CHAPTER FIVE

Leaf Vegetables and Diseases Related to the Industrialized Diet

Malnutrition is an imbalance—a deficiency or an excess—in a person's diet that causes health problems. Traditionally malnutrition has been seen as chronic hunger (undernutrition) and as micronutrient deficiencies. Poor growth, low physical and mental energy and susceptibility to infections are the most common symptoms of traditional malnutrition.

A relatively new form of malnutrition has taken hold mainly in wealthy societies and in the urban parts of developing countries. This newer type of malnutrition is caused mainly by an excess of calories and a shortage of fiber, antioxidants, and certain vitamins and minerals. The new malnutrition manifests itself primarily through increased risk of several chronic degenerative diseases. These include obesity, diabetes, heart disease, cancer, and stroke. This type of malnutrition closely follows the transition from a traditional diet to a westernized or industrialized diet.

The industrialized diet is based on commercial foods that are manufactured from low cost agricultural commodities, especially corn, wheat, and soy. These agricultural commodities are converted into refined sugars, starches, and fats that are assembled into highly processed products with long shelf lives that can be marketed over long distances. Economies of scale keep the cost of manufacturing these food products low, while attractive packaging and creative advertising helps keep the selling prices high enough for a large profit margin. The combination of consumer demand for convenient foods and the logistical capabilities of multi-national food corporations is a powerful force: so powerful that traditional diets are quickly being replaced by a single industrial diet in much of the world.

The typical industrial diet is too high in saturated fat, sodium, and refined carbohydrates. It is characterized by foods with high calorie density and low nutrient density; food with a high ratio of calories to other essential nutrients. These are sometimes called "empty calorie foods." When the diet includes many empty calorie foods it becomes very difficult to obtain all the nutrients we need without overeating.

Overeating, combined with reduced physical activity, cause people to become overweight and in severe cases obese. This has become a huge global health issue. It is estimated that over one billion adults are overweight with over 300 million of them being clinically obese. Obese people have lower overall quality of life and increased risk of premature death.

While the epidemic of obesity began in wealthy nations, it is now the emerging market societies that are experiencing the fastest growth of this health condition. It is especially disturbing that the percentage of overweight and obese children and adolescents is growing more rapidly than that of adults.

An increasingly common result of eating an industrialized diet is the "metabolic syndrome." This is a combination of large waist circumference, high blood sugar, high blood pressure, and high triglycerides or cholesterol in the blood. It is estimated that over 20% of American adults have some degree of the metabolic syndrome. It is a major risk factor for type 2 diabetes, cardiovascular disease, high blood pressure, stroke, osteoarthritis, and many forms of cancer.

Sugars and starches in their natural state invariably coexist with fiber. When that fiber is stripped away during food processing those carbohydrates are digested and absorbed much more quickly by our bodies. This leads to an abrupt rise followed by an abrupt fall in blood sugar levels. The repeated rapid rise and fall of blood sugar levels can lead to insulin resistance. This is a condition in which the pancreas fails to keep up with the body's need for insulin to process carbohydrates properly. Insulin resistance is a precursor to diabetes. It is linked to excessive consumption of sugars, especially fructose which is processed mainly in the liver.

Diabetes is a major public health problem and is emerging as a pandemic. The World Health Organization estimated that over 220 million people suffer from diabetes and that number is likely to double by 2030. The biggest increase in diabetes is coming not from the wealthy countries but from lower income countries of the tropics. This shift in the demographics is accompanied by people developing the disease at a younger age, by about ten years, than people in wealthy countries. Diabetes can cause damage to the nervous system, the circulatory system, eyes, and kidneys. The rapidly increasing number of people affected, coupled with earlier onset, is making diabetes a major drain on the productivity and health care resources of developing countries.

How quickly carbohydrate containing foods elevate blood sugar levels is gauged by the glycemic index. The index is based on glucose, which has a value of 100. High glycemic index foods have numbers above 70. Intermediate foods have numbers between 55 and 70 and low glycemic index foods are below 55. Processed foods such as soda, cookies, cakes, white breads, and crackers generally have high glycemic indexes. The glycemic index of potatoes is also high because much of the starch in potatoes is rapidly digested amylopectin, rather than the more slowly digested amylose starch found in beans. Whole grains and beans generally have lower glycemic indexes.

Most vegetables have low glycemic indexes and leaf vegetables are typically very low in this ranking. Spinach, for example, has a glycemic index of 15. Most leaf crops have not yet been tested for their glycemic index, but it is safe to assume they will be low. Not only do greens have low glycemic indexes, some of them appear to have blood sugar stabilizing properties. The leaves of chaya and bitter gourd, in particular, have shown great promise in moderating blood sugar, though testing is still at an early stage.

Obesity and diabetes are a high price to pay for the convenience of highly processed food. These two diet-related chronic diseases arise together so often that some health workers have begun using the somewhat frightening term "diabesity."

The industrial diet is not only overloaded with saturated fat, sodium, and refined carbohydrates, it comes up short on essential magnesium, calcium, potassium, fiber, and antioxidants. Many leaf vegetables are good sources of all five of these missing components of the industrial diet, and they have extremely high nutrient density.

MAGNESIUM

Magnesium is the eighth most abundant chemical element in the Earth's crust, the ninth most abundant in the known Universe, and the 11th most abundant element in the human body. More than 300 key biochemical reactions in the body require magnesium to function. It helps keeps bones strong, maintain muscle and nerve function, regulate heart rhythm, and keep the immune system working efficiently. Magnesium also helps to regulate our blood sugar levels and blood pressure.

Numerous observational and animal studies have tied low magnesium intake with increased risk of type 2 diabetes. Other studies have suggested a link between low consumption of magnesium and increased risk of chronic inflammation, asthma, arterial plaque formation, osteoporosis, colon cancer and memory loss. The best dietary sources of magnesium are seeds and nuts, green leafy vegetables and whole grains. The industrialized diet generally provides little of these foods and as a result the number of people consuming inadequate amounts of this essential mineral is large and growing. It is estimated that only 32% of Americans take in the recommended amount of magnesium (420 mg per day for men and 320 mg per day for women).

Green leafy vegetables such as spinach and parsley are good sources of magnesium because the center of the chlorophyll molecule (which gives green leaves their color) contains magnesium. The amount of magnesium in leaf vegetables varies greatly and is generally more available in cooked than raw vegetables. (See Chart 5–1.)

CALCIUM

Calcium is essential for forming and maintaining healthy bones and teeth. It also plays an essential role in blood clotting, nerve signaling, muscle contraction and relaxation, use of some key hormones, and sustaining a normal heartbeat. Dairy products are an excellent source of dietary calcium, except that as with most animal-based foods, they are too expensive for many to afford on a regular basis. Also families that don't have refrigerators have trouble with spoilage of dairy products. Another drawback to dairy products as a primary source of calcium is that roughly 75% of the world's adults don't produce enough lactase to digest milk properly. Lactase is an enzyme that infants produce to digest milk. Lactase production declines in adulthood, especially in cultures without a strong tradition of drinking milk.

Among the best plant sources of calcium are sesame seeds, almonds, soy products and leaf vegetables. The leafy members of the cabbage family, including kale, collards, turnip, and mustard greens, as well as many Asian cabbages and mustards, are exceptionally good sources. Other excellent leaf vegetables for calcium include bitter gourd leaves, chaya, grape leaves, moringa, okra leaves, taro, vine spinach and wolfberry.

Several leaf crops such as spinach, Swiss chard, beet greens, parsley, and purslane have high levels of calcium but also have high levels of oxalic acid. Because the oxalic acid combines with the calcium and makes it much more difficult to utilize, these leaf vegetables should not be considered good calcium sources.

FIBER

Fiber is the indigestible part of food plants. There is no fiber in animal-based foods.

Chart 5–1
Magnesium in Selected Leaf Vegetables

Magnesium	Leaf crop
mg	100 g raw leaves per USDA
147	Moringa
95	Grape leaves
81	Swiss Chard
79	Spinach
70	Beet greens
68	Purslane
61	Sweet potato leaf
55	Amaranth leaves
50	Parsley
48	Basella
45	Taro leaf
43	Cowpea leaf
39	New Zealand Spinach
38	Pumpkin leaves
36	Dandelion greens
32	Mustard greens
31	Turnip greens
13	Lettuce, Leaf
7	Lettuce, Iceberg

There are two types of dietary fiber. Both are beneficial. Insoluble fiber comes mainly from the plant cell walls. This type of fiber promotes the movement of material through your digestive system, improving intestinal health and reducing the risk of constipation, hemorrhoids, and diverticulosis. Whole-wheat flour, nuts, and many vegetables, including leaf vegetables, are good sources of insoluble fiber.

Soluble fiber comes mainly from within the plant cells. Soluble fiber dissolves in water to form a gelatinous or mucilaginous material. It can help lower blood cholesterol through a somewhat roundabout means. The liver uses cholesterol to make bile, which our bodies use to break down fats in our food. It can reabsorb unused bile to avoid having to synthesize more of it. Soluble fiber binds with bile and takes it out of the body with the feces. Because of this the liver must draw more cholesterol from the bloodstream to make new bile, and thus the blood cholesterol level is lowered. Soluble fiber is also beneficial because it slows digestion, which helps to stabilize blood sugar levels, which reduces the risk of developing diabetes. Excellent sources of soluble fiber include plums, citrus fruits, oatmeal, broccoli, carrots, peas, and beans.

Most leaf vegetables are good sources of both insoluble and soluble fiber. Leaf crops that have a mucilaginous quality, such as vine spinach (*Basella alba*), bush okra (*Corchorus olitorius*) and okra (*Abelmoschus esculentus*) tend to have high levels of soluble fiber. Most people eating an industrialized diet consume less than half of the recommended 25 to 35 grams of total fiber per day.

ANTIOXIDANTS

In addition to nutrients, our bodies make use of many other compounds to maintain our health. Among these none are more important than antioxidants. There is strong evidence that antioxidants reduce the risk of heart disease, age-related macular degeneration (a common cause of blindness in the elderly) and many cancers. There is also building evidence that they may be at least partially protective against type 2 diabetes, Alzheimer's and Parkinson's disease.

Most antioxidants are found in plant-based food. Fruits and vegetables, along with coffee, tea, and chocolate, are the chief sources of dietary antioxidants. They are molecules that neutralize free radicals and can prevent all sorts of damage to our cells. A free radical is an unstable molecule that is missing at least one electron. It will react with almost any other molecule it might bump into, creating biochemical chaos in the process. As free radicals randomly react with proteins, carbohydrates, fats, and DNA, they can disrupt normal cellular functioning throughout our bodies.

The seriousness of this random chemical activity within our carefully organized biological system can be seen from the list of ailments thought to be related to oxygen free radical activity. These include many types of cancers, heart disease, stroke, arthritis, Parkinson's disease, Alzheimer's disease, cataracts, and emphysema. Free radical damage is even thought to cause much of the tissue degeneration that we think of as normal aging. Although almost all organisms have evolved antioxidant systems to defend against and repair oxidative damage, these systems cannot provide total protection from oxidative damage.

Where do these troublesome molecules come from? Our normal cellular activities create some free radicals, so there is no way to avoid all of them. We are also exposed to varying amounts of external sources of free radicals, coming from cigarette smoke, pollutants, some drugs, and ultraviolet light or radiation.

How can we defend our bodies from oxygen free radical damage? Some of the external free radicals can be reduced through prudent actions, such as quitting smoking and using sunscreen or shade in midday sun. However, it has become increasingly difficult to dodge environmental pollutants. We have introduced more than 80,000 man-made chemicals into the environment in the past sixty years and the long-term impact of most of them is unknown. The various combinations of these synthetic chemicals with each other and with common, naturally-occurring

POTASSIUM & SODIUM

Potassium and Sodium are two essential mineral nutrients in our diet. Their functions include key roles in regulating our blood pressure, maintaining the acid/alkaline balance in our body fluids, and protecting our bones, nervous system, muscle function, heart and kidneys. The industrial diet tends to include far more sodium, mainly in the form of salt (sodium chloride) than traditional and primitive diets. Industrialized diets also provide far less potassium than traditional and primitive diets. These two nutrients are utilized together and the ratio of one to the other is as important as the total intake.

There is a substantial evidence linking diets that are high in sodium and low in potassium with increased risk for several chronic degenerative diseases, including stroke, high blood pressure, osteoporosis (brittle bones) and kidney stones. U.S. dietary guidelines call for a daily intake of at least 4.7 grams of potassium and no more than 2.3 grams of sodium. Americans actually consume about half the recommended potassium and twice the recommended sodium, or the reverse of the ideal ratio.

The American diet has unfortunately become the template for most societies undergoing rapid industrial development. As trends in sodium and potassium intake follow the American lead, developing countries are beginning to see similar rates of stroke, high blood pressure, osteoporosis and kidney stones.

About 77% of the sodium in the American diet comes from processed food. While sodium is added to almost all processed foods, potassium is not. Potassium is naturally found in fresh vegetables, fruit, whole grains, meat, and dairy products, so it is not very difficult to consume enough of it.

Foods that have a large amount of potassium and a small amount of sodium are especially helpful in correcting this dangerous dietary imbalance. Bananas and oranges are both very good sources of potassium with very little sodium. Most green leafy vegetables are also excellent sources of potassium while containing little sodium.

Chart 5–2 shows the quantity of potassium and sodium in some foods, with leaf vegetables in bold. It is easy to see which foods have a ratio of the two nutrients that is beneficial to your health and which have the opposite.

Chart 5–2
Best Ratio of Potassium to Sodium is 2:1

Potassium	Sodium	Food
mg	mg	100 g. edible portion
358	1	Banana
200	1	Orange Juice
762	226	Beet Greens
608	11	Bitter Gourd Leaves
455	7	Cowpea Leaves
433	11	Pumpkin Leaves
337	9	Moringa Leaves
558	79	Spinach
246	18	Cabbage
140	189	Cole Slaw
178	602	Cheeseburger
172	633	Pepperoni Pizza
146	1715	Pretzels

Source: United States Department of Agriculture Nutrient Data Laboratory
www.nal.usda.gov/fnic/foodcomp

compounds create vast permutations of biochemical activities far beyond our capacity to understand and monitor. Until our industries and the environmental groups that watch over them can significantly reduce the load of pollutants, nutrition may be our best ally.

Leafy green vegetables as a group are extraordinary sources of antioxidants. Vitamin A, vitamin C, and vitamin E (A-C-E) are three essential nutrients that also happen to be important antioxidants. All three of these vitamin antioxidants are present in all leaf crops and plentiful in most of them.

Other beneficial antioxidants found in leaf vegetables include the glucosinolates, found primarily in plants of the cabbage (or mustard) and onion families. These are converted to isothiocynates[1] in our bodies and are very potent anti-cancer agents. Kale, collards, broccoli, radish, arugula, mustard, and turnip greens are extremely rich sources of these compounds, especially when eaten raw or lightly cooked. The effect of this class of antioxidants is thought to be sufficiently important to recommend that everyone eat foods from this family several times a week. One of the few food plants outside the cabbage and onion families that provides isothiocyanates is moringa. A hint of this shared attribute is found in one of its common names, the horseradish tree.

Two other important antioxidants we acquire largely from eating green leaves are lutein and zeaxanthin. Lutein and zeaxanthin, are closely related carotenoid pigments that are often considered together as one, because of difficulties in separating them. They are present in tissues in the eye, blood serum, skin, cervix, brain, and breast. They are not produced by the human body and so must be consumed daily through food. We know that lutein- and zeaxanthin-rich foods protect the eyes and the skin from damaging ultraviolet radiation. This is not too surprising if one considers that our eyes and skin are exposed to UV radiation from sunlight in much the same way that the green leaves of plants are. In living leaves, lutein, and zeaxanthin quench the free radicals released by the UV radiation before they can set off chain reactions of cellular damage. This appears to be their main function in our eyes and skin as well. We may not be as different from plants as we think, sharing the same biological sun block and sunglasses.

How much lutein and zeaxanthin is enough? In one large study, people who consumed about 14,000 mcg a day had a significantly lower risk of cataracts than people who ate one-seventh as much. There is also evidence that a diet rich in lutein can slow or even partially reverse the damaging effects of age-related macular degeneration (AMD), the leading cause of blindness in people over age 65 in the United States. Age-related macular degeneration occurs when light-sensitive cells in the macula, the tissue at the center of the retina, break down, making reading difficult and driving dangerous.

The most interesting results from studies on lutein and the skin come from Australia where the hole in the ozone layer and a light-skinned population have combined to create a ferocious epidemic of skin cancer. An eleven-year-long study showed that increased intake of green leafy vegetables was associated with a 41% decrease in the occurrence of skin cancer. The study, published in the International Journal of Cancer, involved over 1,000 Australian adults.[2] One of its more interesting findings was that, among people who previously had skin cancer, the rate of recurrence declined by 55% in those who had increased their consumption of dark

1 Research has recently shown that isothiocyanates bind to mutant p53 proteins. These defective p53 proteins are found in roughly half of all cancer types. While normal p53 proteins are found in healthy human cells and actually prevent abnormal cell growth, the mutated p53 proteins create conditions favorable to the growth of tumors. By binding to the mutant proteins isothiocyanates prevent them from initiating abnormal cell growth. (Selective Depletion of Mutant p53 by Cancer Chemopreventive Isothiocyanates and Their Structure–Activity Relationships. Wang, X., Di Pasqua, A., Govind, S. et al. J. Med. Chem., 2011, 54 (3), pp 809–816)

2 Study published in International Journal of Cancer, Dr. Jolieke van der Pols, from the Queensland Institute of Medical Research. Journal of the National Cancer Institute, November 3, 2004

green leafy vegetables. Some researchers hypothesized that the high levels of folic acid in the greens may have also played a part in the reduced cancer rate, as folate plays an important role in the maintenance of DNA that controls cell replication.

Further evidence of the protection that lutein and zeaxanthin can provide to human skin comes from Italy. In one study, Italian women between the ages of 25 and 50 were given 10 mg of lutein a day, and they showed improvement in several areas of skin health. Skin hydration increased by 38%, skin elasticity by 8%, and the level of beneficial lipids present in the skin by 33%. The study also showed that the lutein decreased oxidation of beneficial lipids by 55%.[3]

Beyond their antioxidant activities, it is suspected that some of the benefit of carotenoids, especially lutein, may lie in their ability to stimulate the immune system, perhaps influencing immune cells at the gene level. How difficult is it to take in the 14,000 mcg of lutein used in the Australian study or the 10,000 mcg used in the Italian study, from foods that you eat? Chart 5–3 gives you a good idea where to start.

The world of antioxidant research is fascinating, complex, confusing, expensive, and fast-changing. Research gets done first on foods of economic importance to wealthy people. Many of the more promising tropical leaf crops have not gotten a glance from the top research labs because they do not normally enter into international trade. From what we know of the patterns of composition, it is likely that many more leaf crops will move into the category of protective super foods, once the world's food scientists are able to test their antioxidant activity.

Meanwhile, the best advice on antioxidants is to eat a large variety of fruits and vegetables every day, as antioxidants from different fruits and vegetables have somewhat different mechanisms of action. Greens of all types, especially members of the cabbage family, all kinds of berries, as well as onions and garlic should definitely be included. No one leaf vegetable or any other plant has all the attributes that are needed to counter micronutrient malnutrition and to offset the imbalances of the industrialized diet. Only variety can accomplish that.

3 Dr. Pierfrancesco Morganti, professor of applied cosmetic dermatology at the University of Naples, "Clinical Evidence for Lutein and Zeaxanthin in Skin Health, Part 1: Comparison of Placebo, Oral, Topical and Combined Oral/Topical Xanthophyll Treatments."

Chart 5–3
Lutein & Zeaxanthin (Cartenoids) in Selected Foods

Cartenoids (mcg)	Food
10,270	Kale, cooked (½ c)
7,690	Collard greens, cooked (½ c)
6,340	Spinach, cooked (½ c)
6,080	Turnip greens, cooked (½ c)
1,480	Lettuce, romaine (1 c shredded)
1,320	Zucchini, raw (½ c)
1,150	Peas, canned (½ c)
1,010	Brussels sprouts, cooked (½ c)
440	Green beans, cooked (½ cup)
340	Orange juice, from concentrate (1 c)
310	Okra, cooked (½ c)
290	Baby carrots (8)
240	Orange (1)
190	Lettuce, iceberg (1 c chopped)
190	Squash, crookneck, raw (½ c)
80	Tomato, raw (½)
50	Cabbage, raw (½ c)

Source: United States Department of Agriculture