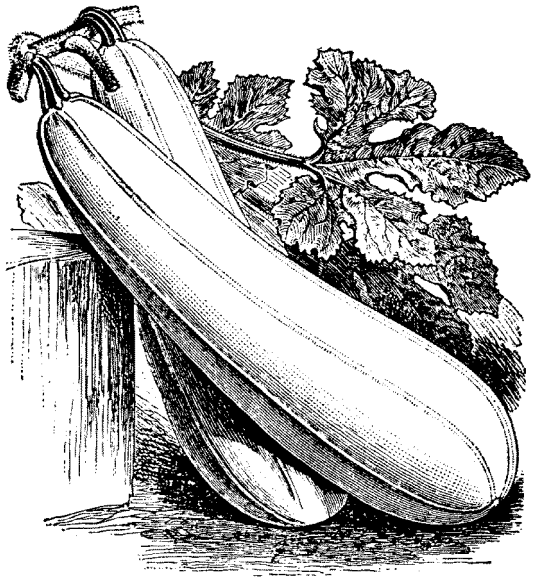
AMERICA'S VANISHING NUTRIENTS:
Decline in Fruit and Vegetable Quality Poses Serious Health and Environmental Risks

By Alex Jack



"It is time to recognize that the threats that nutritional decline pose to homeland security are as real as those we face from international terrorism, global warming, and nuclear war or accident."

America's food is losing its nutrients, vitality, and taste. New research indicates that the vitamin and mineral content of apples, oranges, and other ordinary fruits has declined on average 25 to 50% during the last generation. The study is a follow up to earlier research by the author showing that, according to the U.S. government's own food composition tables, common garden vegetables have lost large amounts of calcium, iron, and other essential elements since the 1960s and 1970s.[1] Together, the earlier study and the present study suggest:

- The health of the American people may be declining because of a sharp loss of food quality. Fruits and vegetables are high in antioxidants, flavinoids, phytoestrogens, and other compounds that are protective against heart disease, certain cancers, arthritis, diabetes, women's health problems, childhood ailments, and other disorders
- The worldwide environmental crisis—including increased use of chemical pesticides and fertilizers, the introduction of genetically engineered food, increased air and water pollution, rising soil infertility, loss of seed vitality, global warming, thinning of the ozone layer, and other factors—may be the primary cause of the nutrient decline
- Current U.S. dietary guidelines such as the Food Guide Pyramid may be based on obsolete data collected during the Cold War. These guidelines, including RDA's for essential nutrients, are the basis for tens of millions of meals served daily in public schools, hospitals, prisons, the military, nursing homes, and other institutions
- The labels on many U.S. foods may also be based on out-of-date food composition tables, creating a distorted profile of the nutritional value of many common foods
- Since the U.S. is the world's largest exporter of food, the decline in its food quality has global consequences. Not only America's health, but also planetary health may be at risk

The original study sparked a national controversy. Since its publication, newspapers, magazines, and web sites across the country have picked up on the research. *Organic Gardening*, the nation's major organic publication, wrote an open letter to the U.S. Secretary of Agriculture demanding to know what his agency was doing to protect the American food supply. *Gardening Design, The Cleveland Plain Dealer, The National Vegetable Growers' Magazine*, *The London Times,* and other publications have also published articles about the research. The USDA subsequently confirmed the loss of nutrients revealed in the original study, but questioned whether it was the result of the environmental crisis, as generally concluded by supporters of organic farming and environmentalists. Rather, the agency contended that natural environmental influences, as well as improved testing methods, may be responsible for the discrepancies.

This report, "America's Vanishing Nutrients," will present the results of the new study on fruit quality in the United States, review research on nutrient decline from other sources, and examine the USDA's detailed response to the original study.

1. Introduction

Many people intuitively feel that food today is losing its energy, vitality, and sweetness. Destruction of the natural environment, especially the further decline in air, water, soil, and seed quality, would appear to be the underlying cause of this loss.

However, the apparent loss in nutritional value could also be the result of natural seasonal cycles and climatic conditions, improved testing procedures, and new

transportation and storage methods. It might also be caused by aging—not necessarily of the food but of the observer! Food may taste different today because we look back and romanticize the way things were in our youth. Or the spread of fast food, microwave and electric cooking, food irradiation and genetic engineering, and other new agricultural and food processing and preparation methods may be fundamentally altering the composition of the foods we eat.

All of these factors may be contributing to the decline in modern nutrition. In this report, we shall examine the extent to which America's food quality is really falling, principal causes of the decline, and potential solutions.

2. The Vegetable Study

Several years ago, while preparing nutritional charts for *Healing Foods*, a new book on diet and health, I discovered that nutrients in selected foods in the USDA's food composition tables had changed dramatically. In the early 1980s, I helped educator Michio Kushi prepare a revised edition of *The Book of Macrobiotics* (Japan Publications, 1985), and in the appendix we included standard nutrient data from the USDA's *Handbook #8*.[2] Published in 1975, *Handbook #8* included information on thousands of foods based on testing done in the 1960s, 1950s, and earlier decades and became the bible of nutrition for a generation of food researchers. It was available in virtually every library and used by nutritionists, dietitians, medical doctors, and researchers as the standard reference.

While updating nutrient information from the tables in *The Book of Macrobiotics*,[3] I learned that the USDA no longer published food data in printed form, but had recently begun to post information on the Internet. An interactive feature on the USDA's web site allowed the user immediate access to the latest nutritional information. The service was free, convenient, and constantly updated. It soon became apparent, however, that some of the latest figures on vitamin and mineral content, drawn primarily from the 1990s, were significantly lower than those published in *Handbook #8*.

As an example, I looked at selected nutrients in broccoli. The results are summarized in Table 1 below:

Table 1. Selected Nutrients in Broccoli*

	1975	1997	Change
Calcium	103 mg	48 mg	Down 53.4%
Iron	1.1 mg	0.88 mg	Down 20%
Vitamin A	2500 IU	1542 IU	Down 38.3%
Vitamin C	113 mg	93.2 mg	Down 17.5%
Thiamin	0.10 mg	0.07 mg	Down 35%
Riboflavin	0.23 mg	0.12 mg	Down 47.8%
Niacin	0.9 mg	0.64 mg	Down 28.9%

*Based on 100 Grams, Edible Portion. *Source: USDA food composition tables*

I was shocked to find that the nutrients in broccoli were down in every single category examined! This discovery prompted me to perform an experiment in which I examined a market basket of 12 common garden vegetables picked at random. These included broccoli, cabbage, carrots, cauliflower, collard greens, daikon, kale, mustard greens, onions, parsley, turnip greens, and watercress. The results were comparable, as Tables 2-5 show:

Table 2. Calcium in Selected Garden Vegetables*

	1975	1997	Change
Broccoli	103 mg	48 mg	Down 53.4%
Cabbage	49 mg	47 mg	Down 4.1%
Carrots	37 mg	27 mg	Down 27%
Cauliflower	25 mg	22 mg	Down 12%
Collard greens	203 mg	145 mg	Down 28.6%
Daikon	35 mg	27 mg	Down 22.9%
Kale	179 mg	135 mg	Down 24.6%
Mustard greens	83 mg	103 mg	Down 43.7%
Onions	27 mg	20 mg	Down 25.9%
Parsley	203 mg	138 mg	Down 32%
Turnip greens	246 mg	190 mg	Down 22.8%
Watercress	151 mg	120 mg	Down 20.5%
Net Change			Down 26.5%

*Based on 100 Grams, Edible Portion. *Source: USDA food composition tables*

Table 3. Iron Levels in Selected Garden Vegetables*

	1975	1997	Change
Broccoli	1.1 mg	0.88 mg	Down 20%
Cabbage	0.4 mg	0.59 mg	Up 47.5%
Carrots	0.7 mg	0.50 mg	Down 28.6%
Cauliflower	1.1 mg	0.44 mg	Down 60%
Collard greens	1.0 mg	0.19 mg	Down 81%
Daikon	0.6 mg	0.40 mg	Down 33.3%
Kale	2.2 mg	1.70 mg	Down 22.7%
Mustard greens	3.0 mg	1.46 mg	Down 51.3%
Onions	0.5 mg	0.22 mg	Down 56%
Parsley	6.2 mg	6.20 mg	None
Turnip greens	1.8 mg	1.10 mg	Down 38.9%
Watercress	1.7 mg	0.20 mg	Down 88.2%
Net Change			Down 36.1%

*Based on 100 Grams, Edible Portion. *Source: USDA food composition tables*

Table 4. Vitamin A Levels in Selected Garden Vegetables*			
	1975	1997	Change
Broccoli	2500 IU	1543 IU	Down 38.3%
Cabbage	130 IU	133 IU	Up 2.3%
Carrots	11,000 IU	28,129 IU	Up 155.7%
Cauliflower	60 IU	19 IU	Down 68.3%
Collard greens	6500 IU	3824 IU	Down 41.2%
Daikon	10 IU	0	Down 100%
Kale	8900 IU	8900 IU	None
Mustard greens	7000 IU	5300 IU	Down 24.3%
Onions	40 IU	0	Down 100%
Parsley	8500 IU	5200 IU	Down 38.8%
Turnip greens	7600 IU	7600 IU	None
Watercress	4900 IU	4700 IU	Down 4.1%
Net Change			Down 21.4%
*Based on 100 Grams, Edible Portion. *Source: USDA food composition tables*			

Table 5. Vitamin C Levels in Selected Garden Vegetables*			
	1975	1997	Change
Broccoli	113 mg	93.2 mg	Down 17.5%
Cabbage	47 mg	32.2 mg	Down 31.9%
Carrots	8 mg	9.3 mg	Up 16.3%
Cauliflower	78 mg	46.4 mg	Down 40.5%
Collard greens	92 mg	35.3 mg	Down 61.6%
Daikon	32 mg	22 mg	Down 31.3%
Kale	125 mg	120 mg	Down 4%
Mustard greens	97 mg	70 mg	Down 27.8%
Onions	10 mg	6.4 mg	Down 36%
Parsley	172 mg	133 mg	Down 22.7%
Turnip greens	139 mg	60 mg	Down 56.8%
Watercress	79 mg	43 mg	Down 45.6%
Net Change			Down 29.9%
*Based on 100 Grams, Edible Portion. *Source: USDA food composition tables*			

Among the many striking correlations and relationships that emerge from this sample, the following stand out:

- All 12 vegetables showed declines in selected nutrients, and 10 of 12 showed declines in all categories examined

- On average for the vegetables sampled, calcium levels decreased 26.5%, iron levels fell 36.1%, vitamin A content fell 21.4%, and vitamin C content was off 29.9%
- All 12 vegetables lost calcium, ranging from a high of broccoli (down 53.4%) to a low of cabbage (down 4.1%)
- Iron levels dropped in 10 of 12 vegetables surveyed. Five vegetables lost a majority of their iron, including cauliflower (down 60%), collard greens (down 81%), mustard greens (down 51.3%), onions (down 56%), and watercress (down 88.2%).
- Eight of 12 vegetables lost vitamin A. Two vegetables, daikon and onions, lost all of their vitamin A, and broccoli (down 38.3%), cauliflower (down 68.3%), collard greens (down 41.2%), and parsley (down 38.8%) showed major declines.
- Eleven of 12 vegetables lost vitamin C. Those showing the highest losses included cabbage (down 31.9%), cauliflower (down 40.5%), collard greens (down 61.6%), daikon (down 31.3%) onions (down 36%), turnip greens (down 45.6%), and watercress (down 45.6%).
- Two vegetables recorded gains in selected nutrients. Cabbage increased in vitamin A and iron, while carrots registered increases in vitamin A and vitamin C
- The study looked at B complex vitamins (thiamin, riboflavin, and niacin) for only a single food, broccoli. However, declines of 35%, 47.8%, and 28.9% respectively in these B vitamins were consistent with the average loss of calcium, iron, vitamin A, and vitamin C in the larger sampling of 12 items

From this sampling, I tentatively concluded that common vegetables were indeed losing their vitamin and mineral content. Whether this was a real trend, and uniform across the entire spectrum of items in the American food supply, I could not yet say. The apparent change could be methodological. For example, the differences in the figures published by the USDA in 1975 and those on its Internet site in the late 1990s could be the result of limited sampling, different classification methods, improved testing procedures, or other technical considerations.

To find out, I called the USDA Nutrient Data Laboratory in Beltsville, Maryland and was connected to scientist David Haytowitz. He turned out to be not only in charge of collecting vegetable data, but also he was the site's web master and evidently familiar with the entire database of 5900 foods. I asked him whether he was aware that the nutrients in the American food supply appeared to be declining. He said this was the first time that he had heard of it.

Surprised, I asked whether the USDA was concerned with the quality of the food that Americans eat every day and taking steps to ensure that grains, vegetables, fruits, and other crops did not lose their nutritional value and vitality. He replied that the agency does not analyze data or monitor trends. It simply collects information and makes it available to researchers (such as myself) to draw their own conclusions!

On the subject of testing, I inquired whether the decline might be the result of new testing procedures over the last 25 years. We had a lengthy conversation and he described how researchers today used colorimetry, atomic absorption, inductive coupled plasma (ICP), and other sophisticated techniques to measure food composition. Would new methods such as these, I asked, result in such large changes or only small, precise ones? Dr. Haytowitz said that the new procedures probably would not result in changes of this magnitude—25 to 50%.

Could the nutrient loss then be the result of environmental influences, especially the increased use of pesticides and chemicals on America's farms? On the contrary, he replied, farmers in the 1950s and 1960s probably used more chemical fertilizers, soil supplements, and other additives than they do today, artificially elevating nutrient levels compared to more recent samples from the 1980s and 1990s.

The food composition tables do not distinguish between food grown conventionally with chemical pesticides and fertilizers and organically grown food. I asked whether the USDA had ever tested the nutrients in organic food and compared

them with chemically grown crops. He replied that such experiments had never been conducted because the agency assumed that the nutrient content in organic and conventionally grown food is substantially equivalent.

I asked on the basis of what scientific or nutritional studies had the U.S. government made this assumption. He had no answer and agreed that in the future such testing would make an interesting comparative study.

In my original article, "Nutrition Under Siege," published in the *One Peaceful World Newsletter,* I presented the results of my research, a summary of my conversation with Dr. Haytowitz, and tentative conclusions. I discussed the possibility that the apparent loss could be the result of laboratory studies on comparatively few samples. For instance, the broccoli studies were based on lab tests performed on from 5 to 33 samples, depending on the nutrient tested. Those for daikon were based on just 1 to 2 samples. I reviewed the Standard Error (SE), the percentage individual samples differed from each other, and found large differences in some cases and virtually none in others. In the case of the market basket of 12 garden vegetables, the SE for iron levels averaged .119 or a 11.9% variation from the mean. Such differences commonly result from growing food in different soils, during different seasons, under different climate and weather conditions, and may be influenced by maturity, harvesting, storage, transportation, freshness, and other factors. In this case, an 11.9% deviation is relatively small for overall losses of 25 to 50 percent, so I concluded that the size of the samples probably was not a decisive factor.

Overall, I concluded in my original article that the nutrient decline was the probable result of environmental factors, especially the continued erosion of the nation's soil, air, and water quality, as well as reduced seed vitality. I marshaled evidence from several sources showing substantial erosion of topsoil on farms using chemical methods, the overall shrinking of cropland due to urbanization, and the introduction of new hybrid seeds. The increased vitamin A and vitamin C levels in cabbage and carrots could primarily be the result of new hybrid seeds developed to boost these specific nutrients. "Growers and seed companies can make more money by introducing high-yield varieties," Michael Joutras, a macrobiotic teacher quoted in the article, observed. "At first, such foods may seem to be more nutritious. But they may be low in other nutrients and in the long run contribute to greater weakness and loss of vitality. Overall, we must examine the complete balance of nutrients and energy of any given food, not just focus on one component." In contrast to vitamins A and C, which are both widely promoted in produce marketing, calcium and iron levels in cabbage and carrots fell sharply.

"The sharp decline in food quality, as pointed to by the newly posted food composition tables and a growing number of environmental studies," my article concluded, "poses a national and international threat. Reversing this trend and ensuring the availability of wholesome, nutritious food are of vital importance to human health and the future of our planet."

3. The Organic Community Speaks Out

The results of the vegetable study were widely reported in alternative and holistic newsletters and publications. In its November/December 1999 issue, *Organic Gardening*, the nation's largest organic publication, featured the research in an open letter to Secretary of Agriculture Dan Glickman entitled "Is Chemical Farming Making Our Food Less Nutritious?"[4]

"The vitamin and mineral content of American and British food supplies appears to be declining, according to analysis of official government reports," Cheryl Long, senior editor, asserted in the beginning of the letter. "[Researcher Alex Jack] has studied USDA nutrient data from 1975 and 1997 and uncovered a disturbing trend: Average calcium levels in 12 fresh vegetables have decline 27%; iron levels have dropped 37%;

vitamin A levels, 21%; and vitamin C levels, 30%." Ms. Long went on to cite similar results from Britain reported in a study published in the *British Food Journal* and cited other research indicating that modern agriculture and industrial practices were damaging the nation's crops.

"Mr. Secretary, what is going on here?" *Organic Gardening's* open letter concluded. "Why do nutrient levels in our food appear to be declining? Is the drop linked to preventable factors, such as American agriculture's overuse of acidic nitrogen fertilizers and the effects of acid rain? Surely you must want to know the answers to these questions as much as we do. Will you ask your top scientists to give us some direct answers that we can share with the readers of our magazine?" *Organic Gardening* is published by Rodale Press, one of the nation's largest health publishers and the communications arm of Rodale Farms, a large experimental farm in Pennsylvania founded by organic pioneer Robert Rodale.

4. The USDA Responds

On December 14, 1999, Phyllis E. Johnson, director of the USDA's Agricultural Research Service replied on behalf of Secretary Glickman to the *Organic Gardening* letter.[5] "Our Nutrient Data Laboratory, which maintains the National Nutrient Database, does not actively monitor changes in the nutrient content of specific foods over long periods of time," she explained. However, after examining food composition data for 1950 and 1963 contained in Handbook #8 and a supplement published in 1984 including data on vegetables, she admitted, "It is true that in many (but not all) cases, the apparent nutrient content of these vegetables has decreased." She cited increased vitamin C and calcium levels in peas, which were not included among the 12 vegetables in the original study.

In explaining these apparent changes, Ms. Johnson listed thirteen factors to consider:

1. Data is gathered from many different sources at different times, including the food industry, published literature, and USDA analyses
2. Food changes, including different cultivars, geographic sources of foods, climates, marketing and distribution practices, may affect nutrient content
3. Changes in the public's acceptance of what is edible may influence what parts of food are analyzed over time
4. Data may have been derived from limited or non-representative sampling or from foods that were not well described (e.g., for leafy vegetables, how many leaves were removed, how much of the stem was retained, etc.)
5. Nutrient content is usually not a primary objective among plant scientists and farmers in developing new cultivars, food handling, or marketing and distribution practices. Rather, priorities are general improved disease resistance, higher yields, more uniform colors, longer shelf life, and other goals that may affect nutrient content
6. Improved testing methods may have "reduced" previously high but less accurate levels for some components. The inability to measure certain types of nutrients or contamination of samples during the analytic process may also be factors. "Chemical methods for measuring iron, for example, have changed substantially in the past thirty years; earlier methods tended to yield higher values."
7. Improved quality control of analytical measures in major laboratories has resulted in further accuracy in measurements
8. Superior instrumentation today allows chemists to measure levels of components previously overestimated or not reported at all

9. Changes in moisture content of samples "stored under less desirable conditions" in the past may have contributed to excessive dehydration and consequently higher values for nutrients
10. Some nutrients may have been calculated from standard factors widely accepted in the past. "For example, it was a widely accepted practice before 1960 to calculate iron content of meat from the protein content."
11. Variability in nutrient content in a specific food can vary during any year, from field to field, and together with limited sampling result in "apparent disparities in nutrient content, even within a single crop year."
12. Changes in carbon dioxide levels in the atmosphere may affect the concentraation of ascorbic acid and other nutrients in some plants
13. Comparisons must be uniform, "based on data for foods expressed in the same units, on the same moisture basis, and on the same weight basis."

Finally, Ms. Johnson noted, the significance of any change must be considered. Even a 78% decrease in corn, she asserted, is "not nutritionally significant" based on the Adequate Intake estimates by the Food and Nutrition Board. "A change in the nutrient content of a food which is only a minor part of our total food intake, such as parsley, is not likely to have a significant effect on one's nutritional status."

She concluded that, given so many variables, it was "virtually impossible to separate or partition effects of soil conditions from all the other factors which may affect the final values for a given point in time." She then rejected *Organic Gardening*'s contention of a link between over application of nitrogen fertilizer and decreased nutrients. "In some cases, nitrogen application has been found to increase the uptake of trace elements into the edible portions of plants." Similarly, she noted that the USDA was unaware of any specific studies linking acid rain and nutrient levels in plants. But because soil pH and nutrient levels are managed intensively on many farms "the net effects of acid rain on cropland may not be the same as the effects on forests." She also noted that much of America's fruits and vegetables are produced in California and other western states where acid soil is not a problem.

5. The Organic Rejoinder

> "A whole new meaning to the phrase "Empty Calories."
> —Vgkg, posted on the forum "Nutrients in veggies disappearing!, www.Nature.Net, October 3, 2000

In its May/June 2000 issue, *Organic Gardening* published a rejoinder to the USDA response.[6] A follow up editorial entitled "As Food Quality Drops, the USDA Just Shrugs" summarized the USDA's position in italics: "*Yes, nutrition levels in many foods appear to be dropping, but we're not sure why they are dropping, and we don't plan to pursue the matter*. Not exactly the response we think this country deserves." The magazine went on to quote Will Brinton, Ph.D., a soil expert and head of the Woods End Research Laboratory in Mount Vernon Maine: "Certainly they can find the causes for the nutrient declines if they try. The problem is, they don't seem to place any value on trying to find the answers."

"Surely the taxpayers who provide millions of dollars to the USDA have a right to expect the agency at least to attempt to find out why the nutrient content of many crops is going down. Science is supposed to be a tool we use to answer important questions," the magazine continued. Citing hundreds of scientific studies that conclude that industrial chemical-based farming is harming soil quality, *Organic Gardening* wrote: "Even though taxpayers have subsidized major erosion-control programs in recent decades, chemical farming is still causing billions of tons of topsoil to be lost every year. Year after year

while crops are harvested and eaten, soils erode away, and essential minerals and organic matter are not replenished." It cited the disposal of human and animal manure instead of recycling it as an example of wasteful modern practices. "Simple logic strongly suggests that this steadily declining soil quality will lead to corresponding drops in food quality. But currently no one in the U.S. government is required to even monitor changes in the nutrient content of our food, let alone try to explore the reasons for the changes. And now that outside analysis of the USDA's own data reveals that nutrients are declining, the agency seems largely indifferent." *Organic Gardening* posted materials related to the controversy, including the original vegetable study, the USDA's response, and the comments of soil experts on its web site to stimulate further public discussion.

Following the exchange of letters between *Organic Gardening* and the USDA, the controversy spread. A variety of magazines, trade journals, and on line publications picked up on the issue, frequently contacting this writer, describing him as a "macrobiotic nutritionist," and quoting the results of the original study. On some web sites, discussion groups debated the issue for months. For example, on Nature.Net, an online forum on "Nutrients in Veggies Disappearing!" brought together organic and conventional gardeners and farmers from across the country with a wide range of views, insights, and experiences. Interestingly, the organic farmers were deeply divided on the principal cause of the nutrient loss, with some arguing that it was weak new hybrid seeds and others that it was soil depletion and erosion. One respondent noted that he had become interested in the issue some time ago when he came across an intriguing archeology find dating to the 1960s. Scientists found a campsite in the arctic used by early arctic exploring in the 1860s, and the artifacts included a can of peaches in heavy syrup from the mid 19th century. "They had been frozen up there for over a hundred years," the forum participant reported. "Obviously they could have lost some food value even frozen. Somebody had the smart idea to test them. The lab reported that they were 50% higher in every measurable nutrient than modern canned peaches."[7]

Following publication of the *Organic Gardening* open letter, I heard from Anne-Marie Mayer, an independent researcher from England now at Cornell University. She sent me a copy of her paper, "Historical Changes in the Mineral Content of Fruits and Vegetables," published in the *British Food Journal* in 1997.[8] She analyzed the content of eight minerals in 20 vegetables and 20 fruits using two versions of the UK Government's Composition of Foods tables with data from the 1930s and the 1980s. She found significant losses in calcium, magnesium, copper, and sodium in vegetables and magnesium, iron, copper, and potassium in fruits. The greatest change was in copper levels in vegetables which plunged over 80%. The only mineral that showed no major change over a half century was phosphorus. The water content increased markedly and dry matter decreased in fruit. Ms. Mayer theorized that the losses could result from a variety of factors, including anomolies of measurement or sampling, changes in the food system such as eating more "out of season" produce and eating imported foods grown on a wide variety of soils, and agricultural practices. "During the early 1930s agricultural chemicals were hardly used," she wrote. ". . . Agriculture which relies on NPK fertilizers and pesticides, that adds little organic matter to the soil and that alternates between soil compaction and ploughing, could produce food depleted in minerals. These practices affect the structure, chemistry, and ecology of the soil in ways that could affect the availability of minerals to plants and hence the mineral content of crops." High levels of pesticide residues could also be a factor. "Considering the magnitude of the reductions this matter deserves urgent attention," she concluded.

From Australia word, I also received word of a study conducted by the Organic Advisory Service of the Organic Retailers & Growers of Australia.[9] Researchers looked at mineral levels of four vegetables (silver beet, capsicums, beans, and tomatoes) to determine whether organic remineralization methods could improve their nutritional content. Equivalent vegetables from a supermarket were then analyzed as a case control comparison. "The hypothesis was based on the observation that consumers purchase fruit

and vegetables from supermarkets and stores on the assumption that they are providing them with sound nutrition," explained Chris Alenson, technical adviser to the Organic Advisory Service. "They do not necessarily know the variety or where or how they are grown. Our believe is that despite its often glossy wonderful appearance, food today is not delivering the range of nutrient elements that it should. The taste is often very average."

In the experiment, the vegetables were grown in a degraded volcanic soil with a pH of 4.5 and low in calcium, magnesium, potassium, and trace elements. The soil was then revitalized with rock dust (basalt) and a special mineral fertilizer containing these elements, a zeolite mineral added to increase the exchange capacity, and good quality compost. The end result was that the vegetables grown on the remineralized soil were often ten times higher in nutrients than the supermarket items.

6. The Fruit Study

As a follow up to the vegetable study, I recently investigated the change in nutritional content of common fruits in America over the last twenty-five years. In an experiment, a "digital fruit basket" of 12 common fruits compared selected nutrient content today based on the USDA nutrient data base posted on the Internet with that published in *Handbook #8* in 1975. The fruits were selected at random and included apples, apricots, bananas, cherries, grapefruits, lemons, oranges, peaches, pineapples, strawberries, tangerines, and watermelons.

Overall, a comparison found that the vitamin and mineral content was substantial down in four out of five nutrients surveyed. Vitamin A levels dropped 16.4%, calcium fell 28.9%, iron plunged 47.6%, and phosphorus dropped 23.9%. Vitamin C levels remained relatively constant, declining only 1.9%. The complete results are shown in Tables 6-10.

Table 6. Calcium Content in Selected Fruits*

	1975	2001	Net Change
Apples	7 mg	7 mg	None
Apricots	17 mg	14 mg	Down 17.7%
Bananas	8 mg	6 mg	Down 25%
Cherries	22 mg	15 mg	Down 31.8%
Grapefruits	16 mg	12 mg	Down 25%
Lemons	61 mg	26 mg	Down 57.4%
Oranges	41 mg	40 mg	Down 2.4%
Peaches	9 mg	5 mg	Down 44.4%
Pineapples	17 mg	7 mg	Down 58.8%
Strawberries	21 mg	14 mg	Down 33.3%
Tangerines	40 mg	14 mg	Down 65%
Watermelons	7 mg	8 mg	Up 14.3%
Net Change			Down 28.9%

*Based on 100 Grams, Edible Portion. *Source: USDA food composition tables*

Table 7. Iron Content in Selected Fruits*

	1975	2001	Net Change
Apples	0.3 mg	0.18 mg	Down 40%
Apricots	0.5 mg	0.54 mg	Up 8%

Bananas	0.7 mg	0.31 mg	Down 55.7%
Cherries	0.4 mg	0.39 mg	Down 2.5%
Grapefruits	0.4 mg	0.06 mg	Down 85%
Lemons	0.7 mg	0.6 mg	Down 14.3%
Oranges	0.4 mg	0.10 mg	Down 75%
Peaches	0.5 mg	0.11 mg	Down 78%
Pineapples	0.5 mg	0.37 mg	Down 26%
Strawberries	1.0 mg	0.38 mg	Down 62%
Tangerines	0.4 mg	0.1 mg	Down 75%
Watermelons	0.5 mg	0.17 mg	Down 66%
Net Change			Down 16.4%
*Based on 100 Grams, Edible Portion. *Source: USDA food composition tables*			

Table 8. Vitamin A Content in Selected Fruits*			
	1975	2001	Net Change
Apples	90 IU	53 IU	Down 41.1%
Apricots	2700 IU	2612IU	Down 3.3%
Bananas	190 IU	81 IU	Down 57.4%
Cherries	110 IU	214 IU	UP 94.6%
Grapefruits	80 IU	10 IU	Down 87.5%
Lemons	30 IU	29 IU	Downs 3.3%
Oranges	200 IU	205 IU	Up 2.5%
Peaches	1330 IU	535 IU	Down 59.8%
Pineapples	70 IU	23 IU	Down 55%
Strawberries	60 IU	27 IU	Down 67.1%
Tangerines	420 IU	920 IU	Up 119%
Watermelons	590 IU	366 IU	Down 38%
Net Change			Down 16.4%
*Based on 100 Grams, Edible Portion. *Source: USDA food composition tables*			

Table 9. Vitamin C Content in Selected Fruits*			
	1975	2001	Net Change
Apples	4 mg	5.7 mg	Up 42.5%
Apricots	10 mg	10 mg	None
Bananas	10 mg	9.1 mg	Down 9%
Cherries	10 mg	7 mg	Down 30%
Grapefruits	38 mg	33.3 mg	Down 12.4%
Lemons	77 mg	53 mg	Down 31.2%
Oranges	50 mg	53.2 mg	Up 6.4%
Peaches	7 mg	6.6 mg	Down 5.7%
Pineapples	17 mg	15.4 mg	Down 9.4%
Strawberries	59 mg	56.7 mg	Down 3.9%
Tangerines	31 mg	30.8 mg	Down 7%
Watermelons	7 mg	9.6	Up 37.1%
Net Change			Down 1.9%

*Based on 100 Grams, Edible Portion. *Source: USDA food composition tables*			

Table 10. Phosphorus Content in Selected Fruits*			
	1975	2001	Net Change
Apples	10 mg	7 mg	Down 30%
Apricots	23 mg	19 mg	Down 17.4%
Bananas	42 mg	20 mg	Down 52.4%
Cherries	19 mg	19 mg	None
Grapefruits	16 mg	8 mg	Down 50%
Lemons	15 mg	16 mg	Up 6.7%
Oranges	20 mg	14 mg	Down 30%
Peaches	19 mg	12 mg	Down 36.8%
Pineapples	8 mg	7 mg	Down 12.5%
Strawberries	21 mg	19 mg	Down 9.5%
Tangerines	18 mg	10 mg	Down 44.4%
Watermelons	10 mg	9 mg	Down 10%
Net Change			Down 23.9%
*Based on 100 Grams, Edible Portion. *Source: USDA food composition tables*			

Among the many findings and correlations, the following stand out:

- Ten of 12 fruits registered a decline in calcium, including a loss of 57.4% of this nutrient in lemons, 58.8% in pineapples, and 65% in tangerines. Overall, the average loss was 28.9%.
- Eleven of 12 fruits showed reduced amounts of iron, with a majority of fruits losing over half their total amount. These included bananas (down 55.7%), grapefruit (down 85%), oranges (down 75%), peaches (down 78%), strawberries (down 62%), tangerines (down 75%), and watermelons (down 66%). Overall, the average loss was 47.6%.
- Nine of 12 fruits lost vitamin A, and five of these lost more than half of this nutrient. These included bananas (down 57.4%), grapefruit (down 87.5%), peaches (down 59.8%), pineapples (down 55%), and strawberries (down 67.1%). Apples (down 41.1%) and watermelon (down 38%) also had steep declines.
- Vitamin C levels remained relatively constant, while apples (up 42.5%), oranges (up 6.4%), and watermelon (up. 37.1%) showed increases in this vitamin. Cherries (down 30%) showed the steepest decline. Overall, the vitamin C levels were down on average 1.9%.
- Phosphorus levels dropped in 10 out of 12 fruits surveyed. Major declines were registered by apples (down 30%), bananas (down 52.4%), oranges (down 30%), peaches (down 36.8%), and tangerines (down 44.4%). Overall, the average loss was 23.9%.

Overall, the results of the fruit investigation are similar to the vegetable study. They show a substantial loss of vitamin and mineral content in most of the items examined.

Though the overall trend was down, a few fruits registered increases in selected nutrients. The iron in apricots rose 8%, calcium in watermelon jumped 14.3%, and the vitamin A in cherries soared 94.6%. New hybrid seeds, variable climatic conditions, and other factors may account for these increases. On balance, it appears that the larger, juicier fruits, including watermelon, pineapples, bananas, and grapefruit, lost the most nutrients. Smaller, more compact fruits such as apricots, peaches, and strawberries lost the least. Citrus fruits such as lemons, oranges, and tangerines fell in between. Apples and cherries showed considerable volatility, losing in some components and gaining in others.

Grapefruit, in particular, seemed to have lost its vitality. This may be the result of pollution in Florida (caused primarily by chemical run off from sugar refining in the Everglades). It may also result from the widespread use of lead arsenate to ripen grapefruits. A mixture of lead and arsenic, the compound is used on one third of the state's crop, allowing suppliers to pick the fruit two months earlier than usual. Normally, grapefruits are harvested in December, but the led arsenate enables farmers to get their fruit to market as early as September. According to the National Coalition Against the Misuse of Pesticides (NCAMP), residues of inorganic arsenic in grapefruit produced in this way average 130 ppb (parts per billion) and grapefruit juice averages 50 ppb. These levels exceed safe amounts allowed in drinking water. Arsenic, a carcinogen, is associated with causing nervous disorders and toxic reactions in the blood, digestive system, liver, and kidneys. The Environmental Protection Agency (EPA) has conducted a ten-year review of the effects of lead arsenate on grapefruits, but has reportedly withheld release of the study until current supplies of lead arsenate are "consumed." NCAMP has warned consumers to avoid buying grapefruit before December and inform produce managers in local natural foods stores and supermarkets of this hazard.

7. Discussion and Conclusion

In the most recent study of nutrient loss, academic researchers confirmed in the *Journal of the American College of Nutrition* in 2004 that there have been statistically reliable declines in six major nutrients (protein, calcium, phosphorus, iron, riboflavin, and ascorbic acid) in forty-three garden vegetables.[10] Comparing essentially the same data that was used in my initial study from the USDA, the researchers charted lower levels of key nutrients over the past half century but said they were uncertain as to the causes. In their view, the primary reason for the difference appears to be that new strains of crops have been introduced over the decades that produce higher yields, growth rates, and pest resistance but select for lower levels of nutrients. Unpredictable genetic variability among seeds was also cited as a factor. Further accounting for the changes, they argue, is the substantially higher moisture content in produce today. Factoring this into the equation, the actual percentage of vitamins and minerals in the dry matter of most crops remains the same. In brief, they took issue with my conclusion that there was "an alarming decline in food quality" and found no evidence that it could be due to a decrease in soil quality, water quality, air quality, or other environmental factors.

While I appreciate the efforts by the researchers to look at the issue from a comprehensive statistical perspective, they miss the key point, namely, that the food that Americans are eating today—for whatever reason, environmental, genetic, or simply the fact that it is grown from seed with inferior nutritional traits—is 25 to 50 percent lower in nutrients than it was a half century ago. Not only that but most of the cookbooks, popular health and diet books, menu plans, and other nutrition-related data and databases continue to use obsolete, misleading figures from decades ago that are significantly higher than the food that people are actually consuming today.

The issue of moisture content is particularly interesting. The scientists are probably right that new hybrid seeds absorb higher levels of water and hence produce greater yields (measured in size, shape, and weight), thus distorting the proportion of the

other nutrients. However, the point once again is that these are foods that people are eating today: larger, more devitalized, and ultimately weaker, compared to those that their parents or grandparents ate one or two generations ago. If this isn't alarming, what is?

Personally, I favor the environmental hypothesis as the a main cause of the decline. In my original article, I was careful to point out that it was only a hypothesis and that further studies were needed to substantiate it. Given the large scale destruction of the natural environment over the last half century, it would be astonishing if pollution and toxicity at so many levels did not appreciably affect the food supply. Like scientists who still deny the reality of global warming, to ignore environment as a factor in nutrient decline, as these researchers go out of their way to do, only serves to postpone the inevitable day of reckoning.

A related issue is whether organic food contains higher levels of nutrients than conventionally grown food. With the introduction of the new USDA organic certification program, one hoped that such studies would finally be undertaken. Yet they have not. Some independent studies are beginning to show what organic consumers intuitively know, namely, that organically grown food is substantially higher in vitamins and minerals than chemically grown food. For example, the second annual State of Science Review reported that cancer-fighting antioxidant levels are, on average, 30 percent higher in organic produce vs. conventionally grown fruits and vegetables.[11] The cause for this, the scientists concluded, is that antioxidant chemicals are created within a plant grown organically or in the wild when the plant triggers internal defense mechanisms. However, these beneficial mechanisms are rarely triggered in plants that are raised with synthetic fertilizers and pesticides.

By all indications, the decline in the modern way of eating begins in the soil, the air, the water, and other aspects of the environment. The U.S. government is doing virtually nothing to address this issue, nor is agribusiness, the food industry, or academia. Yet there is no more important issue than food quality, food safety, and the relation of diet and health. It is time to recognize that the threats that nutritional decline pose to homeland security are as real as those we face from international terrorism, global warming, and nuclear war or accident. The sooner we address this issue with a sustainable, organically-based agriculture and food policy, the sooner we will reclaim our health as individuals, families, a nation, and a planet.

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