

## 1.) Health Risks from Processed Foods and Trans Fats: Part I

Interview With Dr. Mary Enig

Interviewed By Richard A. Passwater Ph.D.

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Mary G. Enig, Ph.D., a nutritionist widely known for her research on the nutritional aspects of fats and oils, is a consultant, clinician, and the Director of the Nutritional Sciences Division of Enig Associates, Inc., Silver Spring, Maryland. She received her PhD in Nutritional Sciences from the University of Maryland, College Park in 1984, taught a graduate course in nutrient-drug interactions for the University's Graduate Program in Nutritional Sciences, and held a Faculty Research Associateship from 1984 through 1991 with the Lipids Research Group in the Department of Chemistry and Biochemistry. Dr. Enig is a Fellow of the American College of Nutrition, and a member of the American Institute of Nutrition. Her many years of experience as a "bench chemist" in the analysis of food fats and oils, provides a foundation for her active roles in food labeling and composition issues at the federal and state levels.

Dr. Enig is a Consulting Editor to the "Journal of the American College of Nutrition" and formerly served as a Contributing Editor to "Clinical Nutrition." She has published 14 scientific papers on the subject of food fats and oils, several chapters on nutrition for books, and presented over 35 scientific papers on food and nutrition topics. She is the President of the Maryland Nutritionists Association, past President of the Coalition of Nutritionists of Maryland and was appointed by the Governor in 1986 to the Maryland State Advisory Council on Nutrition and served as the Chairman of the Health Subcommittee until the Council was disbanded in 1988.

I first learned of Dr. Mary Enig's research from a 1978 report in the Federation Proceedings. We met shortly after that, and since I had written about trans fats several times in *Supernutrition*, we had common concerns about the effect that these trans fats from processed foods were having. We were both concerned particularly about the misconception that processed margarine was better than natural butter.

In several visits by Dr. Mary Enig to the Solgar Nutritional Research Center I quickly learned that she was an exacting scientist who is not afraid to speak out and who supports good nutrition, not just going along with the establishment's party line. While studying for her Ph.D. at the University of Maryland, often she would first respond with the "correct" answer that was expected, and then she would explain why new research indicated "alternatives," such as optimal vitamin and mineral nourishment, provided a better answer. It is not easy to be credentialed by the "system," while your own research shows other facts.

In part I of my interview with Dr. Enig, we will discuss the harm caused by partially-hydrogenated fats that are present in processed foods. In Part II, we will discuss how partially-hydrogenated fats increase heart disease and cancer risks, and how the processed food industry tries to suppress this information.

In her 1978 report, Dr. Enig challenged the speculation concerning the relationship of dietary fat and cancer causation. She concluded that correlations between the increase in per capita dietary fat intake and total cancer mortality over a sixty-year period show significant positive correlations for total fat and vegetable fat, and negative correlation for animal fat. That is the cancer rate is higher when the amount of vegetable fat or total fat is higher in the diet, but the cancer rate is lower when there is more animal fat in the diet. These findings were unpopular then as they are

today, but they are still correct. It is convenient to blame everything on red meat and animal fat, and believe that vegetable oil is the great dietary salvation -- even if it is partially hydrogenated. At least that is what the vegetable oil people would like everyone to believe.

Now, we are not saying that lots of dietary fat is good for you and that vegetables are not good. Eating vegetables, fruits and other whole foods is very desirable. However, that is not the same as eating partially-hydrogenated vegetable oils. Americans eat too much fat (especially partially hydrogenated vegetable oils) and not enough fruits and vegetables. The problem is that the typical American is not eating enough whole foods, but instead, is eating too much partially-hydrogenated vegetable oil -- a fractionated food -- that has been made into "funny foods" such as margarine or added to baked goods. Such "funny foods" are far different than real whole foods.

Hydrogenation ruins the nutritional value of vegetable oils! Why would anyone want to ruin the nutrition value of vegetable oils? The purpose of hydrogenation is to solidify an oil so that it can be made to resemble real foods such as butter. The hydrogenation process imparts desirable features such as spreadability, texture, "mouth feel," and increased shelf life to naturally liquid vegetable oils. In the hydrogenation process, vegetable oil is reacted under pressure with hydrogen gas at 250 - 400oF for several hours in the presence of a catalyst such as nickel or platinum. However, this industrial process cannot control where the hydrogen atoms are added to the "unsaturated" double bonds. Randomly adding hydrogen atoms to polyunsaturated fats converts natural food components into many compounds, some of which have never been seen before by man until partially hydrogenated fats were manufactured.

Some of the several dozens of altered compounds created in the manufacture of partially-hydrogenated fats are "trans" fatty acids. Fatty acids are the building blocks of fats, much like amino acids are the building blocks of proteins. Other new compounds accidentally synthesized include fatty acids having double bonds translocated to new and un-natural positions, and various molecular fragments. Many of these altered compounds are detrimental to health.

Since "trans" fats are so detrimental to our health, permit me to briefly review the relevance of distinguishing between "trans" and "cis" fats before chatting with Dr. Enig. Recently, in the September issue, in the interview with Dr. Jim Clark and Mr. Lance Schilipalius, we discussed "trans" isomers of carotenoids. "Trans" means the same thing here. "Cis" and "trans" isomers refer to how identical atoms are added to double bonds. When the atoms are added to the same side of the double bond, the compound is called "cis" and the molecule is bent because of the crowding of the atoms on one side. When the atoms are added on opposite sides of the double bond, the compound is called "trans" and molecule is "space-balanced" and straightened. The shape of a molecule is important because enzymes and their substrates -- the molecules enzymes act upon -- must fit together like a key in a lock.

Dr. Enig will discuss this during the interview, but the important thing to remember is that natural polyunsaturated fatty acids are "cis" compounds and are bent. Partial hydrogenation produces many un-natural "trans" fats which are straight and not intended for use in the human body.

You don't have to understand the difference between "trans" and "cis," but it is important that you know that there is a difference because, as Dr. Enig will explain, it can affect your health.

**Passwater:** Dr. Enig, a lot of people are interested in "trans" fats now. You have been researching them since 1977. How are trans fats harmful to us?

**Enig:** More than a decade of research at the University of Maryland, as well as research that was being done at other institutions, showed that consumption of trans fatty acids from partially hydrogenated (a process that adds hydrogen to solidify or harden) vegetable fats and oils had many adverse effects in health areas such as heart disease, cancer,

diabetes, immunity, reproduction and lactation, and obesity. It is rather easy today to come up with a long list of these adverse effects from the published research done by many scientists around the world, as well as the researchers at the University of Maryland.

The reason there is so much recent interest is that during the past three years there has been a number of major research reports published in prestigious medical journals that caught the attention of the press. These and earlier reports had shown, for example, that consumption of trans fatty acids lower the "good" HDL cholesterol in a dose response manner (the higher the trans fat level in the diet, the lower the HDL level in the blood) and raise the atherogenic lipoprotein(a) in humans as well as raising the "bad" LDL cholesterol and total blood cholesterol levels by 20-30 milligram-percent. These studies have usually been shown in independent non-industry studies. Perhaps the most significant event though was the report from researchers at Harvard University, who evaluated more than 85,000 women in a long-term prospective study and found that there was a significantly higher intake of trans fatty acids in those individuals who developed heart disease.

As regards to the question of cancer, trans fatty acids induce adverse alterations in the activities of the important enzyme system that metabolizes chemical carcinogens and drugs (medications), i. e., the mixed-function oxidase cytochromes P-448/450. The initial research in this area was done by the Maryland group in collaboration with the U. S. Food and Drug Administration, and was followed by the more extensive evaluation that I did for my Ph.D. dissertation; several groups around the country and the world also reported the same or similar results. Several groups around the world reported a higher intake of partially hydrogenated fats in those individuals who have developed cancer.

Both primate and human studies have shown inappropriate handling of blood sugar; trans fatty acids decrease the response of the red blood cell to insulin, thus having a potentially undesirable effect in diabetics. The primate research was initiated at Maryland in collaboration with the U. S. Department of Agriculture and the National Institutes of Health, and the human research is from the University of Pittsburgh and quite recent.

One major concern is that trans fatty acids adversely affect immune response by lowering efficiency of B cell response and increasing proliferation of T cells. This was shown in research done at Maryland using a mouse model and although there are reports from clinicians that there are problems of immune dysfunction in humans it still needs to be evaluated systematically in humans.

Recent research from outside the U. S. has indicated that trans fatty acids interfere with reproductive attributes and of concern is the finding that trans fatty acids lower the amount of cream (volume) in milk from lactating females in all species studies including humans, thus lowering the overall quality available to the infant. The latter research was done at Maryland by my colleague Dr. Beverly Teter.

Basically, trans fatty acids cause alterations to numerous physiological functions of biological membranes that are known to be critical for cell homeostasis, e.g., appropriate membrane transport and membrane fluidity, and these fatty acid isomers produce alterations in adipose cell size, cell number, lipid class and fatty acid composition.

**Passwater:** Now that trans fats are becoming of more interest, the term may still just be a buzz word to many of our readers. Would you explain just what are trans fats? Where do they come from? How are they formed?

**Enig:** To understand what trans fatty acids are you have to understand what fatty acids are. Fatty acids are basically chains of carbon with a carboxyl group (COOH) at one end that can react (e.g., combine) with another molecule. When

fatty acids are in fats or oils they are combined with glycerol in the proportions of three fatty acid molecules to one glycerol molecule and they form triacylglycerols or in common terminology, triglycerides.

Fatty acids come in different chain lengths ranging from three carbons long (propionic acid) to 24 carbons long (lignoceric acid). These fatty acids are either "saturated" (with an adequate number of hydrogen atoms) and chemically stable, or they are "unsaturated" (missing adequate hydrogens) and chemically unstable. If a fatty acid is missing two hydrogens, it is called a monounsaturated fatty acid, and in place of the two hydrogens, the adjacent carbons "double" bond to each other. If the fatty acid is missing four or six or more hydrogens, it is called a polyunsaturated fatty acid, and it is even more unstable than the monounsaturated fatty acid. Because the double bonds in naturally occurring plant oil fatty acids are curved with a "cis" configuration, the fatty acids cannot pack into a crystal form at normal temperatures so their presence produces a liquid oil. Saturated fatty acids have a straight configuration and can pack into a solid crystal at normal temperatures.

If the unsaturated fatty acids are altered by partial hydrogenation to straighten the chains so that they have some of the physical packing properties of saturated fatty acids they have had their "cis" double bond changed to a "trans" double bond and they turn a technically mostly unsaturated oil into a solid fat. The trans fatty acids are the same length and weight as the original "cis" fatty acid they were formed from, and although they have the same number of carbons, hydrogens, and oxygens they are shaped differently in space. The term that is used is that they are "isomers." The problem arises when a large number of the trans fatty acids are consumed from foods and they are deposited in those parts of the cell membranes that are supposed to have either saturated fatty acids or "cis" unsaturated fatty acids; under these circumstances the trans fatty acids essentially foul up the "machinery."

Although the trans fatty acids are chemically "monounsaturated" or "polyunsaturated" they are considered so different from the "cis" monounsaturated or polyunsaturated fatty acids that they cannot be legally designated, e.g., monounsaturated for purposes of labeling. Most of the trans fatty acids produced by the partial hydrogenation process are chemically monounsaturates.

There have always been small amounts of one kind of trans fatty acids in the human diet from the ruminant fats (dairy, sheep, goat, deer, buffalo, antelope, etc.) because the microorganisms in the rumen try to get rid of the polyunsaturated fatty acids that are found in the plant foods eaten by these animals. In the early days of trans fatty acid research, the researchers assumed that the trans fatty acids found in ruminant fats were no different than those produced by partial hydrogenation in the factory. But the studies showed that not only was the amount much smaller (e.g., the fat in butter might be 2-3% of the ruminant trans), the effect on the "machinery" in the cell membranes was not different than without the trans. Yet all studies feeding the trans produced by partially hydrogenating the vegetable oils showed the adverse effect on the cell "machinery."

**Passwater:** Why are trans fats a problem?

**Enig:** The various mechanisms through which the trans fatty acids disrupt function are related in part to the ability of trans fatty acids to inhibit the function of membrane related enzymes such as the delta-6 desaturase resulting in decreased conversion of e.g., linoleic acid to gamma-linolenic acid or arachidonic acid; interference with the necessary conversion of omega-3 fatty acids to their elongated tissue omega-3 fatty acids; and escalation of the adverse effects of essential fatty acid deficiency. This latter effect was shown especially by the work of Dr. Holman and his colleagues at the Hormel Institute at the University of Minnesota, the other effects have been shown by many researchers including the University of Maryland researchers.

**Passwater:** What were your early findings and what got you interested in this area of research?

**Enig:** My initial published research in 1978 when I was at the University of Maryland showed that trans fatty acids, which were increasing in the food supply at the time and which had not been catalogued in any of the food data tables, were the very factors that explained the positive statistical relationship between the increase in cancer mortality and vegetable fat consumption in the U. S.

It was clear from the literature that once the trans fatty acids were identified as products of partial hydrogenation and studies were engaged in, there were a number of earlier researchers who questioned the biological safety of the trans fatty acids viz a viz their relationship to both cancer and heart disease. In fact, Dr. Ancel Keys had originally claimed that the partially hydrogenated vegetable oils with their trans fatty acids were the culprits in heart disease. This was in 1958, and the edible oils industry was very swift in their squelching of that information; they shifted the emphasis to "saturated" fat and started the phoney attack on meat and dairy fats.

**Passwater:** What have others added to your findings?

**Enig:** As you have noted in some of your writings, we at the University of Maryland were not the first to raise the issue of trans fatty acids and adverse health effects; Dr. Fred Kummerow from the University of Illinois, Dr. George Mann from Vanderbilt University, and Dr. Edward Pinckney with the American Medical Association had sounded the alarm many years before my plunge into the foray. In fact, I had drawn heavily on the research findings of Dr. Kummerow and the informative writing of Dr. Mann when I first started to investigate what was known about health effects of trans fatty acids at the time. Our research findings have been duplicated by others, but more importantly other independent researchers have extended and explained many of our findings and concerns.

**Passwater:** I remember how the processed food industry tried to suppress your early research. In Part II, let's discuss the techniques used against you and how you overcame them, and then we can more fully discuss the relationship of various fats to heart disease and cancer.

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## 2.) Health Risks from Processed Foods and Trans Fats: Part II

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Mary G. Enig, PH.D., a nutritionist widely known for her research on the nutritional aspects of fats and oils, is a consultant, clinician, and the Director of the Nutritional Sciences Division of Enig Associates, Inc., Silver Spring, Maryland. She received her PhD in Nutritional Sciences from the University of Maryland, College Park in 1984, taught a graduate course in nutrient- drug interactions for the University's Graduate Program in Nutritional Sciences, and held a Faculty Research Associateship from 1984 through 1991 with the Lipids Research Group in the Department of Chemistry and Biochemistry. Dr. Enig is a Fellow of the American College of Nutrition, and a member of the American Institute of Nutrition. Her many years of experience as a "bench chemist" in the analysis of food fats and oils, provides a foundation for her active roles in food labeling and composition issues at the federal and state levels.

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Last month we talked mostly about what trans fats (TFAs) were, how they interfere with "machinery" of our normal cell biology and that they are a recent and unnatural intrusion into our diets. In Part II, we will look into the health problems caused by TFAs, and in Part III, Dr. Enig will put the research on TFAs and other fats in perspective and give us her thoughts on the pluses and negatives of the Health Food Industry as seen from academia.

**Passwater:** You mentioned the your research was stimulated by the early investigations of Drs. Fred Kummerow, George Mann and Edward Pinckney. What did you set out to investigate and what have others added to these findings?

**Enig:** Much of the Trans- Fatty Acid (TFA) research that was accomplished at the University of Maryland from 1977 to today was done to answer some very basic questions. For example, we wanted to know how much TFAs people were being exposed to. So during some of the early research, we measured the amounts of TFAs in typical U. S. foods and then estimated the amounts in various diets and in the food supply.

The next set of efforts was done to measure the effects that feeding diets containing physiologically relevant amounts of TFAs to laboratory animals had on some reproductive and lactation functions, on the alteration of membrane properties, and on the consequent alteration of enzyme functions that had physiological importance. These different efforts were measured by our research group, and many of our findings, e. g., that the enzyme functions were adversely affected, were repeated by various other research groups. It is hard to tell sometimes if we were repeating the findings of others or if others were repeating our findings. I think it is safe to say that the research was invariably reproducible as long as the same animal model and the same amount of TFAs were used. In other words, our findings were real and other researchers could easily find the same thing.

A number of research groups were able to use some of our basic findings, and many of the researchers were using their own models and their research was providing information that was parallel and complementary to ours. In many instances, the other research teams had access to better funding and models that we did not have at the University of Maryland.

One research group at Auburn University examined diets of adolescent girls and directly measured the TFAs in their diets by laboratory analytical methods. [16, 17] They found that approximately two-thirds of the TFAs in the diets of these adolescents could be predicted by the food composition data in our 1983 research paper for 220 foods. This is rather remarkable since their research was done in another part of the country. It does show the similarity of many of the same types of partially hydrogenated fats in diets across the U. S.

A research group at Louisiana State University studied, among other things, the effects of TFAs on what is called "the second messenger," cyclic AMP and the digitalis receptor. [18] They found that TFAs affected both.

Still another research group, this one at Virginia Polytechnic Institute, studied the effect of TFAs on bone development. [19, 20] Their research showed some very undesirable effects! AS far as I know, the latter two groups who were finding important effects have not been able to continue because of lack of funds for TFA research. Their efforts were done independent of our concerns and findings but parallel to our efforts.

There have been a number of other research efforts that have been given widespread publicity. These include the published findings from Dr. Martijn Katan's lab in Holland that the TFAs lower the "good" High-Density Lipoprotein (HDL) and raise the "bad" lipoprotein [a] (Lpa) which is atherogenic. [21] Also, the published findings from Dr. Walter Willett's research at Harvard on 85,000 nurses, as well as other prospective studies, have showed that those people who consumed the most TFAs had the most heart disease. [3] Dr. Willett's group also has preliminary, as yet unpublished, data that those individuals who developed breast and prostate cancer had higher intakes of TFAs. These findings have been presented at scientific meetings by Dr. Willett and his staff.

I have recently prepared a technical report which includes additional information that would normally not be found in typical scientific reviews. [22] This information is of special interest to many in the food industry and the regulatory agencies. The report identifies all of the different research groups that have been working on TFAs around the world over the past 60 years.

**Passwater:** I remember how the processed food industry tried to suppress your early research. As Rodney Leonard, the editor of Nutrition Week noted, you fought tenaciously to bring out the truth and were "a burr under the saddle of the [processed food] industry and the government, persistently challenging the contention that the health threat of trans fatty acids is overplayed and that the current level of consumption poses no threat to public health." Most of those who were skeptical then have examined the steady stream of new data and now agree with you that TFAs are a major health threat. How were you able to keep on? What techniques were used against you and how did you overcome them? Where did you find moral and scientific support?

**Enig:** As you know from some of our past conversations, we ran into some strong challenges from certain segments of the edible oil industry regarding our findings. In addition to writing several articles to "refute" our findings, and seeing to it that our major reports did not get properly referenced, those individuals who actively opposed our research were able to influence funding sources. Gradually though, other researchers started to realize that we were correct and

appropriately conservative in our approach to research, and consequently, most of the "bad- mouthing" that we encountered has backfired.

**Passwater:** Yes, I remember well how we were both encountering difficulties with "the establishment." I am happy to note, as you well know, that the same is happening regarding my findings regarding vitamin E and the prevention of heart disease, and of the antioxidant nutrients in the prevention of cancer. We never did get the funding needed to further pursue our research.

**Enig:** You're right. At the University of Maryland we never did get the type of funding that you need to receive to continue the level of research that would have been desirable, but what funding we did receive was carefully managed and many of the people in our research group were dedicated to the research.

I think we found moral support because we knew we were scientifically correct, and ultimately the scientific support came as other researchers started to evaluate the problems without having certain industry people set up their research protocol. AS you realize from your years of involvement in research, good research properly done is always reproducible, if all the variables are the same, but it is also possible for unscrupulous individuals to set up a research protocol designed to obfuscate, and if that gets published, it keeps other good researchers from continuing to work in the area. Frequently, those individuals who are coopted write their summary and abstract the way the industry wants them to, but they usually leave their data intact so that a knowledgeable researcher can recognize the inconsistency. However, it is a very time- consuming task to constantly challenge each piece of misinformation that you see.

**Passwater:** Yes, it is a difficult task, but you and I give it our best shots. In the past we did a lot of challenging others to prove us wrong, and now we can smile a lot.

**Enig:** Our work is not done yet! There is still much to do.

**Passwater:** Right again! How big is the problem with TFAs? How extensive are trans fats in our modern diets, and how does this compare to ancient diets and other diets around the world.

**Enig:** Today the levels of TFAs vary around the world from practically zero to levels much like those found in our foods in the U. S. It depends on how much partially hydrogenated vegetable fats or partially hydrogenated marine oils are present in the food supply.

Without the commercial partial hydrogenation process, as would have been the case more than a hundred years ago, the levels of TFAs in diets would be relatively low. Only the ruminant fats would have supplied any, and the types of isomers that are found in the ruminant fats behave in a very different way from those found in the partially hydrogenated vegetable oils. Additionally, the research shows that the TFAs are more of a problem when the level of saturated fat is low. Diets that are higher in ruminant fats are also higher in saturated fats. Most ruminant fats have about 2- 3% TFAs whereas the partially hydrogenated vegetable fats are commonly 30- 40% and as high as 53% in foods in this country.

After analyzing hundreds of food samples for TFAs, chemically analyzing food composites, and calculating dietary information, I am confident that there are many people in this country who consume 20% of the total fat in their diet as TFAs. On average though, 10.9% is the number we came up with when we looked at all of the published analyses. The typical french fried potatoes are around 40% TFAs, and many popular cookies and crackers range from 30 to 50% TFAs, and every donut I have analyzed has about 35 to 40% TFAs. Since these are all fairly high fat products, someone

who eats a lot of these types of foods will get a large amount of TFAs. Several years ago, we documented nearly 60 grams of TFAs in someone's typical daily diet.

**Passwater:** Wow! I hope that's no one I know. Dr. Enig, you mentioned that TFAs are atherogenic - - that is they cause atherosclerosis. Then you mention that TFAs are more of a problem when saturated fats are low. Yet most people fear saturated fats because they have been told that it is the saturated fats that cause heart disease.

You are recognized as a leading expert on fats and oils, do saturated fats cause heart disease?

**Enig:** The idea that saturated fats cause heart disease is completely wrong, but the statement has been "published" so many times over the last three or more decades that it is very difficult to convince people otherwise unless they are willing to take the time to read and learn what all the economic and political factors were that produced the anti-saturated fat agenda.

Periodically, various reports have come out that show the inconsistencies in the theory. You have already discussed this with the well-known cholesterol and lipids researcher, Dr. David Kritchevsky of the Wistar Institute. [23] In 1977, Dr. Kritchevsky noted that it did not make any difference what kind of fat was added to the whole foods diets in animal studies - - only when the diets were very unnatural chemically could changes be brought about - - and from study to study these changes were inconsistent. [24]

As you frequently report, the latest theories regarding heart disease point to oxidized fats and oxidized lipoproteins as culprits. This being the case, accusations against chemically- stable, basically non- oxidizable saturated fat don't make sense. Most people who find fault with saturated fats do not really understand that our cells are busy making saturated fatty acids all the time from carbohydrates and excess protein.

**Passwater:** Do tropical oils cause heart disease?

**Enig:** No they don't. Several studies have shown that there is no increase in heart disease in countries or communities where most of the fat is either coconut oil or palm oil. Palm oil that is not extensively refined has very high levels of antioxidants, and coconut oil has high levels of very useful medium chain fatty acids. There are many older research studies that showed that adding quite a bit of coconut oil to the diet of persons having high blood cholesterol reduced their level of cholesterol. Dr. George Blackburn from Harvard Medical School has written an extensive review on this topic. [25]

It is unfortunate that this misinformation about these oils became so widespread because they are very stable oils that have unique functional properties and products made with them as the fat component usually have far less fat and therefore fewer calories. Needless to say, they would also have virtually no TFAs which are unquestionably atherogenic. When coconut oil was used in the manufacture of crackers, very little fat was added to each cracker, but the crackers did not become stale before they could be purchased. Now the fat-free crackers become very stale very quickly, and the crackers made with the more unsaturated oils are higher in fat and are greasy or they appear drier because they are made with the high- temperature melting partially hydrogenated oils. Deep fried foods made in these oils never absorb quite as much fat as they do when they are fried with the more unsaturated oils.

**Passwater:** Speaking of deep fried french fries, I notice that the Community Nutrition Institute is pleading with McDonald's to go back to their old cooking oil, an animal tallow. CNI cited higher risks of coronary heart disease,

coronary artery disease, and low birth- weight babies due to the partially hydrogenated vegetable oil that McDonald's has been using since 1990. [26]

**Enig:** Yes, when I analyzed the oils, I found that the percentage of fat that was saturated fat in their french fries dropped from 49% to 24% when McDonald's switched from animal tallow to partially hydrogenated vegetable oil. But the percentage of fat that was TFAs rose from 5% to 42- 48%. McDonald's own study showed that the total amount of fat in its fries rose from 17.6% to 27.9% Recently, McDonald's has again switched to an oil that has cut the TFAs in half. But, those who insist on eating french fries were better off when the beef tallow was used.

**Passwater:** Why were earlier researchers misled about saturated fats and heart disease?

**Enig:** The simplistic, abbreviated story of how some of the anti- saturated fat rhetoric got started and then took a strangle hold, is that when laboratory animals were fed semi- purified and artificially saturated (fat) diets, the animals actually became deficient in essential fatty acids. As a result, these animals developed lesions that were incorrectly defined as the equivalent of heart disease. This "research" was touted as showing an effect of "saturated" fat. Then when Dr. Ancel Keys of the University of Minnesota reported that hydrogenated fats were responsible for heart disease [15], the response from the threatened edible oil industry was to claim that it was only the saturated fats that were the culprits, and that the industry would get rid of the problem by only partially hydrogenating the oils. From that point on, the saturated fats stood "guilty as accused," even though study after study showed that there was no relationship between saturated fat intake and the development of heart disease.

In fact, some of the studies showed that there was less progression of the disease process when the saturated component was higher. [27] Usually the proponents of the lipid hypothesis managed to squelch the effect of these reports. Of course the partially hydrogenated oils were really very little different in saturated fat level than the fats and oils that had been called "hydrogenated," but the public and the media and many of the naive researchers didn't know that.

As time went on, the whole heart disease agenda became a multi- million dollar business that was benefiting the researchers funded by the part of the National Institutes of Health that deals with heart disease, the National Heart, Lung and Blood Institute. The only people not benefiting were and are the consumers who are continuing to get more and more heart disease at higher and higher costs. The consumer may not be dying from heart disease as often as they were 30 years ago, but they are undergoing more surgery such as by- pass and angioplasty, and they are swallowing more expensive cholesterol- lowering drugs. All in all, while the so- called mortality figures have decreased, the incidence has greatly increased.

Of course, the ill- trained consumer activist groups have added to the problem by continuing to publish their own misinterpretations of the science, and this in turn, is further publicized in the media.

**Passwater:** Well, I see that you haven't backed off and cow- towed to the consensus pseudo- scientists that form opinions without looking closely at the data. I would like you to explain the real facts and their proper interpretation for the benefit of our readers. So let's look at fats and cholesterol, TFAs and the obesity trigger, and your thoughts on helping the Health Food Industry in Part III.

### 3.) Health Risks from Processed Foods and Trans Fats: Part III

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Dr. Enig is a Consulting Editor to the "Journal of the American College of Nutrition" and formerly served as a Contributing Editor to "Clinical Nutrition." She has published 14 scientific papers on the subject of food fats and oils, several chapters on nutrition for books, and presented over 35 scientific papers on food and nutrition topics. She is the President of the Maryland Nutritionists Association, past President of the Coalition of Nutritionists of Maryland and was appointed by the Governor in 1986 to the Maryland State Advisory Council on Nutrition and served as the Chairman of the Health Subcommittee until the Council was disbanded in 1988.

In the two previous issues, Dr. Enig and I have been discussing how the trans fatty acids formed upon the partial hydrogenation of vegetable and marine oils are being shown to be more harmful than saturated fats. Margarine and other processed foods rich in Trans Fatty Acids (TFAs) were once touted to be healthy choices for good diets, but now many researchers are recognizing that TFAs are more harmful than the natural butter and animal or tropical fats they replaced.

We discussed how the processed food industry tried to cover up this fact. As Rodney Leonard discusses in Nutrition Week, "The reputation that [hydrogenated] vegetable oil as the fat of choice in a healthy diet lies in ruins. And the real question is why the American health establishment did not act sooner to correct what may be the biggest scam ever perpetuated in nutrition and nutrition policy on the American public...These trans fatty acids were found to not only have more severe health consequences for persons at risks for heart disease, but also to increase the risk for individuals prone to certain types of cancer." [28]

We have let our natural diet be changed by processed food technology. The European Community has decided to limit TFAs to four percent of the energy source. Unfortunately, as Dr. Enig has shown, the American diet is closer to 10 - 14 percent, with some individuals consuming as much as 60 grams of TFAs daily. Let's continue to look into the trumped-up reasons given to us by food processors as why we should switch to TFAs, and then see what the truth is.

**Passwater:** Some "authorities" are implying that all saturated fats or animal fats greatly increase LDL cholesterol by shutting down LDL receptor production which consequently causes LDL cholesterol to build up in the blood, while

they are also implying that all polyunsaturated fats or vegetable fats either lower LDL cholesterol or raise it only modestly.

Would you share with us your perspective of what we can accept as fact about saturated fat, monounsaturated fats, polyunsaturated fats and TFAs with respect to blood cholesterol?

**Enig:** This is a complex subject, that is difficult to explain in a few words, but I'll try to be brief. The current dogma on the effect of saturated fatty acids on LDL and LDL receptors is really an issue that is not satisfactorily clear-cut. It is not surprising that feeding different proportions of different fatty acids have different effects in different animals and different organ systems or tissues. Fatty acids are active components in regulating all sorts of homeostatic mechanisms in mammalian systems. But sometimes some of the basic research that identifies what is happening to one part of the cell does not really show what is going on in another part of the cell or in the whole person, and these reports have to be interpreted carefully.

I am concerned about the inconsistencies in interpreting the research. One example of such inconsistency can be seen when you compare some of the research with recent reviews. In a section of a 1980 report that measured the effect of dietary fats on LDL-cholesterol in humans, i. e., the effect of saturated and polyunsaturated dietary fat on the composition of LDL, the total cholesterol in LDL from feeding saturated fat was 59.1% (balanced is phospholipid and triglyceride) and the total cholesterol in LDL from feeding polyunsaturated fat was 59.5%. Not very different and certainly not higher than from saturated fat!

These data are from the research of Dr. Antonio M. Gotto's group at Baylor College of Medicine. [29]

Given these findings, I have some real problems with the unreferenced or inappropriately-referenced statements in, for example, the recent chapter on regulation of LDL-cholesterol levels that appeared in the 1993 Annual Reviews of Nutrition. The statement was made that "... {fats} containing predominantly saturated fatty acids further increase the concentration of cholesterol carried in [the LDL] fraction ..." and that "... when fed at equal levels, saturated fatty acids are more active in increasing the LDL-C concentration than are unsaturated lipids in reducing the concentration." There was no reference given for the first part of the statement; the references for the latter part (a 1957 paper by Dr. Ancel Keys et al and a 1989 talk by Dr. Mark Hegsted) are really inappropriate in my opinion.

**Passwater:** I see that you still tell it like it is. My next question won't be of interest to most of our readers, but I have to ask it because it will be important to other researchers. So readers please hang on for a brief moment while I get a tad technical, and then we'll get to the practical "take home" message.

Dr. Enig, how about the LDL-receptor?

**Enig:** Briefly, so much of the research on down regulation of the LDL-receptor appears to be done on cells like fibroblasts which are questionably appropriate. One report showed that down regulation of LDL-receptors by saturated fatty acids was considered a good phenomenon since the cell was a macrophage. In addition, any of the changes that are occurring in response to short-term feeding that are likely to be rearrangements of homeostatic mechanisms don't mean very much. I know that many feeding studies have been purposely cut off after a short term so that it would show something that would not show up in the long term.

As I said, I think this very complex area probably needs a whole article that delves into the meaning of the inconsistencies. Many people have interpreted these reports as meaning that people should avoid saturated fatty acids

and consume more polyunsaturated fatty acids. It is important to know that historically no people had a high intake of polyunsaturates in their diets. This is really a phenomenon of the present century, and the evidence against the excess intake of polyunsaturates is mounting.

**Passwater:** Its ironical - - animal fats have been blamed for the damage caused by partially- hydrogenated oils - - which started out as wholesome vegetable oils - - that is, until they were chemically altered by man. I can't help but think about so many in the general public who are not scientifically trained and who have been brain- washed by the countless illegal commercials that promise that using margarine will protect them from heart disease. These people don't even read the newspaper accounts such as the report from Harvard that margarine actually is associated with increased heart disease and heart disease death. In the Harvard study of 85,000 nurses, after adjusting for all known possible confounding factors including total fat and total calorie intake, there was a fifty percent greater incidence of heart disease among those women with consuming the highest fifth of percentage of fats as TFAs compared to those in the lowest fifth. [3] Since all other factors, including total fat and total calories were compensated for, the researchers conservatively concluded, "these findings support the hypothesis that consumption of partially- hydrogenated vegetable oil may contribute to occurrence of coronary heart disease."

Then there is the recent report in the American Journal of Clinical Nutrition that found that the risk of coronary heart disease increases as consumption of vegetable oil rises. [30]

However, the years of newspaper, magazine and TV ads that falsely told them that margarine was good for the heart - - has made them think that it was true.

Now we are learning that mothers are giving their children soda or skim milk with their meals so as to avoid the fat in milk. They want to protect their children against heart disease by giving them very low fat diets in their youth. What effect is the fear of saturated fat having on the health of our children?

**Enig:** It is really unfortunate that children are being encouraged to drink low- fat milk instead of whole milk. In addition to the fact that milk is a good source of calories for growth (children actually need fat as an energy reserve so that the protein they are consuming can be well utilized for growth), there are a number of components in milk that are not widely appreciated. Milk fat globule membrane has anti- cancer properties and some of the fatty acids found in milk (and coconut oil) have anti- microbial properties.

**Passwater:** I am seeing reports that there appears to be a link between TFAs and obesity? Dr. Lewis H. Kuller has made such comments in Lancet, and Drs. Edward Siguel and Robert Lerman have indicated such a possible link in the American Journal of Cardiology. [31,32] I have also read discussions where TFAs have been called "the obesity trigger."

**Enig:** There was a report earlier this year at a major symposium on obesity that was held in New York, that the metabolic effect of increasing dietary TFAs changes characteristics of muscle cells that trigger the onset of diabetes and increasing obesity. I have not seen the actual research, but am looking forward to following it.

**Passwater:** Dr Enig, many of our readers are hearing about trans fats for the first time. Others may not be sure of what your message is regarding red meat, animal fat and vegetable oil. Would you give us a "take home" perspective regarding your advice on dietary fats?

**Enig:** The important thing to understand is that all fats are basically mixtures of saturated, monounsaturated and polyunsaturated fatty acids in different proportions. There isn't any real evidence that everyone needs to consume exactly the same balance of fatty acids, except that we do know that people need to take in at least 2- 3% of their fat as the omega- 6 fatty acids and at least 1- 1.5% of their fat as omega- 3 fatty acids. This means that smaller people expending fewer calories need fewer calories of each fatty acid and total fats than larger or more active people who consume more calories.

The fats that humans have consumed for millennia, such as the fats they added to mixed dishes, were almost always more saturated than they were unsaturated. It was the easily extractable fat or oil. The fat came from the animal, or, in the case of areas such as the tropics, it was the oil that came from the coconut or the palm fruit that was used in cooking. Sometimes it was one of the very stable oils such as olive oil or sesame paste that contained lots of built- in antioxidants and weren't too polyunsaturated.

People didn't really have the ability to extract oil from vegetables such as corn, or from many seeds as they do today. However, they got their essential polyunsaturated fatty acids from many of these plants when they were included in the foods they were eating. People used the intact leaf, root, nut, grain or seed along with all their antioxidants in the stews or the porridges that most people ate. This was the manner in which the polyunsaturates were historically consumed. The polyunsaturated fatty acids didn't have to be hydrogenated to protect their integrity and keep them from going rancid because they were consumed in a protected whole- food state.

People on low- fat diets historically consumed adequate amounts of essential fatty acids from foods such as grains, vegetables and nuts; and then they made their own saturated fat for the necessary structural adipose (structural body fat) and energy storage. Those people with higher fat intakes in their diets still had about the same amount of essential fatty acids, and ultimately the same amount of saturated fat for storage or as the energy source. Regardless of whether they ate it or made it, the fat in the tissues of our ancestors was relatively saturated, and therefore, the fatty acid supply to the tissues was predictably saturated. Today, with the high levels of partially- hydrogenated vegetable and marine oils in the diets of many people, the tissues and organs are faced with a new situation. Many researchers have now concluded that the presence of the TFAs is causing shifts in favor of chronic disease. Not a good situation!

The bottom line is to consume as many whole foods and whole food mixtures as possible. Since we live in a society where other people prepare most of the foods many of us eat, it is important to look for the least processed and the least likely to go rancid when it comes to fats and oils.

There is nothing wrong with consuming your essential fatty acids from oils as long as those oils are safely extracted and carefully stored, but a good balance needs to be maintained with sources of the more saturated fats such as the animal tallows and/or dairy fats for those who are not vegetarians, or the more saturated fats such as palm or coconut oils for those who are vegetarians.

**Passwater:** These facts will be hard to accept by those who have always heard just the opposite, and because of this constant repetition, they have come to believe the erroneous information. While we're on the subject of truth, let's shift gears for a moment.

You attended the Waxman hearing in July. What comments do you have to offer about the FDA efforts to limit nutritional products and information?

**Enig:** One major problem as I see it is that the members of congress and their staffs have only part of the information and almost none of the training to understand that the FDA is running with misinformation a lot of the time. But, if it suits their agenda, they will vigorously use it.

The supplement industry needs to be sure of its facts, needs to spend the time and effort to document these facts. The science is on the side of whole foods and rational supplementation. There is one thing that bothers me; as an expert in lipids I notice mistakes in many books, magazines and newspapers being made by "spokespersons" about the effects of fats and oils in health. I immediately discount the reliability of source of the information and suspect anything else that is being said. Sometimes I make allowances and can salvage certain facts and separate the wheat from the chaff, but others not so inclined, might not be so lenient. Since the FDA has a very biased attitude towards the whole foods and supplement industry, any erroneous written material that is put out by that industry or on behalf of that industry is considered grist for the FDA's mill. I hate to see the good apples spoiled because of the presence of a few rotten ones.

**Passwater:** There is so much that needs to be covered, and we didn't even get around to discussing omega- 3 and omega- 1 fatty acids. Perhaps you will be kind enough to chat with us again. I am sure that TFAs cause membrane abnormalities that can cause irregular heart beats and I want to pursue the research that suggests that TFAs trigger obesity. We are going to hear a lot more about TFAs in the future. It has taken 15 years, but I feel that the corner has now been turned and the momentum is building. The data can no longer be suppressed.

Your pioneering studies will have a major impact on helping people select better diets in the future. Now the public will have to deal with the fact that most junk foods are high in trans fat - - and this is a deadly reality that can not be compensated for merely by juggling other food components. Changing the ratio of polyunsaturates or saturates does not alter or compensate for the accumulation of trans fats. People will no longer be able to rationalize junk food as "just" being devoid of nutrients which can be replaced with supplements. People will no longer be able to rationalize junk food as "just" being high in fat which can be held in check by keeping the total dietary fat to 30% or less of total calories by selecting low- fat high- sugar foods. The reality is that there are only two healthy choices - - either get the trans fats out of foods and pseudo foods such as margarine - - or don't eat them. At least we can control the latter.

Dr. Enig, what are you looking into now?

**Enig:** I have submitted a proposal for a research project that aims to evaluate a specific nutritional support approach that I think will be extremely useful for individuals with HIV/AIDS. I am currently waiting to hear about the funding. I am presently preparing some of the research done by our group at the University of Maryland for submission to the appropriate scientific journals. I am also writing articles and a book aimed at correcting a lot of the misinformation that has been written about fats and oils. The working title of the book is "Know Your Fats: The complete primer for understanding fats, oils and cholesterol." The book is meant to be a comprehensive primer that would accurately explain what I have realized most people involved in nutrition don't really understand. I am also teaching short courses and workshops on lipids and nutrient- drug interactions. I felt that there is a great need for people with my training to continue to teach and consult.

**Passwater:** And, I am sure that you will continue to speak out for scientific truth. I can hardly wait for your book to be published. Thanks for taking the time to inform us about the dangers of trans fats in processed foods. I still admire your bravery in presenting the information in scientific forums, rather than taking the easy path of merely researching topics that are "politically" safe and don't risk losing funding or dirty tricks. I have always enjoyed our nutrition discussions through the years and look forward to more of your visits to the Solgar Nutritional Research Center.

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### **Richard A. Passwater Ph.D.**



Richard A. Passwater, Ph.D. has been a research biochemist since 1959. His first areas of research interest were in the development of pharmaceuticals, spectrophotoluminescence and analytical chemistry. His laboratory research led to his discovery of biological antioxidant synergism in 1962 which has been the focus of his research and patents ever since. In 1970, Dr. Passwater shifted the emphasis of his research from pharmaceuticals to nutrients. In 1975, his best-selling book "Supernutrition: Megavitamin Revolution" was credited with legitimizing megavitamin therapy. Dr. Passwater has continued to research nutritional supplements and has now published over 35 books and booklets, as well as over 400 articles on nutrition and nutritional supplements.

Dr. Passwater was Director, Research Analytical Laboratories at Allied Chemical Corporation in Marcus Hook, PA, Director, Applications Research Laboratory at Baxter-Travenol Laboratories, Inc. in Silver Spring, MD, and Vice President of Research of the American Gerontological Research Laboratories

Division of Life Science Labs, Inc. in Rockville, MD.

### **Antioxidant Research**

Dr. Passwater has been researching antioxidant nutrients since 1959 and discovered biological antioxidant synergism in 1962. In 1970, at Toronto, he presented his evidence to the Gerontological Society's Annual Scientific Congress that antioxidant nutrients offered a practical means of increasing human lifespan. He was the first to show that practical combinations of antioxidant

nutrients increase the lifespan of laboratory animals (Chemical & Engineering News 1970). Previously, Dr. Denham Harman had developed the free radical theory of aging and had shown that large amounts (0.5% of the diet) of some non-nutrient antioxidants increased mouse lifespan.

The reports of Dr. Passwater's research, in 1970, by Ladies Home Journal, and in 1971, by Prevention magazine, may have been the first times that the words "free radical," "antioxidant nutrient" and "selenium" appeared in lay articles.

Dr. Passwater was also the first to publish that a synergistic combination of antioxidant nutrients significantly reduce cancer incidence (Cancer: New Directions. American Laboratory 1973). Dr. Passwater was also the first to publish an epidemiological study showing that vitamin E reduces heart disease risk (Prevention 1976). His original research has now been confirmed by others including three studies by Harvard University researchers.

## **Selenium Research**

Dr. Passwater's research with selenium was first reported to the general public in the December 1971 issue of Prevention magazine. His research with selenium and other antioxidant nutrients had led to patents and a FDA Investigative New Drug application in 1970 for reducing free radical pathology and slowing the aging process. During 1970 through 1972, he found that selenium was a key antioxidant nutrient in reducing cancer incidence. In 1972, he filed for a patent involving selenium and other antioxidant nutrients in preventing cancer. (US 39140, US 97011) His latest selenium patent involves a class of diselenides to protect against cancer (EP 750911, CA126(10)135612s)

In 1973, he published in American Laboratory his research on selenium and other antioxidants in reducing cancer incidence. "Supernutrition: Megavitamin Revolution" (1975) and "Cancer and Its Nutritional Therapies " (1978) reviewed his selenium research in the prevention of cancer. He also published "Selenium As Food & Medicine" (1980), "Selenium Update" (1987), and "Selenium Against Cancer and AIDS" (1996).

## **Chromium Research**

Dr. Passwater conducted laboratory animal research with GTF chromium and diabetic mice in the early 1980's and found that GTF chromium reduced obesity, reduced the side-effects of diabetes and increased the lifespans of diabetic mice.

He has written both a booklet and book on chromium nutrition. His booklet, "Chromium Picolinate" was published in 1992. This was followed by the book, "The Longevity Factor" in 1993. He has written several articles about the role of chromium in health.

## **Other Research**

Besides his discoveries in cancer and aging, Dr. Passwater's research includes a five-year study with Drs. Linus Pauling and James Enstrom (UCLA School of Public Health) on the benefits of dietary supplements on a large group of Californian volunteers, and a study of the protective effect of vitamin E against heart disease. The Enstrom-Pauling study showed that the supplemented volunteers had only two-thirds the death rate expected for Californians of the same age, sex, race, etc. [Proc. Natl. Acad. Sci. 79:6023-7 (1982)]. The vitamin E study was a retrospective epidemiological study of vitamin E users which showed that long-term vitamin E users had less than half the heart disease incidence of typical Americans of the same age, sex and race. {Prevention, Jan – Aug. 1976)

## **Books**

Dr. Passwater has written more than 17 books and 19 booklets. In 1975, his book "Supernutrition : Megavitamin Revolution," (Dial Press, Pocket Books) which was based on his laboratory research, was a #4 national best seller, introducing more than 1,400,000 readers to better health through good diet and supplementation during its 18 printings. Several of today's leading researchers credit this book with sparking their interest in this field.

One book, co-authored with Dr. Elmer Cranton, was selected by Library Journal as one of the top five health books for 1983, and one of the top 100 science and technology books in a field of 40,000 books. (Trace Elements, Hair Analysis and Nutrition, Keats Publishing) Other books include "Selenium As Food and Medicine" (Keats, 1980), "The Easy No-Flab Diet" (Marek, 1979), "Cancer and Its Nutritional Therapies" (Keats, 1978), "Supernutrition For Healthy Hearts" (Dial Press, 19770), "The Slendernow

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In addition, he has written over 19 booklets and co-edited, with Dr. Earl Mindell, a series of over 100 "Good Health Guides."

### **Recent Writings**

Dr. Passwater's most recent books for the public include "The New Supernutrition" and "Cancer Prevention and Nutritional Therapies." He is the Nutrition Editor for "The Experts Journal of Optimal Health," and is the scientific editor for Whole Foods for which he writes a monthly column "Vitamin Connection," to help bring the latest research on nutrients to the public. He also serves on the editorial board of the Journal of Applied Nutrition.

He received his B.S. in Chemistry from the University of Delaware in 1959, and his Ph.D. in Biochemistry from Bernadean University of Nevada in 1975. He was certified by the American Chemical Society in 1959 and in 1984 was elected "Fellow" of the American Institute of Chemistry. Dr. Passwater's discoveries have led to world-wide recognition. He has been twice honored by the Committee For World Health (1978 and 1980). In 1973, he was nominated for the American Chemical Society's Award in Chemical Education. Additional details are found in "Who's Who in the World," "Who's Who in America," "American Men and Women of Science," "Who's Who in the Frontiers of Science" and "Who's Who in Science and Engineering." Yet, he considers his greatest honors his family, his selection as 1987 Citizen of the Year in his community, the privilege of being the Chief of his community's Fire Department for ten years, being voted into the Delmarva Firefighter's Hall of Fame in 1993, and winning the nutrition industry's Achievement Award for 1989.