans fats are very useful to the food industry and, if replaced, a proper substitute must be found. Suggestions have been made for partial replacements to keep their level low. Palm oil could be a good choice.

It is clear that we must label foods for partially hydrogenated fats, just as we label them for total fat and saturated fat. Ideally, foods should be labeled for unsaturated fats as well. It also appears that small amounts of partially hydrogenated fats seem to be harmless, even though some investigators are concerned with the consumption of even very small amounts of these fats for prolonged periods, as well as the effect of trans fats on Lp(a) and particle size of LDL. These could be negative points in need of further study. The food industry should be encouraged to limit their use and to list trans fats on labels even before it is required by the new FDA regulations. A low-hydrogenated-fat or hydrogenated-fat-free food is a very appealing food for many people. No matter if we deal with partially hydrogenated fats or saturated fats, the presence of natural monounsaturated and polyunsaturated fats in the diet is imperative. Let's re-emphasize that trans fats, saturated fats and total fats should be listed on food labels. It is possible that the hydrogenation methods could be modified to make healthier fats. Listing unsaturated fats, as well, would also provide valuable information for the consumer. How the presence of natural trans fats from animal products interacts with trans fats made by hydrogenation needs further study.

What the experts think

In Chapter Nine, you will find out much more about partially hydrogenated and other fats from interviews with experts who have published extensively on this and related topics and you will find differing opinions.

Scientific references

At the end of the book (page 123), for the scientific-minded person familiar with medical and nutrition jargon, you will find extensive scientific references, many of them used in writing this book.

Some Key Dates in the History of Partially Hydrogenated Fats

Beginning of the 20th century

British chemist William Normann invents fat hydrogenation.

Second half of the 20th century

Unsaturated margarines made with partially hydrogenated fats are recommended as a healthy substitute for butter.

1990 Mensink and Katan study

This study makes headlines in United States' newspapers. It shows that large amounts of partially hydrogenated fatty acids raise the bad cholesterol and lower the good cholesterol. But, large amounts of trans fats were used in the study.

1990–2003

Many clinical studies on trans fats appear in the scientific literature.

2003 FDA new regulations

The Food and Drug Administration announces regulations that require the listing of trans fats' content on nutritional labels, beginning in 2006.

Part Three
THE PALM OIL STORY

CHAPTER THREE

The Palm Oil Tree and Its Travels

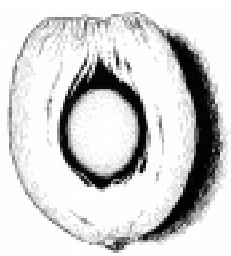
Palm trees are a gift of nature—a gift that has produced fruits loaded with energy and precious nutrients for millennia. There are two main types of tropical palms and one main kind of desert climate palm. The latter, the *Phoenix dactylifera* (*dactylifera* meaning "bearing dates"), is the date palm, considered sacred in North Africa and surrounding regions.

The two main types of tropical palms are the oil palm (*Elaesis guineensis*) and the coconut palm (*Cocos nucifera, nucifera* meaning "bearing nuts"). Their fruit has been used for millennia as an important source of energy in tropical regions.

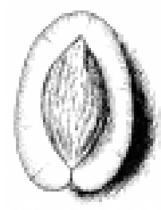
Coconut palm (*Cocos nucifera, nucifera*)**.** Various parts of the fruit of the coconut palm have been and are used for food. The shredded pulp is widely used in cooking. The young fruit supplies a sweet liquid called coconut milk. When the fruit is more ripe and the seed is formed, the seed supplies coconut oil.

Oil palm (*Elaeis guineensis).* The oil palm is a perennial tree that produces fruit year-round. On well-farmed plantations, its oil yield surpasses that of other vegetable oil plants, yielding about six to seven times the oil of coconuts and over ten times that of sunflowers per acre. But, even on the poorest of plantations in Africa, its yield per acre exceeds that of the coconut palm.

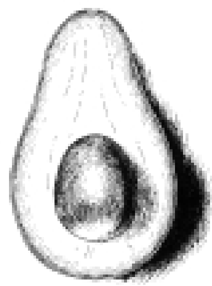
The oil palm bears a fruit that produces two oils, one from the pulp or flesh and the other from the seed, usually referred to as the "kernel." Often in this book we will simply call the oil from the pulp (flesh) *palm oil* or *palm fruit oil* and the oil from the seed—quite different—*palm kernel oil*.



Oil palm fruit



Olive



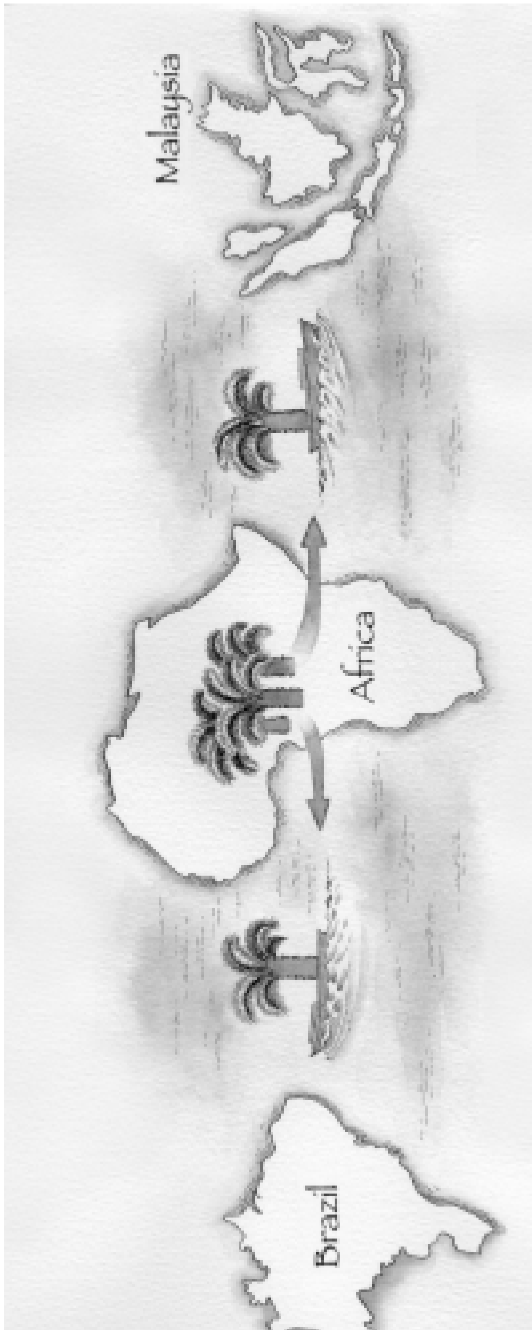
Avocado

Looking at the drawing of a cross-section of the oil palm fruit, you can see the similarity to the structure of other fruits that are high in oils, like the olive from Mediterranean countries and the avocado from Peru.

A gift from Africa to the world

It is almost certain that the oil palm originated in tropical Africa where its oil was probably in use over 5000 years ago, around 3000 B.C. The British archeologist Friedel found in the late 1800s, oil residue in an earthenware jar in an ancient Egyptian tomb that dated to about 3000 B.C. It was later determined that the oil residue was from the fruit of the oil palm, which shows that palm oil had traveled from tropical Africa to the ancient Egypt of the Pharaohs.

Dr. Donald O'Holohan, who describes the origins and the travels of the palm oil tree in his book *Malaysian Palm Oil*, writes that the West African name for palm oil, *ndende,* supports the theory that the palm oil tree originated in tropical Africa. The Brazilian name for palm oil is



Palm oil trees migrating from Africa to Brazil and Malaysia *dende*, which was probably derived from the African name. The reason for the Brazilian name could be that slaves were brought to Brazil from Africa starting in the sixteenth century and many Brazilians are their descendants. These slaves were fed a mixture of palm oil and flour while on the ship from Africa to South America and probably planted the palm oil tree in the fertile, moist, tropical regions of Brazil.

It was only much later that the oil palm moved to Southeast Asia, now one of the largest growers of oil palms and a major producer of palm oil and its products. It was in 1848 that the oil palm was introduced as an ornamental plant in the Dutch West Indies and later it was planted in the botanical garden in Singapore. The oil palm became popular as an ornamental tree in Southeast Asia and it was said that it "throve well and fruited," but it took some time before its potential as a source of edible oils was recognized.

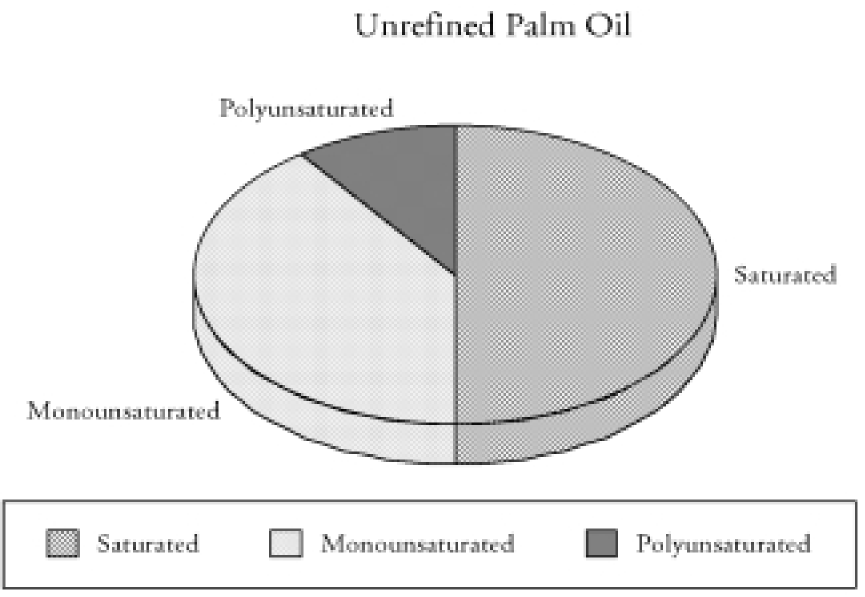
CHAPTER FOUR

What's in Natural Palm Oil?

Oils of different plants have different characteristics that today we know are due to the relative amount of various fats in the oil. Each oil has a special use in preparing foods. Many of these oils are very liquid because they are so "unsaturated." Although these oils are great for many uses, bakers and cereal manufacturers often want a fat that is less liquid at room temperature, so they must look elsewhere. One of the solutions the baker and food processor have found is a chemically-modified oil that is solid at room temperature and has a long shelf life, which is listed on food labels as a *partially hydrogenated oil*. These are the kinds of *trans fats* we talked about earlier in this book. There is no doubt that these fats are great in food processing. For the food manufacturer who wants a non-hydrogenated fat, palm oil could be the answer.

The beneficial nutrients and types of fats in palm oil

Unrefined palm oil from the pulp of the palm oil fruit is a rich source of carotenes. The name *carotenes* comes from carrots, with their typical orange color, and tocopherols and tocotrienols. Tocopherols and tocotrienols are related powerful antioxidants and precursors of vitamin E and phytosterols found only in plants (*phyto* means plant in Greek). Natural palm oil is about half unsaturated and half saturated, making it useful when a fat is desired that has the functional characteristics of a solid or a semisolid fat, such as butter. In palm oil, we have the protective effects of the unsaturated fat with the functionality of saturated fat for baking and food processing. In the following chapters we will discuss all of these key components of palm oil.



The pie chart shows the total saturated, total monounsaturated and total polyunsaturated fats in unrefined palm oil. This is a useful way to visualize the fat composition of the oil of the fruit of the palm oil tree.

The precious carotenes give palm oil its carrot color and for centuries may have helped to prevent eye problems in Africa—problems that could lead to blindness in the native children. This oil was valuable in Africa for millennia, much before the 1900s, when we discovered how protective many of its compounds were.

> *Today natural palm oil should be considered an integral part of a healthy tropical diet in Africa and Southeast Asia and in other tropical regions, just as olive oil is such an integral part of a healthy diet in the Mediterranean region.*

Looking at palm oil we need to understand…

- its fats;
- the tocopherols and tocotrienols, the sisters and brothers that make up the vitamin E family which are powerful antioxidants;
- the carotenes, with their many functions including changing to vitamin A in the body as needed and saving eyesight;
- the phytosterols or plant sterols that help control cholesterol absorption.

Tropical Oils

There are two oils made from the oil palm…

1. palm fruit oil (oil extracted from the pulp of the fruit of the palm), sometimes simply called palm oil and;
2. palm kernel oil (oil extracted from the seed or kernel of the fruit of the palm)

The composition of each of these two oils is quite different.

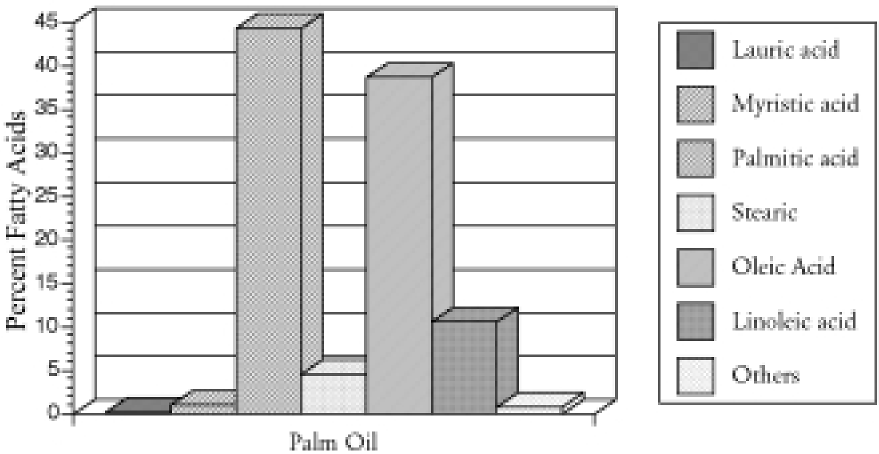
Palm kernel oil is very high in saturated fats and low in unsaturated fats and many people assume that palm oil shares these characteristics. This is not so. Palm oil from the pulp of the fruit has about 50 percent unsaturated fats, while the other fats are mostly saturated. The graphs on page 60 show the breakdown of fatty acids in palm fruit oil and in palm kernel oil.

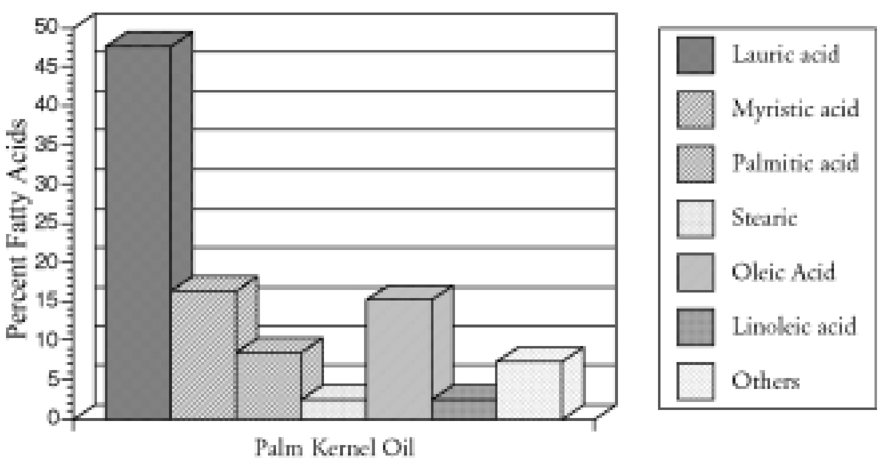
Comparing the fats in palm oil and palm kernel oil

These charts show us two key points:

1. The oil from the pulp of the fruit of the oil palm is roughly half saturated and half unsaturated. Its main saturated fat is palmitic acid, named for the palm tree.
2. The oil from the palm kernel is low in unsaturated fats and the main saturated fats are myristic and lauric acids.

With these points in mind, let's now look into some of the studies on palm oil and blood cholesterol.


Percent Fatty Acids
45
40
35
30
25
20
15
10
5
0
Palm Oil
Lauric acid
Myristic acid
Palmitic acid
Stearic
Oleic Acid
Linoleic acid
Others


Percent Fatty Acids
50
45
40
35
30
25
20
15
10
5
0
Palm Kernel Oil
Lauric acid
Myristic acid
Palmitic acid
Stearic
Oleic Acid
Linoleic acid
Others

CHAPTER FIVE

Palm Oil and Blood Cholesterol

Concerns about blood cholesterol and heart disease

Health professionals began to be concerned about blood cholesterol as a risk factor for heart disease in the late 1960s. The way cholesterol was transported in the blood became the subject of major research. The various lipoproteins that carry cholesterol around in the blood were identified and their relation to risk of heart disease was studied in depth. Currently, most clinical laboratories routinely test the cholesterol in two of the major lipoproteins, LDL and HDL, in addition to total cholesterol.

Today we know that it's healthier to keep LDL cholesterol low and HDL cholesterol high. Some saturated fats raise LDL cholesterol, but do not lower HDL cholesterol. The presence of unsaturated fats changes the way saturated fats—and trans fats—affect blood cholesterol in a beneficial way.

A key question is whether or not there is enough unsaturated fat present. In palm oil, we find about 50 percent unsaturated fat and 50 percent saturated. This gives palm oil the right characteristics for baking and food processing. Other oils, while extremely low in saturated fat, may be too liquid for some manufacturers to use for some types of food production.

A major difference between palm oil and palm kernel oil with significant implication on blood cholesterol is that the main saturated fat in palm oil is palmitic acid, while in palm kernel oil, the major fats are lauric acid and myristic acid.

Dr. Kritchevsky of the Wistar Institute in Philadelphia, Pennsylvania discusses the effect of palm oil and its differences from palm kernel oil and coconut oil:

> *"I think the best studies are the ones Dr. K. C. Hayes has done. He has shown that if the cholesterol level in the diet is low enough, then palmitic acid has no effect on blood cholesterol levels. It only has an effect in a high-cholesterol diet when myristic acid and lauric acid had an effect, no matter how much cholesterol is in the diet."*
>
> *"If you have a relatively low intake of cholesterol, maybe 300 milligrams each day or so, then palmitic acid does not raise blood cholesterol. If you go beyond that, then it does raise cholesterol, while lauric and myristic acids raise cholesterol, no matter how much or how little cholesterol is in the diet."*

Summary of studies on palm oil and cholesterol

There are important differences between palm kernel oil and palm fruit oil, as you have seen in the charts on page 60. Many clinical studies have looked into the effects of tropical oils on blood cholesterol and lipoproteins. For simplicity, from now on we will refer to palm fruit oil as "palm oil."

Most clinical studies on palm oil with subjects who had normal blood cholesterol levels seem to show that palm oil does not raise blood cholesterol. Some of the recent studies have used palm olein, the liquid fraction of palm oil rather than palm oil itself. Palm olein has a reduced palmitic acid and an increased oleic and linoleic acid composition compared to palm oil.

The results of recent research on the effects on blood cholesterol of palm oil (or its liquid fractions like palm olein) agree that the substitution of palm fruit oil for the usual fats in the diet does not result in elevation of blood cholesterol. This is particularly so when there are sufficient levels in the diet of linoleic acid (a major polyunsaturated fat), dietary cholesterol intake is less than 300 milligrams a day and the study subjects are lean and have normal levels of blood cholesterol. And palm oil did not lower HDL cholesterol.

Earlier studies that showed that palm oil raised blood cholesterol have been criticized for using either liquid formula diets or very high amounts of test fats (around 40 percent of total calories), or both, and for including individuals in the study who had high blood cholesterol.

Studies of the effects of palm oil on blood cholesterol agree that neither palm oil nor palm olein caused the kind of blood cholesterol elevation brought about by coconut oil in healthy individuals consuming about 30 percent of calories from fat and less than 300 milligrams of cholesterol a day. Usually these studies involved individuals with normal blood cholesterol.

There is no doubt that the key factor that seems to change the effect of palm oil on blood cholesterol is the amount of unsaturated fat present in the diet and naturally present in palm oil. The best blood cholesterol and lipoprotein profile seems to be reached when a balance of saturated, monounsaturated and polyunsaturated fat is consumed, in a ratio of one-to-one-to-one.

People with high blood cholesterol need further study and the effect of any fat may be different. These individuals react differently to foods and to fats in particular, so they should be more careful about their choice of fats.

The role of palmitic acid and other nutrients in palm oil

There appears to be another factor in addition to the presence of unsaturated fat in natural palm oil that makes palm oil different from palm kernel oil; palmitic acid is the major saturated fat in palm oil. Myristic acid appears to be a potent cholesterol-raising, saturated fatty acid, but it is virtually absent in palm oil while it is high in palm kernel oil (see graphs page 60).

Other factors present in natural, unrefined palm oil that may affect blood cholesterol and risk of heart disease are the tocotrienols, the tocopherols and the carotenes—all powerful antioxidants—and perhaps the phytosterols. The phytosterols are quite low in palm oil, so they are unlikely to play a major role here, even though they are a desirable component of this oil. These compounds are all discussed in the chapters that follow.

The China study

It is beyond the purpose of this book to review all the studies resulting in the conclusion that, when people with low blood cholesterol eat a proper diet containing a moderate amount of fat and the right amounts of unsaturated fats, consuming natural palm oil does not raise blood cholesterol and does not lower HDL cholesterol. Nonetheless, it is interesting to look at a study that involved the diet of Chinese people.

In China, Dr. Jian Zhang and co-workers placed 30 healthy young men with normal blood cholesterol levels on a diet for six weeks that contained 30 percent of its calories from fat, of which 75 to 80 percent of the fat was palm oil. The oil was incorporated into their diet and used in cooking meat, tofu, vegetables and other foods. Their total cholesterol and LDL cholesterol actually went down on this diet.

In a separate part of this study, twenty-five men and women with high levels of blood cholesterol were given a similar diet high in palm oil for six weeks, and in this group as well, the total blood cholesterol and LDL cholesterol went down. This shows that the balance of diet is very important and again reminds us that we always need to look at the total diet.

Natural palm oil, a complex food

As we look at the results of the many studies on palm oil, we must not be tempted to think only about saturated fat, palmitic acid and other fat components. Natural palm oil is a complex entity and the many nutrients present, like the tocopherols and tocotrienols (see page 71),

play a role in the results of studies. The antioxidant power of many of these compounds can affect blood cholesterol oxidation, a possible factor in heart disease.

The diet of Malaysia

The dietary habits of Malaysian people show the relationship between diet and health. Their low-fat diet includes palm oil and rice and they have a very physically active lifestyle. When you walk Malaysian streets, you observe that few people are obese or overweight—most likely the result of the good nutritional status of the Malaysian population. This reminds us of the key role of exercise in disease prevention.

Again, always look at the total diet

All researchers agree that, no matter if you consider the effects on health of palm oil, partially hydrogenated fats or any other oils, be they from vegetable or animal sources, we always need to look at the total diet, including other fats in the diet, its fiber content, the ratio of animal to vegetable protein, the antioxidant, vitamin and mineral content and other components of that diet.

CHAPTER SIX

The Colorful Carotenoids of Palm Oil

What are carotenes?

The term *carotenoids* was first used in 1911 by Dr. Tswett to name a big family of more than 600 compounds. Some of the more commonly known carotenoids are carotenes, which are the bright yellow, orange and red pigments that give many fruits and vegetables their characteristic color. Carrots, winter squash, sweet potatoes, cantaloupe and tomatoes all contain carotene. Carotenes are also found in dark green vegetables, such as broccoli, spinach and kale, but the green pigment, chlorophyll, often overwhelms the orange-yellow of the carotenes. You may have heard about beta-carotene, the major carotenoid in foods, but there are also alpha- and gamma-carotenes, lycopene, lutein, zeaxanthin and many others.

Besides fruits and vegetables, unrefined palm oil is a very rich source of carotenoids, which explains its deep red color. Unrefined natural palm oil contains 50 to 80 milligrams of carotenoids in 100 grams (about three ounces) of oil, mostly as beta-carotene (55 percent) and alpha-carotene (35 percent). When palm oil is partially refined, some carotenes are lost.

From carotenes to vitamin A

Some carotenoids—mainly alpha- and beta-carotene—are "precursors" of vitamin A, which means that they are converted to vitamin A in our body. Vitamin A is a fat-soluble vitamin that performs very important roles in vision, growth and immunity. Natural palm oil is the richest plant source of vitamin A precursors and just five milliliters (less than a teaspoon) of palm oil a day meets the adult daily vitamin A requirement.

The good news is that carotenes are safe and they are changed to vitamin A in the body only when needed. While vitamin A can be found ready to use in many animal foods and in supplements, this is one vitamin that should not be taken in doses greater than the suggested daily requirement. Other vitamins, such as vitamin B and C, are safe even in much larger doses than the required daily amounts. However, vitamin A is an oil-soluble compound found in animal products. It is stored in the body for some time, which sounds good, but toxic side effects could result from prolonged use of large amounts and storage in organs such as the liver may become too high. When we eat foods containing carotenes, only the needed amount of vitamin A is formed; the rest are stored as safe carotenes.

The antioxidant carotenes

Carotenes are powerful antioxidants and can play a role in protecting us from diseases that involve damage caused by free radicals. Why are antioxidants so important? As much as oxygen is a key part of life and we would soon die without it, in the complex biochemistry of the human body, molecules of oxygen can change to harmful compounds. You often read of free radicals, products produced while oxygen is doing its job. Free radicals can damage various components of cells and can even damage DNA, the genetic material of the cells, and can open the door to cancer. Or they can damage cholesterol and make cholesterol much worse for us. Over a period of time, this damage by free radicals can lead to disease and accelerated aging.

Carotenes have been shown to protect against certain types of cancer in laboratory animals, an effect to be expected from antioxidants.

The eye-saving carotenes

Carotenes play a key role in protecting the human eye. Natural, red palm oil, high in carotene, still plays a role today in protecting the eyesight of children and adults in Africa, Southeast Asia and other countries where the oil is readily available and used regularly in the diet.

CHAPTER SEVEN

The Tocopherols and Tocotrienols

Other antioxidants in palm oil are the tocopherols and the tocotrienols. Tocotrienols are present in such great amounts in palm oil that they are extracted and sold to nutritional supplement companies. You could consider all the tocopherols and the tocotrienols like sisters and brothers, looking very similar, but with subtle differences in their chemical structure when you look closely at their molecules.

Vitamin E is, chemically speaking, alpha-tocopherol and other sister tocopherols: beta-, delta- and gamma-tocopherol. Vitamin E was first discovered in 1922 at the University of California at Berkeley. Researchers Drs. Evans, Emerson and their associates found that rats deficient in what we know today as vitamin E were unable to reproduce and named the compound tocopherol, which means "bring forth offspring." Since that time vitamin E has been recognized as an *essential* vitamin, meaning we cannot do without it. Later it was found that a higher intake of vitamin E may be protective against heart disease. This could be due to its antioxidant power that prevents cholesterol oxidation.

While alpha-tocopherol is, by far, the most potent in terms of vitamin E activity, the other tocopherols not only have some vitamin E activity, but are also powerful antioxidants. Gamma-tocopherol is such a powerful antioxidant that it is often used by the food industry as a natural preservative to prevent fats from spoilage.

As for tocotrienols, laboratory research has suggested that tocotrienols may be even more powerful antioxidants than alpha-tocopherol. A study performed at the University of California at Berkeley showed that alpha-tocotrienol is 40 to 60 times more potent than alpha-tocopherol as an antioxidant. The higher antioxidant power of tocotrienols, compared to that of tocopherols, can be explained by some of their unique characteristics. For instance, the fact that the structure of their molecule is unsaturated makes them move more easily in cell membranes. Also, tocotrienols seem to be "recycled" much more quickly than the tocopherols, and can be ready more rapidly to fight those bad free radicals again and again.

An interesting study by Dr. Tomeo and co-workers found that antioxidants such as tocotrienols seem to influence the course of hardening of the carotid arteries—the arteries that carry blood through the neck to the head.

CHAPTER EIGHT

The Phytosterols, the Beneficial Sterols from Plants

Phytosterols are the sterols found in plants. Consider the phytosterols the sisters and brothers of cholesterol that love to help you. Because these sterols are soluble in fat and not in water, we find more of them in plant foods that contain reasonable amounts of oils. On the other hand, animal fats, such as we find in meats, poultry and milk products, contain cholesterol.

Since *phyto* means "plant" in ancient Greek, you can call phytosterols the plant sterols. Phytosterols are present in very small amounts—350 to 650 parts per million—in natural palm oils and somewhat less—100 to 160 parts per million—in refined palm oil. These are amounts that, by themselves, could not do much to lower blood cholesterol. But, as all compounds work together in a food and beyond a single food in a diet, we need to consider them as part of the heart disease prevention picture. It is wise to choose foods high in phytosterols.

Looking at the structure of phytosterols, we marvel at how compounds in foods such as cholesterol in humans and phytosterols in plants, so very similar in molecular structure with just minor differences, can have such different effects in our bodies.

Cholesterol lowering with phytosterols

The cholesterol-lowering effect of plant sterols is so powerful that, years ago, before the cholesterol-lowering pills of today, liquid products based on phytosterols were prescribed for people with high blood cholesterol. The liquid products were successful, but not as convenient to take, like the now popular cholesterol-lowering statins.

The first studies showing that phytosterols reduced blood cholesterol date as far back as the early 1950s. Dr. Farquhar of Stanford University was a pioneer in this field and found that LDL, the “bad” cholesterol, was reduced by 20 percent when subjects with high blood cholesterol levels consumed 12 to 18 grams of plant sterols each day. Plant sterols act by restraining the absorption of cholesterol in two ways. First, they limit the absorption of cholesterol obtained from the diet. Second, they also limit absorption of cholesterol that goes back to the intestines from the body mixed in the bile secreted by the gall bladder. The latter can then be absorbed again farther down in the intestines as part of the natural “recycling” of cholesterol.

The research continued in the following years and more recent studies have observed a lowering of blood cholesterol with much smaller amounts of plant sterols. It appears that intakes of 2 to 3 grams a day result in LDL cholesterol reductions ranging from 10 to 15 percent. Some recent studies have shown equal reductions with much smaller daily doses of phytosterols, such as 0.7 to 0.8 grams.

An interesting study in 1989 showed that the amount of phytosterol in the normal diet of Finnish middle-aged men was inversely related to cholesterol absorption. These findings suggest that phytosterols at levels found in common diets, without any specific effort in achieving high intakes, can lower cholesterol absorption and, possibly, blood cholesterol levels.

Once more, the selection of a variety of foods of plant origin, with an emphasis on unrefined oils, nuts, whole grains, beans and other seeds, will ensure an adequate amount of plant sterol in the diet and help protect from heart disease.

Beyond cholesterol, some new research is showing that plant sterols may have a protective effect against colon cancer.

Palm Oil Through the Centuries

3000 BC

In Egypt and tropical Africa palm oil gives energy and powerful antioxidants to the natives. Its carotene content makes palm oil a great product to prevent blindness in the natives. Anthropologist M. C. Friedel finds an earthenware vessel in the late 1800s containing an oil residue while excavating the ruins of an Egyptian tomb. This residue is dated about 5000 years ago, showing that palm oil was used at that time.

Sixteenth, seventeenth and eighteenth centuries

The oil palm travels to Brazil with African slaves who plant the trees in the tropical climate of that country.

Nineteenth and twentieth century

The palm oil tree migrates from Africa to other countries. A major migration takes place to Southeast Asia and Malaysia becomes a major producer of palm oils.

Second half of the twentieth century

Some food manufacturers replace palm oil—which contains saturated fats *together* with unsaturated fats—with trans fats because trans fats are considered better as they have an unsaturated bond. Trans fats become very popular and useful in the baking industry and in many other kinds of food processing where a hard fat is needed.

Last decade of the twentieth century and beginning of the new millennium

Palm oil slowly finds its way back to its proper place in food processing and the diet. Studies show that palm oil's main saturated fat, palmitic acid, has a different effect on blood cholesterol than the myristic and lauric acid found in palm kernel oil. Natural palm oil contains many valuable compounds such as tocopherols, tocotrienols and carotenes and is about 50 percent unsaturated.

Part Four
WHAT THE EXPERTS THINK

In the previous sections of this book we have told you the history, the science and the dilemmas of partially hydrogenated fats. And we have told you the history, science and dilemmas of palm oil. At times we have provided brief quotes from prominent researchers and medical scientists.

In this chapter, you will find extensive interviews with experts in the field, and you will see as you read that the controversy about partially hydrogenated fats still exists, even among the experts. Some of these interviews contain more technical terminology than we have used in other parts of this book. Many of these terms are defined in the glossary on page 119.

Please note that the opinions expressed in this section are those of the interviewees and not necessarily those of the author or the publisher of this book. The sole responsibility for the scientific statements in these interviews is that of the researchers.

Let's hear from…

John W. Farquhar, MD
K. C. Hayes, DVM, Ph.D.
David Kritchevsky, Ph.D.
Artemis Simopoulos, MD
Kalyana Sundram, Ph.D.
Walter C. Willett, DrPH, MD

John W. Farquhar, MD

Stanford University School of Medicine
Professor of Medicine, Emeritus
Stanford, California

"The whole question of trans fatty acids has arisen because of the evidence that trans fatty acids are atherogenic (cause formation of plaque in the arteries). The first question is, 'Why is that the case?' The evidence shows that trans fatty acids, substituted for the cis form of oleic acid, will raise LDL and lower HDL concentrations in plasma. There is plenty of evidence that increasing the ratio of LDL to HDL or total cholesterol to HDL promotes atherogenesis.

Asking whether or not this LDL effect is key does not totally settle the issue. Nor is this issue settled when we consider whether or not the amount of trans fatty acids in the diet, as a proportion of total fatty acids, is totally equivalent in atherogenic potential to the amount of saturated fat in the diet. At first glance, it appears that since a trans fatty acid is unsaturated, you have a favorable composition of fatty acids, on a saturated/unsaturated ratio. But, that is not the case. Whenever you have enough trans fatty acids, you end up with a higher LDL and more atherosclerosis.

In order to explain the scientific puzzle, one needs to ask whether the amount of trans fatty acid in the diet is totally equivalent to the same amount of saturated fatty acid in the diet. If so, the simple assumption can then be that you are increasing the amount of *effective* saturated fat. When you look at the trans configuration versus the cis configuration, in the spatial sense, the cis form is shaped in a molecular direction, bent on itself, and it occupies a smaller volume. However, the trans form is linear, thus the total length of the molecule is much greater. This may influence function in any kind of membrane where the fatty acid is attached to a triglyceride or phospholipid molecule. The molecular mechanism by which trans fatty acids raise LDL has never been worked out in a really exacting way and that's why it is of interest to dwell on their spatial relationships.

Years ago, when I was doing fatty acid biochemistry at the Rockefeller Institute in New York, I learned that there was an amazing diversity of fatty acids. Even then, in the late 1950s when I was working with Dr. E. H. Ahrens, the question always arose as to why saturated fats raised cholesterol compared to unsaturated fats. The physical chemists would tell you about a fatty acid's molecular dimensions—saturated fatty acids being linear and unsaturated fatty acids being bent at the location of the unsaturated bond, thus occupying less linear space.

What we have been exposed to is a considerable adherence to the idea that the proportion of saturated versus unsaturated fat is the key issue in lipid metabolism. We can see how readily one gets duped, since trans fats can be hidden in foods, but still registered as unsaturated fats.

The labeling laws allow for trans fatty acids to be counted as 'unsaturated,' which they are, and yet these trans fatty acids act as if they are saturated fatty acids. It would be more accurate to have the trans fatty acids listed on the label, something that the new FDA regulation will require.

I learned years ago that, in Europe, the technology existed to hydrogenate a fat quickly to saturated, and to mix the proportions of saturated and unhydrogenated to achieve the right melting point, without having any trans fatty acids. The larger manufacturers could, in fact, do that. This is now a political issue, forcing manufacturers to create margarine that has very low amounts of trans fatty acids. They could do it in Europe, so I'm told, but since it's more expensive we don't do it in the United States.

So as long as trans fatty acids are hidden in foods, we don't know how much we're getting. Some manufacturers are beginning to list them and lower their levels even though not yet required by law. This is a step in the right direction.

I know that some people are not concerned with small amounts of trans fatty acids in food products. If you buy certain food and you find there is a trace of trans fatty acids, less than 1 percent, 'So what? It doesn't make a difference,' they would say. But I think you must take the total dietary profile on that individual and you may find 1 percent here and 1 percent there, and pretty soon you're talking real trans.

So, I think it has to be answered only in the company that it keeps. That's the simple answer. I don't think there's a threshold that I know of. One can always have miniscule concentrations of offending agents having an undetectable effect on biological systems."

K. C. Hayes, DVM, Ph.D.

Professor of Biology (Nutrition) and
Director, Foster Biomedical Research Laboratory
Brandeis University, Waltham, Massachusetts

"Having researched fats and oils for about 30 years, I'm very interested in fats—not just the whole fat in a bottle or tub, but more specifically the individual fatty acids attached to each fat molecule. My interest focuses on how each fatty acid affects the metabolism of the fat molecule. That differs from the layperson's usual understanding of what fat is all about, which centers around saturated fat or monounsaturated fat or polyunsaturated fat being good or bad. Most don't realize that any one of those fats contains three distinct fatty acids, and that even a saturated 'fat' contains a few polyunsaturated 'fatty acids' on some of its molecules.

When you consider an edible fat, for example, a total fat like palm oil, one should ask, 'What are the characteristics of its three fatty acids, i.e., what is the relative profile of saturated, monounsaturated, and polyunsaturated fatty acids within that fat?'

To that point, my interest in palm oil developed about 15 years ago, when I was studying the effect of various fats and oils—predominately saturated animal fats, but also vegetable oils like corn oil, safflower oil and canola oil—on the response to blood cholesterol, primarily in animals, but subsequently focusing on humans. What we found was surprising: a saturated fat like palm oil does not raise total blood cholesterol as much as one might predict, and at times, not at all. In the process of exploring this observation, we studied animal fats that had been stripped of cholesterol, e.g. beef tallow, which is probably the most widely consumed saturated fat, as well as stripped pork fat, lard and butter fat. It soon became evident that even something like beef tallow or lard did not raise blood cholesterol as much as expected once cholesterol was removed, suggesting that the saturated *fatty acids* present in a saturated *fat* interacted with dietary cholesterol to raise blood cholesterol.

To examine this further we studied palm oil, coconut oil and other natural saturated oils, the so-called tropical oils, that naturally contain no cholesterol. In the tropics, where it is very hot, unsaturated oils would deteriorate under the heat, so nature has made them saturated to protect against rancidity and breakdown. Coconut oil raised blood cholesterol extraordinarily, very much like butterfat. Palm oil, itself, was intermediate. It didn't raise cholesterol very much, unless or until diet cholesterol was added. Then, it behaved much like beef tallow or butter that naturally contain cholesterol. In essence, palm oil was not as cholesterol-raising as butter because the saturated fatty acids present in butter (and coconut oil) are different from those saturated fatty acids present in palm oil.

So the first message when considering fat is to include the concept of fatty acids. The second point is that, within the framework of saturated fats, not all saturated fats are equal. The reason is they contain saturated fatty acid chains of different lengths, ranging from 2 to 18 carbons, and their content of *polyunsaturated fatty acids* (PUFA) can differ 4- to 5-fold. The length of the carbon chain plus the available PUFA greatly influences the texture and metabolism of the fat, including how it affects blood cholesterol.

We have actually touched on three key points about fat:

1. The so-called classification of *fats*: saturated, monounsaturated, and polyunsaturated fats;
2. Classification depends on the *profile of fatty acids.* The fatty acid profile for any given fat can be saturated, monounsaturated, or polyunsaturated and, within a fat molecule, one type of fatty acid class tends to predominate. If the majority are composed of saturated fatty acids, it is a saturated fat; if predominantly composed of monounsaturated fatty acids, the fat is

monounsaturated; and if PUFA predominate, then it is a polyunsaturated fat. So the classification of fat and the profile of its fatty acids are important considerations.

3. The fact that not all saturated fats are equal is an important public health point, not well understood by the average consumer. Most think that a saturated fat is a saturated fat. That is problematic for the manufacturer, trying to educate the public about the fact that they're not all the same—coconut oil contains mostly saturated fatty acids (SFA) with carbon lengths of 8 to 14, while palm oil contains primarily 16 carbon and some 18 carbon saturated fatty acids. Thus, one can appreciate the difference in the fatty acid profiles that could influence how the body reacts to any particular fat.

Dietary fat raises and lowers total blood cholesterol depending on fat saturation. It tends to raise it when saturated fat is consumed and lowers it when polyunsaturated fat is consumed. The interesting part here is that monounsaturated fats, rich in monounsaturated fatty acids (MUFA), tend to be neutral; i.e., MUFA neither raise nor lower cholesterol. From this standpoint, monounsaturated fat is a safe fat. That's partly why olive oil gets such good marks—in isolation it doesn't seem to do much of anything either bad or good to blood cholesterol, so it can be added as a fat to provide energy without manipulating blood lipids. On the other hand, if it replaces saturated fat, especially ones rich in 12+14 carbon fatty acids, blood cholesterol will fall because SFA were removed. If it wholly replaces a polyunsaturated fat, cholesterol will rise slightly because PUFA are removed.

Another good aspect about certain vegetable oils is their content of so-called phytochemicals, including cholesterol-like molecules called phytosterols. Phytosterols, present primarily in corn oil, soybean oil and cottonseed oil, are very effective reducers of the bad LDL cholesterol.

When we lower or raise our cholesterol by the fat we eat, subfractions of blood cholesterol are affected differently by the type of fat. The two major subfractions are the LDL cholesterol—'L is for lethal' or the bad cholesterol, so one prefers not to have much of it—and HDL cholesterol, which is high-density lipoprotein cholesterol—'H is for healthy,' so we want as much HDL as possible.

The story is more complicated when describing how fats and their fatty acids work—not on total cholesterol, but on LDL and HDL cholesterol independently. Saturated fats, like coconut oil and butter fat, raise total cholesterol, but they raise LDL cholesterol more than HDL. Thus, saturated fats rich in 12 and 14 carbon fatty acids tend to raise cholesterol by raising LDL, or bad, cholesterol the most.

In contrast, palm oil or lard, or even beef tallow stripped of its cholesterol—i.e., animal fats with cholesterol removed—tended to raise HDL as much, if not more, proportionately, than the LDL if PUFA intake was also adequate. That was revealing because, although saturated fats can raise total cholesterol, it is important to know whether the fat you consume is raising LDL (the bad) or HDL (the good) cholesterol. Not all saturated fats are equal in that capacity.

On the other hand, the main effect of polyunsaturated fat is to lower total cholesterol quite dramatically. The good part is it lowers your LDL. The bad part is that excess polyunsaturated fatty acids also lower HDL … not so good. Ideally, it would be nice to devise a fat—make a new fat, in other words—by blending natural fats to ensure enough PUFA to lower LDL, the lethal cholesterol, and enough SFA to raise HDL, the good cholesterol.

Accordingly we blended different fats and conducted feeding trials. The bottom line is that you can blend a polyunsaturated fat like corn oil or soybean oil (those are probably the two best ones along with canola oil), or some combination of those polyunsaturated fats, together with a saturated fat to gain the desired combination. We tried coconut oil or palm kernel oil—which is very much like coconut oil—and regular palm oil and a liquid fraction of palm oil called palm olein.

The different types of palm oil is a story in itself. The oil palm nut has a hard kernel inside and a soft fruit on the outside, much like a date palm fruit. The soft fruit contains the 'palm oil.' But, if the hard nut or the seed is removed from the center, crushed, and extracted with steam, one melts out the seed oil, and palm kernel oil is isolated. It looks and behaves biologically very much like coconut oil and has a fatty acid profile similar to that of coconut oil.

Thus, most of the fatty acids in palm kernel oil, as in coconut oil, are 12 and 14 carbons long. Palm oil, however, is predominantly 16 saturated carbons and 18:1, shorthand for 1 unsaturated carbon–carbon double bond in the 18C chain, i.e., mostly 16:0 (palmitic acid) and 18:1, which is oleic, the predominant fatty acid in olive oil.

When palm oil is isolated from the fruit, it is a soft solid at room temperature. If warmed, it becomes liquid. Rapidly cooling it will generate a liquid fraction that rises to the top and a more solid fraction that settles to the bottom—i.e., it separates into two layers. The upper liquid layer is called palm olein, so named because it is rich in oleic acid, a monounsaturated fatty acid, and in many respects is beginning to assume the characteristics of olive oil. This palm olein fraction of palm oil is the major form of palm oil sold in the Far East for everyday use, where palm oil is widely utilized. In those markets the oils are liquid when sold. They are not solid and you would not think of them as 'saturated fat.' That reflects the fact that the palm olein fraction—the oleic acid, monounsaturated fatty-acid-rich fraction, is used for cooking oil.

So we examined the different fractions and different fats by feeding them initially to animals. After about 200+ fat blends over several years, we selected the best palm oil-based blends that also included soybean, canola or corn oils. These blends proved quite useful and stable to heat, which is important for cooking, and so forth. We manipulated the various levels of these fats in our search for a blend of fat that would lower the bad LDL cholesterol while increasing the good HDL cholesterol. In essence, the polyunsaturated portion of fat blend lowered LDL, while the saturated fatty acids from palm oil raised the healthy HDL cholesterol.

Initial studies with these blends in animals—gerbils and hamsters and then monkeys—eventually became collaborative studies with colleagues from the Palm Oil Research Institute in Malaysia in humans. Together we identified blends of fat that would lower the LDL slightly and increase the HDL. The total cholesterol did not change much in humans, because in that population the cholesterol was already low—about 175 mg/dL, not a bad level. But the ratio in the blood LDL to the HDL was improved. It confirmed the animal data, but demonstrating the effect in humans was important.

In addition, the fat blend stabilized the polyunsaturated portion against heating, which rendered it a superior frying oil, as well. The discovery was patented and the technology used to make the blended fat into a margarine spread, cooking oil, mayonnaise and shortening. It has also been added to fat in popcorn. So it is possible now to go through the day and obtain your fat from many sources of food stuffs, all of which contain this blend, which is a balance between the SFA and PUFA. It performs well—mouth feel, texture, etc. and the spreads are very flavorful—very nice products.

Trans fatty acids (TFA)

We began these studies about 15 years ago when it became apparent that trans fatty acids, which are made superficially in the manufacture of fats, and which are present in most margarines and especially in fast food fry oils, were harmful to biological systems. This is revealed in abnormal metabolism of cholesterol that causes a distortion in the LDL/HDL ratio, because, unlike saturated fats, which raise both LDL and HDL, trans fatty acids decrease the HDL and raise the LDL; so, in essence, TFA are worse than the saturated fats and SFA that they replaced!

You may ask, 'Why did we ever start using TFA? What good are they?'

The story reflects the excess supply of vegetable oils—soybean oil, corn oil, cottonseed oil—that developed and a need for stable frying oils and shortenings for making breads, pastries, biscuits and crackers, etc. You can't very well make a cake with oil—it just turns out a bit greasy and oily.

What the industry found was that the extra soybean oil available could be modified by bubbling hydrogen through it to partially harden it. When we talk about saturated fat, what we mean is that the carbon chains are all saturated, i.e., their bonds are filled up with hydrogen molecules. Nature completes that process when saturates are made. So oil chemists asked, 'Why not take hydrogen and bubble it through vegetable oils and see what happens?' They found that the hydrogens would bind to any unsaturated carbon molecules. (That's where we get the term, *unsaturated fatty acids*—i.e., they are unsaturated with hydrogen.) They bubbled hydrogen until they achieved the degree of hardness desired, 'partially hydrogenating' the unsaturated carbon chains.

If continued long enough, fully hydrogenated oils result. But the fat becomes very hard. It's very non-plastic, very brittle, much like candle wax. That's not appealing or acceptable for food processing. But if they stopped hydrogenation three-quarters of the way through the process, a goo or semi-solid fat resulted that was very much like palm oil in its consistency. At room temperature it would remain solid, i.e., hold together, and make a suitable tub or stick margarine. And these products pleased the cooks and bakers greatly, and for many years the trans fats produced seemed acceptable until it was discovered that the trans-monounsaturated acids formed in the process of partial hydrogenation of vegetable oils were inducing abnormal metabolism... unlike the oleic acid formed during nature's process. In TFA the hydrogens happened to be on opposite sides of the carbon chain, which is trans—instead of the natural cis form, where the hydrogens are located on the same side.

So, we found out that trans fatty acids made by human hand—bubbling hydrogen through oils—is a 'no-no.' We don't understand the full degree of distorted metabolism yet or exactly how it works, but one of TFA main effects is to interfere with the normal metabolism of polyunsaturated fatty acids (PUFA).

Polyunsaturated fatty acids (PUFA)

To take this story full circle one can ask, 'Well, what's so important about polyunsaturated fatty acids?' For starters, our bodies cannot make PUFA from scratch, like SFA or MUFA, so we must eat them. Thus, by definition, they are essential to our diet, and we have nicknamed them, 'essential fatty acids,' or EFA. These essential fatty acids come in two families, so-called omega-6 and omega-3 fatty acids (n6 and n3 for shorthand). Omega-6 is present in most vegetable oils, while omega-3 occurs in select vegetable oils, like canola and soybean oils, with flaxseed oil being the richest source of omega-3.

Omega-3 fatty acids are also found in plankton in the sea, an oceanic vegetable source. The plankton are eaten by fish, which make them into long chain n3 fatty acids, converting 18 carbon n3 into 20 and 22 carbon n3 fatty acids. These are the fish oil n3 PUFA, which are the most biologically active within the n3 family.

When people refer to omega-3s, they're usually referring to the long-chain omega-3s in fish oil. More is learned about that group every day.

Fish consumption, and the associated omega-3 fatty acid intake, is very beneficial to metabolism. The underlying physiology is that polyunsaturated fatty acids are very special, whereas saturated fatty acids and monounsaturated fatty acids are mainly for burning—i.e., we use them for energy. We store them as the fat around our midriff. When we need them, e.g. if we exercise enough or get lost in the woods for six weeks, we actually go into fat breakdown and start burning up these fats. The fat stored in your adipose tissues, i.e., your body fat stores, is primarily palmitic acid, or 16 carbons as in palm oil, and 18:1, which is oleic acid, the other main fatty acid in palm oil.

Basically, in the absence of dietary fat, our body makes its own fat from the extra carbohydrate energy that we eat and generates the same two fatty acids (16:0 and 18:1) that we find, ironically, in palm oil. So, we know that these two aren't bad fatty acids. By contrast, PUFA (18:2n6, 18:3n3, 20:5n3, 22:6n3) tend to be scarce in nature and, accordingly, are hard to come by in our food. The reason is that polyunsaturated fat in nature tends to become rancid easily; so plants limit the amount of PUFA they incorporate in their oils.

For complex biochemical reasons, we have a metabolic need for PUFA—both the omega-6 and -3 families. Both types are needed for the structure of membranes, where saturates and monounsaturates cannot function. Much of the fat in our brain, which insulates the brain cells and nerve fibers, is composed of special polyunsaturated fatty acids, especially omega-3s. The retina, the structure in the back of our eye responsible for our vision, is the richest source of n3 PUFA in our body, and represents a very highly structured membrane. In fact, wherever special membranes are present for cell function and structure, these essential fatty acids reside; and all originated with our diet—we can't make them. So they are very important—the most important type of fat we eat.

PUFA are also critical for regulating bad LDL cholesterol, getting it out of the blood and into the liver so we can eventually excrete it. Both omega-6 and omega-3 PUFA are involved. The omega-6 is the only fatty acid, really, that effectively lowers LDL cholesterol; omega-3 fatty acids, on the other hand, are key to special hormonal functions of cells. The n6 and n3 PUFA tend to oppose each other metabolically. Omega-6 are pro-inflammatory, so whenever we develop an infection, omega-6 fatty acids bring out the cell warriors to attack the invader, the microbes and bacteria, or whatever enters the cell, the skin, or other break in the body's surface. The omega-3 fatty acids tend to restrain the process, in essence saying, 'Hey, wait a minute, not so much inflammation; things are getting out of hand.' In essence, the omega-3s prevent the anti-infection process from getting out of hand. If you have a skin rash that won't heal—sometimes because it is too inflamed—omega-3s will help calm it down so healing can proceed.

Because they compete in metabolic processes, the dietary ratio between omega-6 and omega-3 is highly discussed and somewhat controversial; it should ideally reside somewhere between 4:1 and 8:1 of n6:n3. Some have retraced the evolution of dietary PUFA and speculate that the original dietary ratio was closer to one to one, but we don't need that much omega-3, and omega-3s do tend to be expensive and more unstable. Having omega-3s in a product limits its shelf life. That's one of the reasons that soybean oil was partially hydrogenated, because it is rich in omega-3s that tend to be easily damaged by air and light that induce rancidity. That produces a stable product—but it also destroys the important omega-3 fatty acids that the body needs in metabolism. Therein lies part of the problem with partial hydrogenation in the trans fatty acid story; that is, we have been too vigorous in our attempt to stabilize oils to prolong shelf life and sacrificed an important PUFA in the process.

So you can see that the fat story is very complicated. In one sense, it is simple—you can tell people, yes, avoid saturated fat or eat unsaturated fats that fall in the simple categories of monos and polys (depending on either one or two or more carbon-carbon double bonds). Nutritionists suggest you avoid saturated fat, but what they mean is don't consume too many saturated fatty acids; and I'm telling you it is not just saturated fatty acids—you must be careful which kinds of saturated fatty acids you consume and how much PUFA are eaten at the same time. I would agree that eating too many 12- and 14-carbon saturated fatty acids, i.e., the fats that contain those two fatty acids in abundance, is, indeed, very cholesterol elevating. On the other hand, I have told you that some saturated fatty acids are required to make certain food products, since you can't cook everything with liquid oil. So a somewhat harder fat is needed. I've also tried to explain why it's better to have a naturally hard fat, with its fatty acids provided by nature, rather than partially hydrogenated unnatural trans fatty acids that were made as a modified fat. These partially hydrogenated fats don't metabolize very well.

Assure yourself of the right fat blend in your total diet—remember that we usually eat fat all day long and there is no magic bullet in a teaspoon of the special balanced fat blend or a teaspoon of modified butterfat with corn oil added—that won't do it. Rather, examine your total fat profile and approximate the proper fatty acid balance when all the different fat components are totaled for the day. You need to assess the profile of fatty acids and then say to yourself, 'Ah ha, now I've made my own fat by choosing and selecting foods during the day that give me a balance of my entire fatty acid intake.' You want a roughly equal balance: one-to-one-to-one, of saturates to monounsaturates to polyunsaturates. That will assure you a healthy fat metabolism."

David Kritchevsky, Ph.D.

Wistar Institute
Philadelphia, Pennsylvania

Trans fats

"In the 1950s, researchers began to study trans fats. Animal studies showed that trans fat did not affect reproduction over a number of generations or litter weight or litter size. In the 1970s, this issue was raised again, and, at that time, the Federation of American Societies of Experimental Biology (FASEB) and the British Nutrition Society convened committees to discuss the effects of trans fat. What they decided was (1) we need more research—which is always a safe decision, and (2) that at the then current level of intake, trans fat posed no danger.

But this topic didn't die; people keep talking about the trans fat. Here at Wistar, we have done two studies on trans fats—one in rabbits and one in monkeys. In rabbits, on a cholesterol-free diet, trans fat does, indeed, raise cholesterol level, but has absolutely no effect on atherosclerosis, and the same was true in the monkeys. But people persist in saying, 'look what it does.'

About 10 years ago, the trans fat problem started again, and again there were several organizations—FASEB, National Institutes of Health, British Nutrition Society—that all agreed that, at the current level, trans fat was probably not harmful. In 1975, a nutritionist at Unilever said he thought trans fat was like saturated fat, because if you have enough polyunsaturated fat in the diet, you don't get any trans fat effects. You would think this would be a pretty good clue, but people never give up. Ed Emken did a study, and just looked at all the data on the human studies. He took the diets and the percentage of trans fat and percentage of polyunsaturated fat and if the ratio of trans fat to polyunsaturated fat was high, then you got elevation in cholesterol, but if it was low, you didn't.

In the work of Katan and Mensink (that is quoted in this book), if you plot LDL:HDL ratio against percentage of calories from trans fat you get a straight line going up. If you plot LDL:HDL ratio to the percentage of calories from polyunsaturated fat, you get a line with the same slope going down. What this says to me is that trans fat can be a danger in the absence of enough polyunsaturated fat; but in the presence of enough polyunsaturated fat, it doesn't seem to have too many deleterious effects. Nobody has done a side-by-side comparison of trans fat low 18:2 vs. trans fat high 18:2.

A couple of other things: Instead of worrying about the implication of all the research, if you look at trans fat intake and death from heart disease in the United States, the trans fat intake over the last 20 or 30 years has not changed or has changed very little, and death from heart disease has plummeted. So you can't say it's really leading to more heart disease. In the May, 2003 issue of the *American Journal of Clinical Nutrition*, there is an article from Katan's group again and they say, several times, while the effect on the ratio of HDL to LDL might predict what is going to happen to serum cholesterol, we have absolutely no idea of what it does to coronary heart disease. And the only way to test that is by clinical trial.

Let's remember that we have trans fat in our diet in many animal foods and most commonly used oils, like soybean oil, have traces of it.

Palm Oil

The palm oil scare in this country began when Phil Sokoloff, a layperson who had survived a coronary, took out full-page ads in many papers saying tropical oils were killing us.

I think the best studies on this, that may go a little toward clarifying it, are those done by K. C. Hayes. He has shown that if the cholesterol level is low enough, then palmitic acid in the diet has no effect on cholesterol levels. It only has an effect in a high-cholesterol diet, whereas fats like myristic acid and lauric acid had an effect no matter how much cholesterol was in the diet.

If you have a relatively low intake of cholesterol, maybe 300 milligrams or so, then palmitic acid is not hypercholesterolemic. If you go beyond that, then it does raise cholesterol, while lauric and myristic acid raise cholesterol no matter how much or how little cholesterol you have in the diet."

Artemis Simopoulos, MD

President, The Center for Genetics, Nutrition and Health
Washington, DC

"The early research on the effects of trans fats on health has now been confirmed by several studies in various parts of the world. What is important is that the level of trans fatty acids, which normally do not occur in our diet in more than 2 percent of energy, has increased to very high levels, almost 5 to 7 percent of energy, both in Canada and in the United States. In Europe, the level was much lower; however, in Holland, the government stepped in and recommended that the level of trans fatty acid should not be more than 2 percent—in fact, they recommended that 1 percent would be best.

Having adverse effects in diets has led to government involvement in certain countries. In the United States, we still do not label trans fatty acids, but the Food and Drug Administration has just issued new regulations and some companies list them voluntarily.

What is happening is that every time you use pressure and hydrogen to solidify the oil, all kinds of trans fatty acids are being formed above and below where the double bond is going from the cis to the trans position. Although there are studies in animals showing that certain trans fatty acids are worse than others, and some may be beneficial, there are no clinical studies of any worth that will make you consider either that trans fatty acids have a beneficial effect or that one could actually know which trans fatty acids are in what cracker or cookie or cake that is made with trans fats and margarines.

In animal experiments, certainly trans fatty acids seem to increase the aggregation of platelets found in the blood. Also in animal experiments they decreased testosterone production in rodents. But none of these studies actually have been carried out in humans. I think what happens in humans, particularly in Western diets that are higher in saturated fat and trans fatty acids, is that there is a high degree of platelet aggregation, which *may* be due to trans fatty acids. But these studies have not been confirmed in larger groups. On the other hand, we know that omega-3 fatty acids decrease platelet aggregation.

I honestly believe that the moment you digress a lot from the evolutionary aspects of the diet—for example, we know that normally humans did not have more than 2 percent of energy from trans, and that was because some plants have trans fatty acids, naturally, and also from many of their dairy products because of the bacteria in the rumen (they have trans fatty acids). Our organism really is not able to tackle this high amount of 5 and 7 percent trans, and we know that, relative to the lipid levels, they have detrimental effects. I do not recommend that people eat packaged food that contains trans fats.

It is true that there are natural trans fats in natural foods. Take a fat with one double bond and a length of 16, for example. Wild plants like purslane, a Mediterranean plant that is common in southern Italy and Greece and is part of the diet of these regions, has a little bit of trans fats. The picture is quite complicated when we try to distinguish between natural trans fats from vegetable and from animal sources, but trans fats from animal sources apparently have different functions than trans fats from vegetable sources.

But this is something that people are just beginning to recognize. There is still much more we need to learn about this whole trans fat story."

Kalyana Sundram, Ph.D.

Head of Food Technology and Nutrition Unit,
Malaysian Palm Oil Board

"Palm oil originated from West Africa. In West Africa, when technology is not available, they simply take the oil palm fruit, put it in a pot and cook a stew out of it. The oil leaches out along with its constituents—provitamin A, carotenoids and vitamin E. We have perfected a technology for Malaysian palm oil, and this technology allows us to produce red palm oil that retains its carotene content and its vitamin E content. We are talking of carotenoids of about 500 mg/kg of oil and vitamin E up to 800 mg/kg of oil. This is the only oil commercially available that is rich in natural carotenoids and vitamin E.

Palm oil contains both tocopherols and tocotrienols that are vitamin E isomers. We currently know of 4 tocopherol isomers and 4 tocotrienol isomers. There are only two commercial edible oils that are rich in the tocotrienols: one is rice bran oil, the other is palm oil. In palm oil, the vitamin E consists of about 30 percent tocopherols and 70 percent tocotrienols.

A number of studies have been done, and more studies indicate that tocotrienols behave as very strong antioxidants. These studies suggest the antioxidant properties of tocotrienols to be about 40 times those of alpha- tocopherol. Thus, whenever we do antioxidant studies, we find that the antioxidant potential of tocotrienols is very potent indeed.

In Malaysia most cooking oil that is used is what we call 'refined palm oil' or the liquid fraction called 'palm olein.' If you take a typical

Malaysian diet, we are what Americans would call a low-fat-consuming population. Our fat intake is only about 26–27 percent when compared to America, where it is looming at about 32–35 percent energy. If you analyze the fat content in any Malaysian diet, you will find that almost 80 percent of the fat consumed is predominantly palm olein or palm oil. So Malaysians typically are consuming most of their visible fat as palm oil and palm olein.

With the red palm oil, it is a little bit different. Red palm oil is sold as a health oil and it is retailed typically at a higher price than the ultimately refined palm oil. There is a lot of interest in the red palm oil, but because of its color, which is red due to the carotenoid, there is some consumer resistance to acceptance of the oil. This is seen not only in Malaysia, but also throughout the world. But once people understand that the red color is due to the carotenoids, which have beneficial health properties, they then start rather willingly to consume the red oil.

When we refine palm oil, we are removing all the free fatty acids and some pro-oxidative materials that we don't want in the oil. The reason is that we want to prepare an oil that is totally bland, that does not provide any aroma or flavor of its own. We want it to just absorb the aroma and flavor from the foods you cook. During refining, a little of the vitamin E is lost. In the crude oil, we start with about 800 mg/kg, and in the refined oil, up to 500–600 mg of vitamin E are definitely retained. Thus, only a maximum of 200 mg of vitamin E is lost during refining. When I say vitamin E, it is a combination of tocopherols and tocotrienols, and it is all in the same proportions (30 percent tocopherols and 70 percent tocotrienols). When you fully refine the oil, *ALL* the carotenes are lost. The idea is to arrive at a golden-yellow-colored oil.

The amount of saturated fat and mono fat and polyunsaturated fat in this refined palm oil is not changed as a result of the refining process. We still have about 46–48 percent saturated fatty acid, about 40 percent of monounsaturated oleic acid, as you find in olive and canola, for example, and the remaining amount is the polyunsaturated linoleic acid.

Using palm oil in baking and prepared food

If the baking or the cereal industry wants to replace hydrogenated fats, it would be advantageous to look at palm oil. It is a semi-solid fat, because of its fatty acid compilation. If you want to make a solid fat, like a margarine or a frying fat, and keep the solid texture of these products, you can't get this consistency by using liquid oils such as soybean, corn or sunflower. That is why the industry takes these liquid oils and hydrogenates them, to increase the melting point of these liquid oils. In the process, we introduce trans fatty acids.

If you start with palm oil, you can actually make a solid fat with palm oil, which calls for little or no modification of the fat, either by hydrogenation or any other process. You can use a hundred percent natural palm oil and still have a natural fat without hydrogenation.

What we have done now is to formulate many palm-based, non-hydrogenated solid fat formulations that include margarine, fat, bakery and frying fat, that come with zero hydrogenation or zero trans fatty acids. Basically, because technology is very advanced, you can blend palm oil with the liquid oil to the consistency you require and produce an oil that is zero trans (no hydrogenation).

There is a very good example of this in the United States market. Today there are a range of products that contain a fat blend that is a balance between the SFA and PUFA. These products have been patented and designed through Brandeis University and are available in the United States, through supermarkets, and they actually make the claim, 'Improves human cholesterol ratio.' They have balanced fatty acid composition in that oil composed of a combination of palm oil with liquid oils, including soy.

The question is, 'Does palm oil, either the very natural one or the refined palm oil that you sell to the industry or for use in Malaysia, raise blood cholesterol?'

What we have done to answer this question in Malaysia is to undertake more than 152 studies worldwide, many of which are human studies. The human studies have looked at blood lipids and lipoproteins such as blood cholesterol, LDL cholesterol and HDL cholesterol. Palm oil was used at what is known as recommended levels of fat intake; that is, about 30–32 percent of fat intake. In these studies, we find that palm oil does not raise blood cholesterol levels. Palm oil behaves as a neutral fat and we equated these effects to controlled human clinical trials and made comparisons with olive oil, canola and rapeseed oil, for example. The results have been very consistent. They show that palm oil is equal to these monounsaturated oils for the effects on blood lipids when consumed at recommended levels of fat intake, 30–32 energy percent. If you compare palm oil with a hydrogenated fat, you find that palm oil does much better than the hydrogenated fat. The hydrogenated fat increases total cholesterol and LDL cholesterol and reduces HDL cholesterol; but palm oil does nothing to your total cholesterol, and sometimes reduces the LDL cholesterol and basically increases your beneficial HDL cholesterol.

Trans fatty acids

The Institute of Medicine has recommended that there should be zero level or zero tolerance of trans fatty acids in the American diet. The industry needs to get away from hydrogenated fat and look for an alternate fat. The only way you're going to do that is to incorporate natural solid fat, and palm oil is a natural fat that would lend itself to these formulations.

If the food industry doesn't want to use palm oil itself, the Malaysian industry has the facility to provide different palm fractions—it's like cutting and pasting fractions—that will go wonderfully well with food formulation technology. You can choose these palm fractions and put them in different types of products, depending on what is your ultimate desired composition.

The question that is often asked is, 'What about just very small amounts of hydrogenated fats?' This is controversial at this time. Trans fatty acids demonstrate an ability to accumulate in tissues and organs. If you look at the studies from Harvard Medical School, they looked at the long-term accumulation of trans fatty acids in adipose tissue and established a strong positive relationship to cardiovascular disease individuals. They showed that there is a direct correlation between the amount of trans fatty acid consumed and the incidence of a myocardial infarction, for example. Although people argue that small amounts would be tolerable, it would be wise to simply avoid trans fatty acids.

Palm oil types

When we talk about palm oil, we are talking about the oil from the flesh of the fruit. There are only a few commercial oils that are extracted from the flesh of the fruit—one is palm oil, the others are olive and avocado oils—and I guess that is why there are so many similarities. The seed oil from the palm fruit is known as palm kernel oil and its composition is very different from palm oil. People have confused this palm kernel oil with the one from the pulp of the fruit of the palm.

Palm kernel oil is a very highly saturated fat. It has about 85 percent saturation and it is best equated with coconut oil. It is what we call a 'lauric oil.' Palm kernel oil is mostly used by the oleo-chemical industry for making soaps, detergents, washing liquids, and similar things. And, very little is used in the food industry.

I believe that the palm kernel oil is what gave a bad name to palm oil, because people confused the oil of the pulp with the oil of the kernel, so people think palm oil is a super-saturated fat, right?

The evidence is very strong at the moment that, compared to current formulations in the industry that now use trans fatty acids or hydrogenated products, a switch to palm oil would definitely guarantee a much healthier fat formulation that can better protect consumers against cardiovascular disease. That's the message we want to convey from Malaysia. I think the industry needs to examine the evidence critically and take up the challenge."

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"Trans fats are a very big concern. Actually, they are by far the worse type of fat in the diet. If you stop eating them, it will take years before your body really gets rid of all the trans fatty acids. We know that the amount that you eat is represented almost proportionally in the body's fat stores, where we store fatty acids. It's better to start sooner rather than later, but it's going to be a long-term process.

As a physician, I was telling people during the early 1980s that they should be using margarine instead of butter because the American Heart Association and other organizations told us that it was better, and we somehow believed that someone had actually investigated this and found that margarines were better than butter. But most margarines at that time were very high in trans fats, about 25 to 30 percent of the fat in the margarines. The problem was that there was very little research. There was never any study done to show that people who ate margarine had better blood lipids or lower risk of heart disease than people eating butter.

There were a few studies that looked only at total cholesterol and concluded that trans fats seemed to be no worse than saturated fat, although that wasn't exactly a strong recommendation. But it somehow suggested that trans fats were a little bit better than saturated fat with regard to total cholesterol in the blood.

The real problem is that total cholesterol can be very misleading, and it was really the study by Drs. Mensink and Katan in the early 1990s that clearly showed the problem with trans fat from the blood cholesterol standpoint. What they did was look not just at the effect of trans fat on total cholesterol, but on LDL (the bad cholesterol) and HDL (the good cholesterol). What they showed was that trans fat has about the same effect as saturated fat on the LDL fraction, but unlike any other fat, trans fats reduce HDL, the good cholesterol in the blood. So the ratio of LDL to HDL, or total cholesterol divided by HDL, which provides the best prediction of heart disease, is about twice as bad for trans fat compared to the same amount of calories from saturated fat.

That study done by Katan and his colleagues was controversial. It used trans fat at about 10 percent of calories, which is pretty high. There were some people in Holland actually consuming that much, but the average in the United States was more like 3 or 4 percent of calories from trans fats. Of course, that's the average—some people were eating 5 or 6 percent of calories from trans fat and other people were eating just 1 or 2 percent—quite a range.

There was a lot of criticism of the Mensink and Katan study, but since then many other studies have been done, including a study sponsored by the food industry done by Judd and his colleagues of the U.S. Department of Agriculture. They used trans fat at 3 percent of calories and also at 6 percent of calories, replacing unsaturated fat. Basically, they found exactly the same effects as had Mensink and Katan, essentially that trans fats increase LDL and reduce HDL cholesterol.

Many people have looked at this and the results all really line up. An analysis that we published a couple of years ago plotted out all the studies on trans fat. If you look at the effect on total cholesterol-to-HDL ratio, the studies all line up and the degree of change really just depends on how much trans fat was given. There's a very clear linear relationship between the amount of trans fat and the adverse effect on lipids. I don't think there is anybody who disagrees now that trans fat has bad effects on blood lipids. Now the Food and Drug Administration has announced that they are going to require labeling of trans fats.

Along with the adverse effect on lipids, we have done epidemiological studies—the kind of study where we look at a large population for possible connection between, for example, food and disease over many years—looking at the amount of trans fat consumed in relation to risk of heart disease. There we see a very strong relationship: trans fat is by far stronger than any other type of fat in terms of its relationship with heart disease risk—which isn't surprising given its effect on blood lipid factors. We are looking in the range of what people are actually eating in the United States, not just that high 10 percent of calories from trans fat. We're looking across the range of actual diets within the United States and, again, we see a linear relationship between the amount of trans fats—down to 1 or 2 percent of calories from trans fats—and risk of heart disease.

This association with heart disease has been seen in a number of other epidemiological studies. The group from Holland did a summary analysis a couple of years ago, which was published in the British medical journal *Lancet*. There was a highly significant, overall positive association between trans fat consumption and heart disease risk. Again, this is within the range of actual diets that people are consuming.

There's now a lot of interesting work going on regarding the health effects of trans fats, and what is clear is that trans fats appear to be doing many nasty things. Besides affecting the LDL and HDL, trans fats increase triglycerides, and they increase the dysfunction of the endothelium in arteries, that layer of cells lining blood vessels, which increases risk of heart attack. Lp(a) is now recognized as an independent lipid risk factor for coronary heart disease, and trans fats compared to saturated fats do raise Lp(a). Again, that's also something we don't really understand. But we're somehow disrupting the normal metabolic machinery and one of the consequences we see is increased Lp(a).

Trans fats also seem to have some adverse effects on insulin resistance. We have seen in the Nurses' Health Study a clear relationship between trans fat and risk of type 2 diabetes. If we just didn't hydrogenate 2 percent of the polyunsaturated fats in our diet and transform them into trans fat, but rather just consumed it as natural, liquid vegetable oil, that would, we estimate, lead to a 40 percent reduction in the incidence of type 2 diabetes in the United States.

Parts of the baking industry have resisted the evidence that trans fats have adverse effects. There are reasons that they like to use trans fat. The majority of the fat used in the U.S. food supply is from soybean oil, and soybean oil is a good source of omega-3 fatty acids, which are essential. But omega-3 fatty acids do tend to go rancid if the product sits on the shelf for many months. The baking industry has an expectation that baked goods can sit on shelves around the country for six months—unbelievably, your cakes and cookies have a shelf life of six months—but if you have enough omega-3 fatty acids in the product, like you have in soybean oil, and it is warm or the products get into a little bit of light, they will tend to go rancid. So a major reason that the industry is using partially hydrogenated fat is to get rid of the omega-3 fatty acids and, in the process, trans fats are created. In addition, of course, they like solid fat for some of these products, but many of these products don't really require that.

From the standpoint of wanting a hard fat you could use a number of options—a little bit of palm oil or coconut oil are clearly going to be better than trans fats.

But the baking industry is not using just small amounts of trans fats. In many of the products, the amounts are actually quite high. There will be few products where there are only trace amounts. And the question is, without the trans fat content on the food label, how can the consumer know whether or not the product contains them? As of now, the only thing a consumer can do is look carefully at the food label to check for partially hydrogenated or vegetable shortening, and to avoid those products because they could contain large amounts of trans fats. On the other hand, there could be just a trace, and that might not actually be important.

Going back to hydrogenation, this process is actually pretty frightening when you think about it, and that's what got me concerned back in the 1970s when we first started looking at this issue. Basically, you are taking molecules that have important biological functions—like the essential polyunsaturated fats—and you are putting little twists in those molecules and you completely change the function. It's not just one or two different trans fatty acids, you create dozens of different artificial fatty acids that look similar to, but not exactly like, the natural ones. This is really like throwing sand into fine machinery—the body is like really fine metabolic machinery, and you are throwing dirt into this process and it's likely to cause huge problems. I should point out that it's not just the many different unofficial fatty acids; not all of them are trans fats, some are other positional isomers of fatty acids. For example, with vitamin K, you get partially hydrogenated vitamin K, as well, and destruction of some of the tocopherols. And you are creating dozens and dozens of artificial chemicals that people are eating, and not just in trace amounts. Many of these are actually fairly substantial amounts of artificial chemicals. I think we will never know all of the adverse health consequences of that process.

In the past, people thought of fat as just fuel: you burn it and it's calories. But fat and different types of fatty acids have critical biological rules. We are now learning about dozens and dozens of different critical processes. They act like hormones, they act with relation to blood clotting, they act in terms of how platelets respond, how the lining of the blood vessel responds—another kind of hormonal signaling—and in ways possibly related to cancer and cardiovascular disease. So, we're just really throwing all kinds of garbage into these important biological processes when we scramble up our fatty acids, because their function does totally depend on their shape, and we're creating all sorts of weirdly shaped compounds and gobbling them down in large amounts every day.

Let's think for a moment about natural fats. When the body or plants make fatty acids, we make them very carefully—they're sort of all made from a very careful mold. There are double bonds in the fatty acids—all of them are in the cis position—and plants make double bonds exactly in the same place time and time again. There is a special shape that the fatty acids have that is produced naturally. But partial hydrogenation is just like hitting them, hitting the fatty acids with a huge sledgehammer, and they come out twisted in all different shapes. The double bonds move up and down the fatty acid chain—those are called positional isomers—and then the double bonds also get twisted from their natural cis position to the trans position. We then have all different combinations of positions and cis versus trans, so the process of partial hydrogenation is creating dozens of artificial types of fat and all of them have different functions than did the natural fat, and that our body really uses in several metabolic processes.

When we study the effects of trans fatty acids or partially hydrogenated fats, we're talking about this whole big package of dozens of different artificial chemicals. We don't really have the power to pick them out and study them individually; they come in this huge jumbled package of artificial fats. So, that's what we call trans fatty acids. Indeed, some of the adverse effects we see coming from partially hydrogenated fats could be coming from some of these elements that are positional isomers rather than trans fatty acids.

Historically, back in the 1970s, there were just a few people who raised concerns. I worked on developing a database where we could put together the amounts of trans fats in different foods, and then with our large studies we could actually calculate how much each person was consuming. That's how we were able to design long-term studies.

It's absolutely going to be a step in the right direction to use a little bit of saturated fat in place of trans fat to get hardness in a product. I must say, some in the food industry like Unilever and many other European manufacturers have been very proactive and good about this. They saw in the early 1990s that trans fats were a problem and instead of denying the problem they invested a lot in research on how to make foods that were trans-fatty-acid-free and also low in saturated fats. What they found is that they don't have to replace trans fats one-to-one with saturated fats in their products. They can be trans-fatty-acid-free and also still low in saturated fats—not zero, but they can still be quite low in saturated fat. It only takes just a little bit of one of these other harder fats, if they spend some time working on the product, to get the consistency and the shelf life and the taste and flavor that they need.

Europe has been much more careful and much more proactive about trans fats. In fact, I went into a Danish bakery a couple of months ago in Copenhagen and there was a big sign saying 'Trans Free.' Holland has reduced the trans fat in their food supply from 6 percent of calories down to 1 percent of calories in 10 years, so they've been making some big changes in Europe."

Epilogue

Palm fruit oil in its natural or minimally refined state provides a balance of saturated and unsaturated fat. In its unrefined state, it supplies carotenes and tocopherols and is one of the few common oils that contains reasonable amounts of tocotrienols. Palmitic acid, the main saturated fat in palm fruit oil, does not raise cholesterol when consumed with a low cholesterol diet. Palm fruit oil should not be confused with palm kernel oil which always raises blood cholesterol. And unrefined or minimally refined natural palm oil is a source of precious nutrients like tocopherols, tocotrienols and carotenes.

Also, palm oil is a great choice when an oil is needed that becomes solid at higher temperatures than olive, avocado, almond, sesame and other seed oils. This is important in some types of baking and food manufacturing. It fits into a unique niche in the picture of natural oils.

Partially hydrogenated fats are, at best, equivalent to saturated fats but without the valuable nutrients and antioxidants that are present in a natural fat. These trans fats can lower HDL, the good cholesterol, something that saturated fats do not do. The larger the intake of trans fats, the greater the lowering of the HDL. Recent research shows some deleterious effects of trans fats on the particle size of LDL and levels of Lp(a), both indicators of heart disease risk. The presence of natural unsaturated fats may play a protective role when trans fats are consumed as it does when saturated fats are consumed. Manufacturers of trans fat may find other ways to hydrogenate that yield a different kind of fat.

A key point that often contributes to confusion and disagreement in nutrition is that we need to keep in mind the entire diet, including the other types of fat in the diet. There appears to be agreement that large amounts of trans fats should be avoided and that the sum of saturated fat and trans fat should not exceed 10 percent of the calories in the diet and be no more than one third of the fats. The other two-thirds should be mono and poly fats. There also seems to be agreement that, if we consume trans-fat-containing products at all, they should not exceed 2 to 3 percent of the calories, hopefully less. Some researchers, like Dr. Willett (interview page 107), feel that they should be avoided completely.

There is no doubt that natural palm oil has a lot to offer and it should find a proper niche in a healthy diet and could be a great replacement for part or all of the partially hydrogenated fats.

Always remember that neither trans fats nor palm oil and its products or any other fat lives in dietary isolation!

There is no doubt that natural palm fruit oil has a long history of use—millennia in fact—and brings us many protective phytochemicals when not refined.

A final reminder:

> *No matter what is the source of saturated fats, or if we use small amounts of partially hydrogenated fats, the sum of saturated fats and trans fats should always be balanced by unsaturated fats and should not exceed about ten percent of total calories in the diet. And let's never forget the total diet and physical activity!*


NOW WE UNDERSTAND THE GOODNESS OF PALM OIL, AND WHAT TRANS FATS ARE ALL ABOUT!
YES, BUT DON'T FORGET THE TOTAL DIET AND PROPER EXERCISE!

Glossary

Adipose tissue. The body's fat stores.

Antioxidant. A substance, such as vitamin E, selenium, and many other organic or inorganic compounds, capable of counteracting oxidative damage in animal and human tissue.

Arrhythmia. A disordered rhythm of the heartbeat that can be fatal but which usually is not life threatening, especially if it originates from the atrium, the upper chamber of the heart.

Artery. Any of the small and large blood vessels that carry oxygen and nutrients to all parts of the body.

Atherogenic. Causes formation of plaque in the arteries.

Atherosclerosis. Deposits in the arteries characterized by plaques containing cholesterol and lipids in the inner layers of the walls of some arteries.

Blood cholesterol. A fat-like substance produced by the liver, an important building block of cells and a precursor of various hormones.

Coronary arteries. The arteries that feed and bring oxygen to the heart muscle, the clogging of which leads to heart disease.

Coronary heart disease (CHD). One of the common forms of diseases of the heart where the coronary arteries that feed the heart muscle to give it oxygen and nutrients for its daily work become clogged with cholesterol deposits and may eventually become blocked.

Endothelium. A thin layer of flat epithelial cells that lines serous cavities, lymph vessels and blood vessels.

Epidemiological. Studies of health-related states conducted in specific populations of humans. Results of these types of studies are used to help control health problems.

Gram. One one-thousandth of a kilogram, abbreviated as g.

HDL (high-density lipoprotein). A globule that carries cholesterol in the blood. When cholesterol is in this form, it is considered to be protective and good, and is often called "good cholesterol."

Hydrogenated fats. Unsaturated fats treated with hydrogen under special chemical conditions to make them solid rather than liquid at room temperature. Hydrogenation can be partial or total. These fats are widely used in many prepared foods.

Isomer(s). Any two or more substances that are composed of the same elements in the same proportions, but differ in properties because of differences in the arrangement of atoms in their structure.

Kilogram. One thousand grams, or about 2.2 pounds, abbreviated as kg.

LDL (low-density lipoprotein). One of the globules that carries cholesterol in the blood. When cholesterol is in this form, it is considered to be much more damaging and to cause bad deposits (plaques) in the arteries that slowly narrow the openings of the blood vessels. That is why LDL is often called "bad cholesterol."

Lipoprotein(s). A term derived from *lipo*, which means fat, and protein. There are many large particles or globules composed of fats, proteins and related compounds that contain cholesterol and carry it around in the blood. There are many of them with many different fractions. The two most commonly used in determining risk of heart disease are low-density lipoprotein (LDL) and high-density lipoprotein (HDL).

Lp(a). Sometimes called "Lp little a," this is a special lipoprotein and an indicator of heart disease risk.

Milligram. One one-thousandth of a gram, abbreviated as mg.

Monounsaturated fats. Fats with one double bond. When they replace saturated fats in the diet, they lower blood cholesterol. Olive oil and many nuts are very high in monounsaturated fats.

Phospholipids. Any of various phosphorus-containing lipids, such as lecithin and cephalin, that are composed mainly of fatty acids, a phosphate group, and a simple organic molecule. Also called phosphatide.

Phytochemicals. Beneficial chemical compounds found in plant foods. *Phyto* means plant in Greek. Although now we know that many of these compounds are usually beneficial to health, they were not considered beneficial until recently.

Plant sterols. Compounds contained in plant foods that are somewhat similar in their chemical structure to cholesterol, but which actually help to lower blood cholesterol and may possibly have a protective effect against colon cancer.

Plaques. Deposits of cholesterol and fibers in the inner wall of arteries.

Platelet(s). Control blood clotting.

Polyunsaturated fats. Fats with two or more double bonds. When they replace saturated fats in the diet, they lower blood cholesterol.

Statins. Drugs that inhibit cholesterol production.

Sterols. See plant sterols.

Tocopherols. Any of a group of closely related, fat-soluble alcohols that behave similarly to vitamin E and are present in milk, lettuce, wheat germ oil and other vegetable oils.

Total blood cholesterol. The sum of the cholesterol in all types of lipoproteins (HDL, LDL, VLDL). To be very precise, referred to as plasma or serum cholesterol. The plasma or serum are, with minor modifications, the blood after the cells—such as red cells and white cells—have been removed.

Trans fats. Trans fats may be natural as found in many animal foods or made by partial hydrogenation of a polyunsaturated liquid oil such as soybean oil.

Triglycerides. One of the ways fats are found in foods and in the body.

Unsaturated fats. Fats that have one or more double bonds between the carbon atoms in their molecules. This makes them more reactive than saturated fats. They are usually liquid at room temperature.

VLDL (very-low-density lipoprotein). One of the lipoproteins that carries cholesterol in the blood.

Some Scientific References for the Science-minded Reader

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