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Functional Foods for Health

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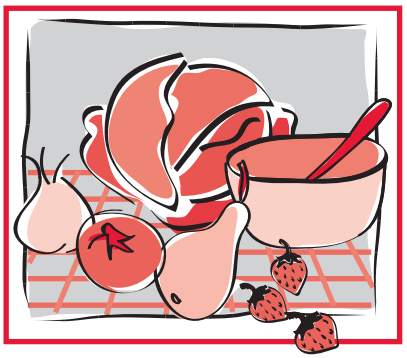
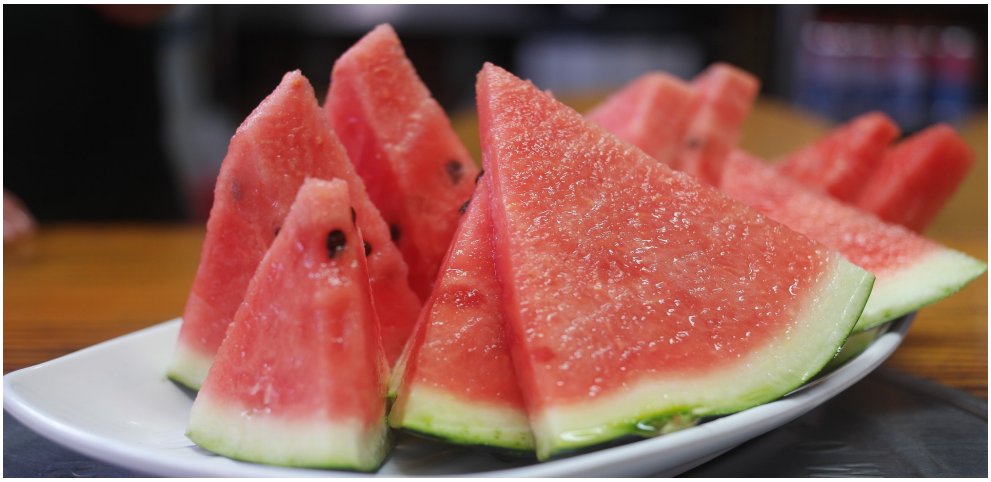


by N. Litwin, J. Clifford, and S. Johnson

Defining Functional Foods

The concept of food as medicine is not new and has been around for thousands of years. In fact, the tenet "Let food be thy medicine and medicine thy food," was put forth by the father of medicine Hippocrates approximately 2500 years ago. The concept of functional foods was first introduced in Japan in the mid-1980s when the Japanese government began funding research programs to study the ability of certain foods to influence physiological functions. This led to the creation of a law in 1991 defining a category of Foods for Specialized Health Use (FOSHU) which allowed certain foods to be approved by the Japanese government and carry the FOSHU seal of approval on their labels. In the late 1990s, the European Commission Concerted Action on Functional Food Science in Europe (FUFOSE) was created to establish a science-based approach for concepts in functional food science.



Today, the term functional foods is used to describe foods or food ingredients that provide health benefits beyond meeting basic nutrition needs due to their physiologically active food components (i.e. bioactive compounds or bioactive food components). However, there is no clear definition for functional foods in the United States. Importantly, the Food and Drug Administration (FDA) does not have a statutory definition for functional foods and therefore does not regulate them. Several prominent organizations have their own definitions (Table 1). Although these organizations recognize that all foods are functional on some level as they provide energy and nutrients required to sustain life, they acknowledge that certain foods may provide positive health benefits beyond this, and may exert specific functional effects within the body (e.g. reduction in blood pressure).

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Quick Facts

- The term functional foods is used to describe foods or food ingredients that provide health benefits beyond meeting basic nutrition needs.
- Inclusion of these types of foods can provide further protection against chronic disease and condition development.
- Different compounds most often work together synergistically to alter one or more physiological process in the body, so including a variety of foods is best.
- "Superfood" and "miracle food" are marketing terms and advertising foods as such can lead to unrealistic expectations.
- Consuming plenty of plant foods and choosing variety among foods can help increase intake of functional foods and the positive effects they may have on the body.

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Table 1. Examples of definitions of functional foods.

Organization	Definition
Academy of Nutrition and Dietetics	Foods defined as whole foods along with fortified, enriched, or enhanced foods that have a potentially beneficial effect on health when consumed as part of a varied diet on a regular basis at effective levels.
Institute of Food Technologists	Foods and food components that provide a health benefit beyond basic nutrition (for the intended population).
International Life Sciences Institute	Foods that by virtue of the presence of physiologically active food components provide health benefits beyond basic nutrition.

Although there is no clear or established definition of functional foods, conventional foods, modified foods, and food ingredients are the primary categories of functional foods that fall under existing definitions (Table 2). Foods are typically considered functional if they contain a bioactive component such as nutrients (vitamins, minerals, protein, etc.) or non-nutrients (phytochemicals including polyphenols, prebiotic dietary fibers, etc.) that affect one or more physiological functions in the body to improve well-being and health, reduce disease risk, and/or improve disease outcomes. Conventional foods are unmodified or whole foods that may be functional due to the bioactive compounds it contains. These compounds often work additively and/or synergistically to exert their effects. Modified foods considered to be functional foods have been modified through factors involved in food production and/or processing to modify the type, content, bioaccessibility, and/or bioavailability of bioactive compounds. Food ingredients may be isolated and/or synthesized bioactive components that are used in food products to confer a functional effect. Definitions of categories of functional foods and examples are provided in Table 2.

Depending on which definition of functional foods is being considered or followed, functional food definitions may also include nutraceuticals, dietary supplements, and medical foods. Definitions for these terms also vary depending on the source. Nutraceuticals may be isolated, modified, and/or synthetic bioactive components and are typically given in the form of a dietary supplement. Dietary supplements may include whole foods or other plants such as herbs, food ingredients, nutraceuticals, extracts, etc. Medical foods are formulated to meet the nutrient needs of a patient and is used in the dietary management of a disease and/or medical condition under the supervision of a physician.

Scientific Basis for Functional Foods

The identification, development, and establishment of functional foods typically requires a foundational knowledge of food, nutritional, and biological sciences. This knowledge is used to identify and determine mechanisms by which potential functional foods and food bioactive components exert physiological and functional effects to improve health and well-being, reduced chronic disease risk, and/or improve chronic disease and condition outcomes. Functional effects and potential mechanisms may be evaluated through basic research (cell and animal studies) and/or clinical research (human studies). The results of such studies are then used to support new hypotheses for human nutrition studies. The results of human nutrition studies provide necessary information to determine whether more research and development is needed to enhance the function of the food or food component, to reduce disease risk, or improve disease management. All steps support the establishment of functional foods (Figure 1).

Why Know about Functional Foods?

Many people consume functional foods inadvertently and/or purposely to achieve specific health benefits. Following a healthy dietary pattern is important for maintaining optimal health and reducing chronic disease risk. The inclusion of certain foods and food components with health benefits extending beyond meeting basic

Table 2. Categories of functional foods.

Categories	Definition	Examples
Conventional Foods	Unmodified foods	Whole fruits, vegetables, grains, nuts, seeds, legumes, dairy, fish, and meats.
Modified Foods	Foods that have been modified through enrichment, fortification, or agricultural, enzymatic, chemical, or technological means.	Calcium fortified orange juice, omega-3 fatty acid fortified margarine and omega-3 fatty acid enriched eggs, fermented foods, purple potatoes.
Food Ingredients	Isolated or synthesized food ingredients.	Indigestible carbohydrates (e.g. oligosaccharides and resistant starch) that provide prebiotic effects.

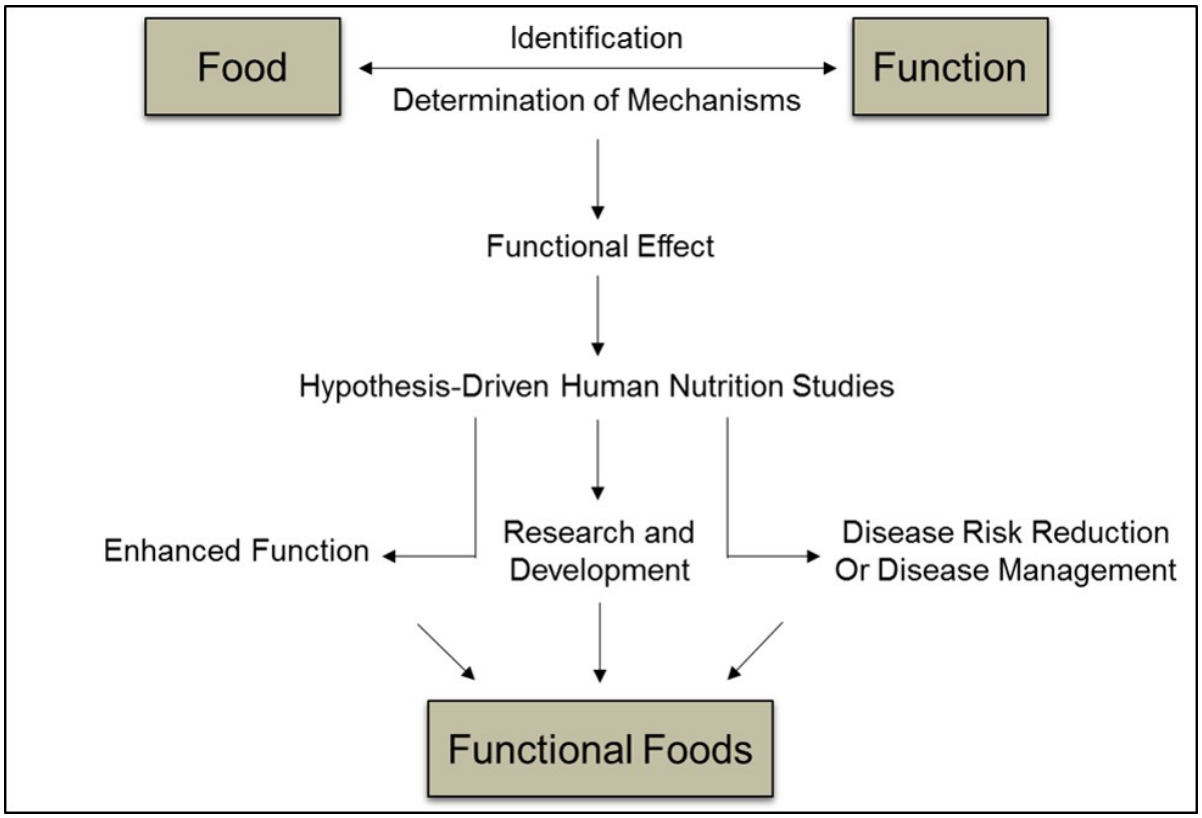

Figure 1. Scientific Basis for Establishing Functional Foods. Gibson GR, Williams CM. Woodhead publishing limited; 2000 Jan 1.

nutrition needs can provide further protection against chronic disease and condition development and may contribute to improved quality of life and longevity. Certain foods may be marketed for specific health effects, and may use health claims based on scientific evidence or without scientific basis. For these reasons, it is important to understand what functional foods are, how they are established, what is required to use health claims, and which foods exert specific functional effects.

Role of Functional Foods in Health and Disease

Functional foods and food components are being extensively studied for their effects as they relate to the optimization of human health and well-being, and in chronic disease/condition risk reduction and management. Growing scientific evidence indicates that certain foods and food components (i.e. functional foods) have biological activity in the human body and can exert specific health benefits.

The health effects rendered by functional foods are typically due to the bioactive compounds they contain. Different compounds can exert specific effects in the body, but most often work together to alter one or more physiological process in the body. To achieve the health benefits of the diverse compounds that different foods contain, it is important to consume foods in their whole form when possible. For example, whole grains contain the bran, germ and endosperm of the grain. Whole grains contain dietary fiber, B vitamins including folate, niacin, thiamin and riboflavin, as well as trace minerals such as iron, magnesium, and zinc.

Table 3. Examples of Functional Foods, Bioactive Food Components, and Potential Health Effects

Food	Bioactive Food Component/Class	Potential Health Effects
Tomatoes	Carotenoids (e.g. lycopene, beta-carotene), vitamins C and A, and potassium	Supports cardiovascular health, may reduce the risk of certain cancers such as mouth, pharynx, larynx, prostate, and lung cancers
Blueberries	Flavonoids (e.g. anthocyanins, phenolic acids), pterostilbene, vitamins C and K, manganese, and dietary fiber	Supports cardiovascular, metabolic, and brain health, may reduce the risk of cancer such as mouth, pharynx, larynx, and lung cancers
Fermented milk/dairy	Bioactive peptides, probiotics, calcium, and protein	Supports gut, immune, cardiovascular and metabolic health
Walnuts	Ellagitannins, phenolic acids, omega-3 fatty acids (alpha-linolenic acid), phytosterols, melatonin, vitamin E, copper, manganese, and magnesium	Supports cardiovascular and brain health, may reduce the risk of certain cancers such as breast and prostate cancer
Broccoli and cruciferous vegetables	Glucosinolates, vitamins C and K, manganese, folate, potassium, fiber	May reduce the risk of certain cancers such as colorectal, mouth, pharynx, larynx, and lung cancer, cardio-protective, may improve antioxidant defenses
Salmon and other fatty fish	Omega-3 fatty acids	Supports eye, brain, and cardiovascular health
Whole grains	Flavonoids, saponins, lignans, resistant starch, B-vitamins, vitamin E, selenium, manganese, dietary fiber, and protein	Supports gut and cardiovascular health, may reduce the risk of colorectal cancer

These particular nutrients are found in the outer layer of the grain or the bran that functions as a protective shell for the germ and endosperm inside. The germ contains phytochemicals such as polyphenols and lignans, vitamin E, and B vitamins. The endosperm provides carbohydrates, protein and energy. Several epidemiologic al studies have shown that a high intake of whole grains is associated with a reduced risk of type 2 diabetes, coronary heart disease, stroke, obesity, and all-cause mortality. Lower risk of cancer, particularly colorectal cancer, has also been reported. In fact, consumption of 90 grams of whole grain foods per day (about 3 servings) has been shown to reduce the risk of colorectal cancer by 17% according to the American Institute for Cancer Research. These effects have been attributed to combination of bioactive compounds that whole grain foods provide. It is thought that whole grain foods may lower cancer, heart disease and diabetes risk by reducing chronic inflammation and oxidative stress, preventing insulin resistance, reducing cholesterol levels, and improving gastrointestinal health. Overall, the evidence suggests that consumption of whole grains can enhance health and promote disease prevention by exerting effects beyond meeting basic nutrition needs and are therefore deemed to a functional food. Additional examples of functional foods, their bioactive components, and associated health benefits are shown in Table 3. It is important to note that although the presence of bioactive compounds in foods is important, their digestion, absorption, and metabolism are also critical factors that influence their health effects. Potential influences on digestion, absorption, and metabolism include accompanying foods, beverages, and/or nutrients consumed, the oral and gut microbiome, quantity consumed, duration of consumption, and health status of the individual (e.g. presence of disease, genetics, and age). Also, factors within the food production chain such as processing and distribution of foods can influence the content and types of bioactive compounds found in the foods when they are consumed.

Regulation of Functional Foods in the Marketplace

As previously mentioned, the FDA does not provide a specific definition for functional foods, and thus a formal regulatory category and framework does not exist. The only

regulation for functional foods is related to its intended use, which is determined by the manufacturer and is often determined for marketing purposes. Fortunately, current legislation in the United States is designed to protect consumers from misleading and false information that may appear on these food products. Functional foods can be categorized as either conventional foods, foods for special dietary use, food additives, dietary supplements, or medical foods – all of which are dependent on the intended use and type of claim made by the manufacturer. The FDA regulates all claims associated with food products, including that found on the product label, website, or any other form of advertisement. There are four types of FDA-regulated claims that can be used on the labels of functional food products:

•**Nutrient content claims** characterize the level of a nutrient in food and are limited to nutrients that have an FDA-established Daily Value. Nutrient content claims are most familiar to consumers as they relate to the "Nutrient Facts Label" box on all packaged foods and are typically placed on the front of the package. Examples include "low sodium", "fat-free", "high fiber", "contain 1200 mg of calcium", or "excellent source of vitamin C". All of these nutrient content claims have specific definitions and requirements mandated by the FDA.

•**Authorized health claims** characterize the relationship of the food or substance to a disease or health-related condition and is supported by substantial scientific evidence, demonstrating clinical effectiveness, and/or "significant scientific agreement" among qualified experts from accredited scientific bodies.

-An example of an authorized health claim for dietary fiber and some types of cancer is as follows: "Low-fat diets rich in fiber-containing grain products, fruits, and vegetables may reduce the risk of some types of cancer, a disease associated with many factors."

•**Qualified health claims** characterize the relationship of any food or substance to a disease or health-related condition, and are based on the totality of available scientific evidence. The available scientific evidence does not have to be as strong or well-established as that required for authorized health claims.

-An example of a qualified health claim for walnuts and heart disease is as follows: "Supportive but not conclusive research shows that eating 1.5 ounces per day of walnuts, as part of a low saturated fat and low cholesterol diet and not resulting in increased caloric intake, may reduce the risk of coronary heart disease. See nutrition information for fat [and calorie] content."

•**Structure-function claims** characterize the mechanism by which a nutrient affects a structure or function in the body or an individual's well-being, provided that such statements are not disease claims. A key requirement of a structure-function claim is that it cannot purport to act as a drug or, in other words, it cannot claim to treat, cure, or diagnose a disease. For example, general claims such as "calcium builds strong bones" or "protein helps build strong muscles" are generally accepted by the FDA as appropriate structure-function claims and do not require post-market FDA review. In addition, these types of claims may characterize the means by which a nutrient or dietary ingredient acts to maintain such structure of function, for example, "fiber maintains bowel integrity".

Can You Believe the Health Claim on that Food Label?

Food product health claims are designed to transfer information regarding the nutritional and/or health benefits of the food from manufacturers to consumers. These claims are often placed on the front of the product's package to gain consumer attention for marketing purposes. It is therefore important to understand what these claims mean in order to make informed decisions about a food. Below are a few tips on how to evaluate claims about food products and determine if they are truthful and not misleading.

•**Claims about serious diseases or health conditions call for serious science.**

•**Read the Nutrition Facts label**. Do not forget to examine the calorie and nutrient content of your food products, despite what the health claim is professing. Check out the total calories, and be sure to limit saturated fat, added sugars and sodium, and make sure you are choosing a food that is high in fiber, vitamins and minerals.

•**Look at the ingredients list.** Ingredients in a food product or beverage are required by law to be listed in order by quantity from the highest to lowest amount. That means the first ingredient is what the manufacturer used the most of. You can use this list to look for the ingredient that the claims is referring to and determine its quantity in the product by where it's listed on the list. You can also use this list to spot foods that might be high in fat, added sugar, or sodium. A common rule of thumb is to avoid lengthy lists that have extra, and possibly unnecessary, ingredients such as artificial ingredients. (To learn more about additives and their potential effects, visit the Center for Science in the Public Interest website.)

•**Watch out for "red flag" labels.**

-"**Natural"**: Currently, there is no formal definition for the use of "natural" on food labels by the FDA. The term "natural" simply means that nothing artificial or synthetic has been included in, or added to, the product that would not normally be expected to be in that food or beverage.

-**"Light"**: Light products are processed to either reduce calories or fat. The product must contain at least 50% less fat or calories than the regular product per FDA guidelines. It is important to check the Nutrition Facts and Ingredient labels to make sure other ingredients have not been added, like sugar.

-"Organic": This label has very specific criteria and legal definitions. Organic foods must be produced without using conventional pesticides, fertilizers made with synthetic ingredients, bioengineering or must be from a farm where animals are given no antibiotics or growth hormones.

A government-approved certifier must inspect the farm to ensure these standards are met. A product can only have the U.S Department of Agriculture Organic seal if at least 95% of its ingredients are indeed produced organically. It is important to remember that the "organic" label provides no meaning for whether the product is healthy or not. For example, organic sugar is still sugar.
For more information and tips on interpreting health claims, read the Colorado State University Extension fact sheet entitled "Nutrition Misinformation: Hot to Identify Fraud and Misleading Claims".

Common Misconceptions about Functional Foods

•**"Superfoods":** Superfood is a marketing term used to describe foods rich in nutrients and other bioactive compounds. Foods can have high nutritional quality and may exert specific functional effects (e.g. lower blood cholesterol levels). Myths about so-called superfoods may be perpetuated by marketing and misinformation. Foods are not "super" and advertising them as such can lead to unrealistic expectations. Foods marketed as superfoods have beneficial health effects. However, consuming too much of any one food can lead to nutrient deficiencies if a variety of foods are not consumed, and excess consumption of certain foods rich in calories such as dark chocolate, nuts, and wine can contribute to weight gain and may have detrimental health effects.

•**Miracle foods:** There is no such thing as a miracle food, and any food marketed as such or promoted as a "cure" for diseases such as cancer is not based on scientific evidence, or is based on misinterpreted or exaggerated scientific evidence.

•**"White" colored foods are not good for you:** Over the years, "white" foods have gotten a bad rap. This is partly due to the fact that white bread and white rice are processed to remove most of the nutrients except for the easily digestible and high glycemic index starch component. Also, there is a common misconception that "white" foods do not contain phytochemicals since these chemicals are known to exist in colored plant foods. The truth is that many white colored foods such as potatoes, onions, and garlic contain numerous nutrients and phytochemicals.

Incorporating Functional Foods in Your Diet

Incorporating functional foods into the diet can be easily achieved with a little thought and planning, and does not have to be expensive. Including an abundance of plant foods as well as healthy protein and dairy foods in your diet is a sure way to increase your intake of functional foods. Consider these tips:

1. Fill most of your plate with plant foods
With each meal, consider filling half of your plate with fruits and veggies among other plant-based foods such as whole grains, beans, nuts, and soy. Phytochemicals are specific type of bioactive compounds that are found in plant foods such as fruits, vegetables, nuts, and whole grains, so by consuming more of these foods on a regular basis, will help to increase consumption of health promoting phytochemicals.

2. Select a variety of colors
When choosing plant foods such as fruits and vegetables, select a variety of colors. Phytochemicals often present themselves in the form of a color but are found in white or colorless foods as well. Often, it is foods with the most vibrant colors that have the most abundant source of beneficial phytochemicals. However, white and colorless foods such as garlic and onions are rich in health-promoting phytochemicals. By consuming many different colors of plant foods, the more likely it is that you will consume a larger variety of phytochemicals.

3. Choose a variety of foods
While fruits and vegetables may be the most abundant suppliers of phytochemicals, foods from every food group are important in maintaining health. Choose a variety of foods among all of the food groups, being thoughtful to include fruits, vegetables, whole grains, proteins, and dairy. Also choose a variety of foods within each food group. Choose a variety of different fruits and vegetables, a variety of grains such as rice, wheat, quinoa, and oats. Vary proteins in your diet including fish, poultry, soy, beans, and nuts. And, if you consume dairy, think about consuming milk, yogurt, cheese, and kefir.

It is important to remember that there is no "magic bullet" when considering what to eat and how to best support health. No one food can provide all the essential nutrients needed to sustain life. The most benefits will come from eating a variety of foods, as they will provide a variety of essential nutrients and bioactive compounds. Furthermore, variety allows for bioactive compounds to act additively and/or synergistically,

which may provide added health benefits. For example:

•Toss roasted broccoli with olive oil, crushed garlic, and a bit of lemon juice.

•Top a bowl of oatmeal with chopped walnuts and blueberries, and sprinkle with flaxseed.

•Roast beets and top with a savory yogurt sauce.

•Drizzle sliced tomatoes with olive oil, balsamic vinegar, and chopped basil.

•Add salmon to a bed of spinach topped with sliced strawberries, slivered almonds, and a lemony poppy seed dressing.

•Make a bean salad with a variety of beans, diced onion, edamame, cherry tomatoes, and a vinaigrette.

4. Prepare foods in a variety of ways

Just as important as choosing a variety of foods is choosing a variety of ways in which the food is prepared. Different preparation techniques can have different impacts on foods and their nutrients. Cooking with heat may destroy some compounds but enhance the bioavailability of others, and this may vary among foods. For example, vitamin C is sensitive to high heat, and some may be destroyed when heated, whereas vitamin A is more stable to heat and, in fact, may increase in availability when heated. For instance, when processing, heating and adding a fat such as olive oil to tomatoes, a phytochemical and carotenoid called lycopene found in tomatoes increases in availability for the body to use and may have beneficial health effects.

5. Reduce intake of highly processed foods

Highly processed foods are generally low in vitamins, minerals, and bioactive compounds, but high in refined sugar, sodium, and saturated fat, which are consumed

in excess by many Americans and the culprit behind many chronic diseases impacting our population today. Reducing intake of highly processed foods will leave room in the diet for more whole, nourishing foods. That is not to say these must be eliminated entirely. Everything can be enjoyed in moderation, if your health allows. Balance is the key to enjoying eating, while at the same time providing the body with the nutrients it needs to stay healthy and reduce the risk for disease.

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