

The Avocado and Human Nutrition. II. Avocados and Your Heart

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Abstract. Avocado fat is predominantly monounsaturated oleic acid, which has been shown to reduce blood levels of the low-density lipoprotein (LDL) cholesterol that contributes to atherosclerotic heart disease. Unlike polyunsaturates, oleic fatty acid consistently maintains levels of the apparently beneficial high-density lipoprotein (HDL) and may even directly reduce heart artery risks from LDLs. The avocado has additional potential heart-protective benefits in its high content of antioxidant vitamins A, C and E, high density of other nutrients, and high soluble fiber content. Actual experimental results strongly confirmed that the addition of avocado to human diets produced the presumed oleic acid benefits. Compared with a commonly recommended low-fat diet, the higher-fat, avocado-enriched diet lowered LDL statistically significantly more and maintained HDL better, and it reduced total cholesterol more than could be explained by replacement of saturated fat. In a second experiment, avocado enrichment reduced total cholesterol below the levels achieved by a very low-fat diet, while increasing average HDL and palatability. The third known research on effects of avocado consumption found that adding avocado to the diets produced an average increase of 24% in daily calories and 54% in fat, but a 19% *reduction* in total cholesterol. In all three experiments, the diets enriched with avocado resulted in a small average weight *loss*. Certain popular misconceptions and a misinterpretation of research data are noted.

What would you think of a diet that claimed it could lower blood cholesterol significantly although it increased fat consumption and total calories? Well, there is such a diet, and it could be titled: *eat avocados!* Before looking at the actual experimental results derived from adding avocado to the diet, let us summarize some medical facts.

Health of the Heart Arteries

Cholesterol. The chief cause of death in the United States is coronary (heart) artery disease. It can result from a build-up of deposits inside the artery walls, eventually leading to blockage. This problem, atherosclerosis, has as its major cause high blood cholesterol levels; we average about twice as much blood serum cholesterol as our body actually needs. In the last 10 years or so, it has been clinically demonstrated that heart attacks can be reduced by lowering blood cholesterol levels: the risk appears to drop at least twice as fast as the total cholesterol content drops. Specifically, we want to lower the level of the harmful cholesterol fraction, the *low* density lipoprotein (LDL); 3rd

maintain or increase the *high* density lipoproteins (HDL) which actually seem to protect the heart.

The fat connection. Our HDL and LDL levels are determined partly by our genes and partly by our lifestyle. Lifestyle includes exercise habits, but the chief factor appears to be diet, especially fat consumption. Fats have long been recognized as saturated or unsaturated; the former increase the toxic LDL, the latter reduce it. Hence, for some time, nutritionists have warned against saturated fats and believed that the more unsaturated the fat, the better. At the same time, the usual recommendation has been to reduce total dietary fat, in favor of complex (non-sugar) carbohydrates. Atherosclerotic consequences will not appear until middle age or later, but the artery narrowing may begin in youth and dietary concerns should begin then.

Monounsaturated fat. A major review article by Grundy (1987) noted the increased risk of heart disease from high blood levels of cholesterol and that the usual nutritional "recommendations have been for increasing polyunsaturated fat or carbohydrates." He then cites several recent experiments involving different combinations of treatments: diets high in monounsaturated, or high in polyunsaturated fats, or low in fats and high in complex carbohydrates, all three reduced the harmful LDL; but usually, *only the monounsaturated maintained the level of the good HOL.* (Indeed, it sometimes increased it.) Also, diets high in other polyunsaturates or complex carbohydrates caused worrisome increases in triglyceride levels. A table compared results from a typical American diet with 40% of the calories from highly saturated fats to one with the same high fat level but of monounsaturated fats, and to a diet high in carbohydrate, low in fat (20%). Both the latter two diets significantly reduced LDL, but the diet with monounsaturated fat reduced it more. However, the low-fat diet also significantly reduced the desirable HDL as well, and it significantly increased triglycerides. Most nutritionists consider the LDL/HDL ratio more important than either value alone. The ratios can be calculated from the table in the article. The ratio calculated for the monounsaturated fat diet is strikingly lower, making this diet superior to either the diet high in saturated fat or the low-fat diet.

Moreover, evidence is beginning to emerge that, more than polyunsaturates, monounsaturated fats can significantly ameliorate another factor in heart disease, high blood pressure (*Vitality* health magazine, July, 1991). Moreover, polyunsaturates are more readily oxidized, producing "free radicals" which are thought to have various health drawbacks. Oxidized LDLs appear to be a first stage in atherosclerosis and thus increase the risk of heart disease. Parthasarathy *et al.* (1990) found that enriching a rabbit-model diet with monounsaturated fats resulted in LDLs that were "remarkably resistant" to oxidation. Because "there is no evidence that monounsaturated fat-rich diets are anything but safe," their data have "exciting implications" for still further heart protection.

Avocado Advantages

Oleic acid. The monounsaturated fat that has usually been tested in human nutrition is that of the readily available olive oil. With one exception, no readily available fat matches the olive's very high level of monounsaturated fat combined with low levels of both polyunsaturated and saturated fats. Fat analyses vary with variety, climate, degree of maturity, and probably other factors. Typical values for the olive are 77% monounsaturated, 9% polyunsaturated, and 14% saturated fats with nearly all the monounsaturated fat as oleic fatty acid. Researchers touting the nutritional benefit of monounsaturated fats sometimes refer to it specifically as an oleic acid benefit.

The other olive-like fat comes from the avocado. (Canola oil is quite high in monounsaturated fat, but much higher in polyunsaturated than is olive oil). Its most thorough analysis was by Slater *et al.* (1975), involving 700 fruit from all growing districts in California and through different seasons. For the dominant Hass cultivar, the overall average was 82% monounsaturated, 8% polyunsaturated, and 10% saturated fat, presumably an even better distribution than that given for olive. Moreover, the 'Hass' avocado's monounsaturated fat was 95% oleic acid. Bergh and co-workers (unpublished) found a higher oleic acid percentage in *Persea americana* than in other, non-edible, *Perseas* examined. They also found that cultivars combining genes from both the Guatemalan and Mexican races had more oleic acid than cultivars derived from only one race.

A further concern with diets high in polyunsaturated fat is that they have not been long-range tested on any known human population. Conversely, a high monounsaturated (oleic acid) diet has been eaten by some Mediterranean peoples for thousands of years: olive oil. In fact, epidemiologists have noted what appears to be a negative correlation there, between (high) oleic acid fat consumption and (low) incidence of heart disease. The Australian *Medical Observer* for August 17, 1990, quotes cardiologist David Colquhoun: "For example, in Greece, which spends less money per capita on health care than [others], people live longer and are healthier, even though they smoke a lot and do less physical work their diet seems to be protective high in monounsaturates " Thus, the olive appears to provide a reassuring, long-term pre-testing of the health benefits of a diet rich in avocados. The avocado has many more nutrients, is more versatile as a food, and, to most people, tastes better than olives.

Some enlightened, upscale restaurants have reportedly replaced high-saturated table butter with carafes of olive oil. A good idea, but why not replace it on bread with a still more nutritious, interesting and flavorsome treat, avocado!

Vitamins E, C, and A (beta carotene). Nutrient analysis data vary with several factors. Combining results from Slater *et al.* (1975) and later, scattered analyses establishes that the avocado is exceptionally nutrient dense: a quantity that provides, say, 10% of daily calorie needs will provide about 20% of the person's daily needs of four important minerals and seven essential vitamins. This rich nutrition may itself be heart-protective. Three of those avocado "double-density" vitamins are listed in the above heading. They

are pertinent to this paper because these three are antioxidants, which can reduce heart disease by reducing blood LDL oxidation that leads to plaque deposits in arteries. (As antioxidants, they may also reduce the risk cancer).

The journal *Men's Health* for May, 1991, reported one study that actually found heart disease associated more with low consumption of vitamin E than with high levels of either cholesterol or with high blood pressure. The study concluded that most Americans get too little vitamin E. Study results will vary depending on the particular background of the group sampled. The current campaign to reduce fat levels will tend to increase this deficiency if consumption of vitamin E-rich vegetable oils is reduced. Increased avocado consumption could compensate.

Excess vitamin A can be toxic, but avocado has it in the safe beta carotene form. Smith *et al.* (1983) analyzed the avocado and six "common" fruits for vitamin A content. Per unit weight, avocado contained more Vitamin A than peach, three times as much as orange, and seven to 30 times more than the other four fruits (apple, banana, grape, and pear). The John Hopkins Medical Letter *Health After 50* for February, 1991, reports a preliminary finding of the Physician's Health Study that at-risk doctors receiving added beta carotene instead of a placebo had only about half as many heart attacks, strokes and related cardiovascular problems. Rutgers University professor of food science, Paul Lachance, has estimated that the average American consumes only about 1/3 of the beta carotene optimum. Antioxidants may work in distinctive ways, so that they are complementary rather than interchangeable.

For three reasons, it is usually safer to receive needed nutrients from wholesome food than from concentrated supplements. First, supplements commonly provide so much of a particular nutrient that, even if safe, much of it may be money wasted, and the excess could possibly unbalance the person's metabolism so as to create some new deficiency. Second, supplements may create a false sense of nutritional security in a diet including too much junk food. Third, natural foods may contain associated nutrients, perhaps needed in only trace amounts, that make the nutrient in question more effective or, at least, that contribute to specific or general health.

The avocado, with its remarkable richness in a remarkably wide spectrum of nutrients, is an exceptionally good choice for maximum health of the body in general and the heart specifically.

Fiber. According to Anderson (1990), "High fiber intake lowers risk for cardiovascular disease [and several other health problems]... In addition, dietary fiber has therapeutic value in treatment of coronary heart disease (CHD)... the links between dietary fiber and CHD appear strongest...Most individuals in the West ingest suboptimal amounts of dietary fiber." He cited a finding that increasing daily fiber by less than the amount present in one avocado was associated with a statistically significant 25% reduction in CHD death rate.

Anderson (1990) reported that pectin fiber "decreases serum cholesterol 11 % [and] does not significantly affect serum HDL-cholesterol or triglycerides." A former chairman of the Nutrition Department at Rutgers University suggested that with its general nutritiousness "An apple a day may keep the doctor away... because of the additional benefit derived from pectin" (Kinderlehrer, 1975). The highly nutritious avocado is a good source of pectin (Kinderlehrer, 1975). In fact, the avocado has four times as much soluble fiber as the apple (Smith *et al.*, 1983).

It is the water-soluble fiber fraction such as pectin that is more directly involved in maintaining heart health. Smith *et al.* (1983) reported the analyses of 16 fruits and 18 vegetables. Of six common fruits, the pear had 2/3 as high a proportion of soluble fiber as avocado, the other five had from 1/3 to 1/6 as much. Among tropical fruits, guava was extremely high at 2.5 times the amount of avocado, the other eight had only 1/2 to 1/10 as much. Of the vegetables, only broccoli (commonly preferred with a saturated-fat cheese or butter sauce) slightly surpassed avocado; the others analyzed ranged downward to 1/6 of avocado soluble fiber level. And what a delicious way to get heart-protecting fiber!

Palatability. We Western moderns are being killed prematurely by the flavor-enhancing fats that we enjoy in our diets, particularly saturated fats. An early solution was to replace saturated fat with polyunsaturated, but we have noted serious weaknesses in that approach: especially a reduction in the good HDL, increased oxidation, and absence of long-term human experience. In addition, there is now growing concern with partially hydrogenated 'trans' unsaturated fats. As a consequence, extremely low-fat diets, in which about 10% of calories are fats, such as those of Pritikin or Ornish have become popular. These have indeed proven effective in reducing blood cholesterol, and even in reversing heart disease. Their weakness is that most of us find such food less enjoyable. Grady (1987) quotes the former head of the American Heart Association's (AHA) nutrition committee: "The problem is that most people don't stay on such a diet. They prefer ...more fat It's a very impractical diet." The AHA recommends reducing our fat calories from the present average of nearly 40% half-saturated to the more achievable level of 30%. But 30% fat, with saturated no more than 10%, may not be adequate to stop artery blockage (Grady, 1987).

We are in a bind. Our present typical highly saturated high-fat diet is killing us. The plan to reduce blood cholesterol by switching to highly polyunsaturated fat has run into serious problems, and most of us won't stick to the really low fat diet that would safely lower cholesterol.

As we have seen, a way out of the bind is a diet rich in oleic fatty acid monounsaturates. It is superior to our present diet in significantly lowering toxic LDL cholesterol, superior to a diet high in polyunsaturated fat in maintaining HDL, resisting oxidation, and being tested over many generations; and superior to a diet very low in fat due to better palatability from the higher fat content. (The very low fat diet will remain available to those who actually want it because of exceptional taste buds, genetic metabolic differences, or exceptional motivation, perhaps from a present serious heart condition).

To the basic benefits associated with the oleic acid of olive oil, avocado provides additional benefits for a healthy heart including remarkable nutrient density and high soluble fiber, plus additional palatability from that great avocado fruit flavor, Consuming avocados can increase both our eating pleasure and our heart safety!

According to Ann Landers' recent 'Gem of the Day': "The way to live longer is to stop doing all the things that make you want to live longer." *Avocados are a beautiful exception!*

Common Misconceptions

"Fat is fat", The American Heart Association is helpfully encouraging a reduction in the consumption of artery-clogging saturated fat and problematic polyunsaturates by recommending a reduction in consumption of all fats. But this has the unfortunate result of implying to many people that "fats are bad." A parallel misconception is that "cholesterol is bad" but recall the apparent heart-protective action of HDL. Similarly, oleic acid monounsaturated fat appears to protect the heart.

This failure to differentiate is also evident in the United States Department of Agriculture's now controversial food pyramid, which was meant to recommend the frequency of consumption of the basic food groups. All groups are recommended at two to several servings per day, except for the combined group of "fats, oils, and sweets" which we are told to "use sparingly." Thus, butter fat (54% saturated) and coconut oil (86% saturated) are lumped with olive oil and avocados!

When challenged on this discrepancy, two Australian organizations have fallen back on the fact that all fats are high in calories. In a letter dated 10 October, 1990, the National Heart Foundation of Australia's Food Program Manager noted that "our dieticians and home economists often promote avocados as a very good substitute for butter or margarine as a spread on bread." And "moderate consumption of avocados poses no health risk whatsoever." But "The reason why we list avocados in the 'foods to limit' category is... their high fat content... Excess fat consumption is one of the leading reasons why more than half of all Australians are overweight... " This "fat is fat" fallacy overlooks the avocado's high nutrient density and remarkable nutrition *per calorie*. In the next major section, we will see that adding avocado to diets has resulted in weight stability *or reduction*. The avocado can be a useful addition to a weight-loss program.

A similar curious blend of enlightenment and illogic occurred in the response from the Pritikin people, promoters of a diet very low in fat. A letter from the President of the Pritikin Lifestyle Association (Brisbane) dated 26 October, 1990, states that "unfortunately, avocados have a high fat content. It is our contention that fat is extremely dangerous..." Again, we see the failure to discriminate between types of fat. Monounsaturated [oleic acid] fat that appears to have protected the heart and health of southern Europeans for many hundreds of years is not distinguished from harmful saturated or dubious polyunsaturated fats.

Nevertheless, the same letter notes that "the Pritikin Society has indeed altered its advice to members... the suggested amount being one-half an avocado per day." For a very-low-fat group, this is a courageous concession. In fact, if the average American ate avocados at that rate, our national consumption would be over 20 billion pounds per year!

"Unsaturated is unsaturated". In a subset of the above confusion, a California medical doctor's letter was printed in the July, 1991 issue of *Sunset* magazine: "As a cardiologist,... I feel that you should also include [in recipes] the amount of saturated and polyunsaturated fats... saturated fat that exceeds the amount of polyunsaturated fats...may cause elevation of serum cholesterol."

After presumably due investigation, the editor responded: "We agree. As of this issue,...each *Sunset* recipe will include not only total grams of fat, but also grams of saturated fat (polyunsaturated fat makes up the difference)." Apparently, neither doctor nor editor were aware of the recent literature casting doubt on the desirability of polyunsaturates; and at least the editor seems not to have heard of monounsaturated fat.

Knowledge spreads slowly. Consider a belated correction of the above sort of misinformation. Paul Donohue is a nationally syndicated doctor who responds to reader health queries with highly knowledgeable and reliable sources of medical information. In November, 1986, he wrote: "Olive oil is only monounsaturated... It's not a good substitute for the [polyunsaturates]." This was well after some of us non-medical lay people knew better. I caught no correction until two years later: "Olive oil lowers... the bad kind of cholesterol, the kind responsible for [artery plaque] buildup [LDL]. It also raises the good kind [HDL]." In March, 1990, he got to us: "Avocados are loaded with fats, ...mostly the monounsaturated kind, the kind that lowers cholesterol." He added: "Beware of [its] calories", which I trust he will also amend eventually.

Fat per food versus fat per day. The avocado gets most of its calories from fat (oil), varying with variety and season up to as much as 90%. The American Heart Association recommends that we lower our fat consumption to 30% or less of total calories. Now, we have seen that even as low a level as 20% may not be as effective in improving blood constituents for heart health as a 40% level with high oleic acid. However, with the present typical fat type distribution in our diets, a reduction of total fat to the AHA recommended 30% would certainly help.

A 1990 survey by the American Dietetic Association found that two-thirds of Americans believe that the AHA limit would apply to every food they eat, which would obviously rule out avocados. Comments the *Mayo Clinic Health Letter* (December, 1990): "That's a common mistake. Limiting fat to about 30% of daily calories doesn't mean eliminating fatty foods. It means balancing high-fat options with low-fat choices." Their example indicates that this is not even necessary at the same meal, two high-fat foods at one meal can be balanced by the other two meals being low in fat.

Dubious interpretations. Popularizations in newspapers or magazines sometimes give a misleading impression of technical findings. More rarely, the original researchers themselves give a biased interpretation of their own results. A flagrant example is the study by Ginsberg *et al.* (1990), which was reported in our local newspaper under four columns of large headline: "**Extra monounsaturated fats not beneficial**". The Associated Press reporter evidently interviewed the senior author and quoted him as saying, "What we hoped to do here was try to straighten out some misconceptions about 'monos'..., that they have some independent effect on lowering cholesterol." Such a research "hope" is not unscientific, but allowing it to bias one's conclusions certainly is. In the prestigious *New England Journal of Medicine*, (Ginsburg *et al.*, 1990) described a comparison of 3 diets: standard American (high fat, increased saturated fat), American Heart Association Step 1 (lower fat), and Mono (high fat, increased monounsaturated fat). Their abstract ends, "We conclude that enrichment of the Step 1 diet with monounsaturated fat does not alter the beneficial effects of the Step 1 diet on plasma lipid concentrations." The authors note, "Our study, however, was not designed to have the statistical power needed to attempt direct comparisons between the effects of the Step 1 diet and those of the Mono diet..." Also, dietary compliance overall was estimated at just 85-90%.

Most of their results are graphed in their Figure 2. Compared with the standard-diet controls, both the Step 1 and Mono diets reduced total cholesterol significantly (the Mono by about 30% more than the Step 1 diet). Triglycerides declined under Step 1, but more than twice as much under Mono. The "good" HDLs were unchanged with Mono, but reduced with Step 1. In keeping with the limited discriminatory power of the experimental design, neither the triglycerides nor HDL differences were statistically significant. Likewise, the LDL reduction in Step 1 was not significant, but the larger reduction in Mono was significant. And the probably more meaningful total cholesterol/HDL ratio was reduced significantly in Step 1 and in Mono by more than fourfold, which was highly significant. Thus, the results of this research agree with those we noted earlier: adding monounsaturated fat to a low fat diet can produce superior blood serum concentrations by maintaining HDLs while lowering LDLs. Yet, Ginsberg *et al.* (1990) arrived at a different conclusion as quoted above from their abstract! (Apparently, not one of the 9 co-authors or the reviewers, took an impartial, objective look at the actual results.)

Avocado Experiments

We have noted the blood serum benefits afforded by the oleic acid of olive oil and that avocado oil is very similar in composition. Without test results for the avocado itself, uncertainty nags. Three such studies are known.

David Colquhoun. Australia. Dr. David Colquhoun is Consultant Cardiologist at the Wesley Medical Center in Brisbane. His research was presented at the International Atherosclerosis meeting in Chicago in October, 1991, but has not yet been published. He has shared the following essential details.

"The traditional diet propounded by the [Australian and American heart organizations] has been based on a moderate reduction of total fat with a mild increase in polyunsaturates.... Foods which have been high in monounsaturated fatty acids such as avocado have in fact been advised against. This has been based on the simplistic notion that avocados are high in fat "

For 15 subjects, he compared blood analyses for individuals following habitual eating patterns (moderately high in total fat, much of it saturated), on the American Heart Association phase 3 diet (fat reduced to just 20%, high in complex carbohydrates), and on avocado-enriched diet (about as high in fat as the habitual level, but with more monounsaturated fat because of eating an avocado a day). Total calories were the same in all three diets. The subjects were first on one of the special diets for three weeks, then on the other for the same period.

Both the AHA low-fat and the avocado-enriched diet resulted in an average weight loss of about 1 kg (a little more than 2 lbs). Dr. Colquhoun believes that this is due to an increased metabolic rate from the new diets. The "avocado-enriched diet had a favorable effect on blood fats, with a significant (7.2%) decrease in total cholesterol with preservation of the HDL level. In contrast, the low-fat diet was less effective in lowering LDL and also had the disadvantage of lowering the protective H DL." Moreover, the avocado-enriched diet is "nutritionally balanced" and, with its good flavor, "is associated with excellent compliance." Thus, the benefits to the heart provided by avocado monounsaturated fat appeared to be at least as great as had been found with the earlier extensive experiments with olive oil. Additionally, of great interest and contrary to some earlier thinking, the avocado enrichment had cholesterol-lowering benefits *greater* than expected from saturated fat replacement alone.

Concludes Dr. Colquhoun: "...avocados are an important addition to cholesterol-lowering diets. The inclusion of this versatile food... should improve long-term compliance with a healthy diet A cholesterol-lowering diet does not have to [be] a very low fat diet, which is often unpalatable."

M.G. Steele. Australia. This research was conducted by M. G. Steele at the private La Mancha Health Center (which features low-fat meals), at Wollongbar, New South Wales, and privately printed with the title "Avocados, cholesterol, and heart disease".

One group substituted avocados for butter, margarine, and cheese. Over the 4-week trial, they had blood cholesterol reduction as expected. A second group was more interesting, for they added avocados to a low-fat diet, being "encouraged to eat as many avocados as possible." After 4 weeks, their average cholesterol had *increased* 6%. It seemed reasonable that this was due to the sudden increase in calories and fat, so they were asked to continue the diet 4 weeks more. Their cholesterol now was reduced below initial values for all participants by an average of 8%. Moreover, their HDL levels averaged a 6% increase.

Two significant points emerge. First, especially when adding avocado energy to a diet, it is important to continue the trial long enough to get past temporary "hiccoughs." Second, even "participants who were following the [very low fat] Pritikin regression diet prior to the study were able to achieve a further reduction in their cholesterol levels. For those in the study who were following the Pritikin diet, the avocado was a welcome addition." Overall, there was again a small reduction in average weight by the end of the avocado period.

W.C. Grant. Florida. This research was done before nutritionists understood the significance of the differences between types of either cholesterol or unsaturated fatty acids. Nevertheless, it remains in some important respects uniquely instructive.

Grant (1960) worked with 16 male hospital patients, four of them bedridden. This choice of subjects had the great experimental advantage of ensuring excellent dietary compliance; but, as we shall see, it led to certain metabolic ambiguities. Another hospital complication was early discharge: treatment length varied from 85 days down to just nine. Except for three subjects, avocado was simply added to the regular diet, with no attempt to control either fat percentage or calories. There was no measurement of LDL or HDL cholesterol.

Of the 16, seven had a statistically highly significant reduction in total cholesterol after a period of eating California avocados. For an eighth man, the reduction was statistically significant. Of the remaining eight, six had a marked reduction in total cholesterol, averaging 10.3%. In fact, five of the six had a greater percent reduction than did one of the significantly reduced group, but vagaries of error variation precluded "significance" by statistical convention. That leaves two of the 16 without apparent cholesterol benefit from avocados. One of these should not, by present knowledge, have been in the experiment: he had a very rare genetic condition (cholesterol = 552) now known to be largely immune to any sort of dietary amelioration. The second "non-responder" increased his total calorie and his fat consumption by a whopping 46 % and 81 %, respectively, while on the avocado diet for just 21 days. Recall Steele's finding that a sudden increase in dietary avocado calories and fats resulted in a temporary "hiccough": average cholesterol level was higher after 4 weeks, but 8 % lower than the original average after 8 weeks of eating avocados. Grant (1960) pointed out another equivocal aspect of some of these hospitalized patients: they had metabolic diseases that could affect fat metabolism in a study involving fat metabolism. These problematic patients were all in the group that failed to show statistically significant cholesterol reduction. However, it is questionable science to discard data *ex post facto*. For detailed analyses, four of the men did have to be omitted: the individual who was genetically hypercholesterolemic and three for whom measurements were incomplete.

That left a group of seven "responders", all with cholesterol reduced by avocado consumption to a highly significant degree statistically; and five "non-responders", for whom cholesterol was not reduced significantly according to standard statistics. The non-responders were three with diabetes and one each with liver cirrhosis and nephrosis. The responders all had non-metabolic illnesses: hernia, neuralgia, paranoia

(2) and heart conditions (3). I have calculated the group averages and presented them in Table 1. Thus, the group that ate twice as much avocado, increased their fat and calorie consumption, respectively, 3 times and 2 times as much as did the second group, but decreased their total cholesterol three times as much. These comparative figures should not be taken as general estimates; the two groups were too different metabolically and in other respects. Always, there is the factor of our individual uniqueness: one "responder" eating just half an avocado per day for just 13 days, with large increases in fat and in calories, reduced his total serum cholesterol a remarkable 43% (296 to 169 mg), while losing 3.2 kg (7 lbs)! But this is highly exceptional. Again, a diabetic "non-responder" eating 1/2 avocado for 20 days, but with fat consumption and total calories kept constant, reduced his cholesterol by 15% and his weight by 1.4 kg (3 lbs).

Individual success stories like these must be modified by looking at the overall mean values. Although metabolic diseases and short test durations make it likely that some of the test subjects yielded results that underestimated the cholesterol-related advantages of an avocado diet, it would be improper to discard any subjects. The overall average figures, responders plus non-responders are shown in Table 2.

Table 1. Effect on avocado consumption on caloric intake, fat intake and blood cholesterol levels. (Grant, 1960).

	Change from control period			
	Avocados/day	Calories	Fat	Cholesterol
Responders	1.32	+30.0%	+76.9%	-26.5%
Non-responders	0.65	+14.3%	+27.3%	-8.8%

Table 2. Effect of avocado consumption on caloric intake, fat intake, blood cholesterol levels, and weight. (Grant, 1960).

Avocados Per day	# of days	Calories	Fat	Cholesterol	Weight
1.04	33.2	+23.9%	+53.7%	-19.3% (-55 mg)	-1.1 kg (2.3 lbs)

Common nutritional advice is: to reduce cholesterol, reduce fat; and to reduce weight, reduce calories (and fat). Nevertheless, a carefully controlled diet that increased the fat content by 50% and total calories by 25% actually *reduced* total cholesterol by 20% and even weight by a bit. The diet's "magic" addendum? Avocado. One wishes for HDL-LDL analyses, which would be expected to make the cholesterol benefits still more striking.

The large increase in calories would surely be expected to increase average weight. Steele, with quite different subjects, reflected on that expectation: "Some of the participants were apprehensive about a ...weight gain since they were encouraged to

eat as many avocados as possible." Instead, he, like Grant and like Colquhoun, found a slight mean weight loss. Steele suggested as explanation the satiating qualities of avocado; appetite control through a feeling of fullness. This should indeed be an avocado weight-control benefit. But in Grant's research, calories were counted and were known to increase sharply. A likely explanation here is that unsaturated fat (unlike saturated fat) increases human metabolic rates, i.e., "calorie burning."

Conclusion

Human nutrition is a highly complex subject, made more so by the notoriously high degree of human variability, both genetic and environmental (including eating habits). Therefore, contradictory research results are often obtained. And, therefore, the degree of concordance to date in favor of monounsaturated fats, in general, and the avocado, in particular, is impressive.

However, as an example of the complexities encountered, preliminary studies have found a statistical association between reduced blood cholesterol and increased aggressiveness or proneness to accidents. Thus, reduced mortality from heart disease could be offset by increased mortality from violence, among some children and a small number of adults. Further study is needed to determine if the added risk is actually due to cholesterol changes and, if so, to identify the subgroups at risk. It is thought that the tendency toward violence may be due to a reduction in the brain chemical serotonin. Thus, the agent of cholesterol-lowering may be important, the avocado happens to be exceptionally rich in serotonin. But, the avocado also contains a lot of tyramine, which reduces serotonin availability. Needed are long-range, carefully monitored studies on all significant effects of adding avocado to diets. This could be prohibitively expensive, and in any case would not give definitive results for years. It seems unwise to permit such speculative uncertainties to interfere with recommendations based on the demonstrated blood-serum benefits of avocado.

A University of California at Los Angeles School of Public Health (1989) publication discussed at some length blood cholesterol and factors influencing it. It pointed out the changing thinking on monounsaturates, adding: "Ever since the virtues of monounsaturated fatty acids were recognized as substances which may help reduce the risk of cardiovascular disease, foods high in monounsaturates have been receiving increasing attention. One important source (and one that is often overlooked) is the avocado."

Let's work together to spread the word. Let's not let probable avocado heart-related benefits be overlooked any longer!

Two final points. First, cholesterol is not the only determinant of heart health; also important are good genes, minimizing stress and strain, avoiding smoking and abuse of alcohol or other substances, controlling hypertension, proper exercising, and weight control with a sound overall diet. Second, the dietary advantages of the avocado go far

beyond the cardiovascular as discussed in *The Avocado and Human Nutrition. Part I. Some Human Health Aspects of the Avocado.*

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