Vol.1, Issue 1 NATURAL FOODS MERCHANDISER'S March 1996

NUTRITION SCIENCE NEWS

Enhancing Nutrient Bioavailability With Black Pepper Extract

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BLACK PEPPER

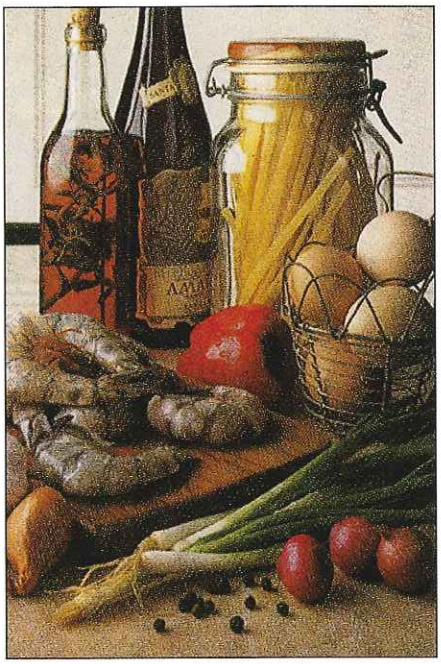
Enhancing Nutrient Bioavailability

A new class of supplements—thermonutrients such as black pepper extract—may increase the absorption of nutrients into the body

It is a fact well recognized by the medical community that the dramatic increase in life expectancy in this country between the 1930s and 1990s is largely due to the increase in quantity and affordability of food. Recent advances in the field of nutrition, however, indicate that it is the nutritional quality of food, rather than its quantity, that can further increase life expectancy. And even if the nutritional quality of food is sufficient, it does little good for the person eating it unless there is sufficient absorption of the essential nutrients from the food into the body.

From a purely scientific viewpoint, "ideal" nutrition is characterized by an optimal composition of food (i.e., as a source of essential nutrients) and an adequate absorption of these nutrients into the body. This ideal, if achieved, would result in sustained health.

There is, however, no known nutritional paradigm that will guarantee that "eating right" will result in proper nutrient delivery. (Please see related article on nutritional individuality on page 30.) Eating better is possible, but the ideal of "eating right" will always be confounded by too many counteracting factors. On one hand, reducing dietary input of certain foods has proven beneficial to prevent certain diseases—for example, cardiovascular disease is reduced by avoiding certain forms of animal and vegetable fats. But on the other hand, unless one is particularly careful, limiting our menu can result in inadequate supplies of essential nutrients, which in turn makes us vulnerable to other forms of nutrition-related disease. This paradox is exemplified in that red meat, liver, egg yolks and cheese are often restricted because of their high cholesterol content, but they are excellent dietary sources of iron, zinc, copper, manganese and selenium and vitamins A, B_1, B_6, B_{12} and D.



In Ayurvedic medicine, certain spices such as black pepper, long pepper and ginger are used to enhance digestion of other foods and medicines.

This review on nutrient bioavailability will first focus on obstacles to attaining proper nutrition, then on a way to improve the "efficacy" of nutrient absorption through the use of a new class of supplements we propose to call thermonutrients—compounds that actually increase the body's metabolic rate and, hence, increase nutrient uptake.

by Vladimir Badmaev, M.D., Ph.D. and Muhammed Majeed, Ph.D.

Factors Influencing Nutrient Bioavailability

The quality of our nutrition depends on the distribution of environmental nutrients and their availability in the food and water we consume. Despite the fact that food is relatively plentiful in countries with well-developed agriculture systems, several problems negatively affect environmental nutrient distribution.[1]

The first problem is a well-recognized and growing agricultural phenomenon: the depletion of minerals and organic matter from cultivated soils. This in turn leads to the depletion of nutrients from cultivated produce and a corresponding depletion of nutrients in those who eat it. Epidemiological surveys indicate that populations in areas with nutrient-depleted soils experience increased rates of health problems.

A second problem is that environmental pollution from agricultural chemicals and industrial waste results in the degradation of nutrients in foods. Polluted nutrients even become, in a way, anti-nutrients. Environmental pollution affects the quality of our food and water and ultimately compromises nutrient absorption.

Another factor affecting nutrient availability and absorption has to do with nutrient interactions within the diet—the way foods, or lack of foods, affect each other. Absorption of fat-soluble vitamins such as vitamin A[2], vitamin D[3] and vitamin

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E[4], for example, may be compromised by reduced dietary fat intake. Significantly, vitamin D absorption decreases with advancing age,[5] and this deficiency may be further compounded by fat-free, or cholesterol-free diets.

One of the well-documented nutrient interactions affecting absorption is the influence of chronic alcohol consumption on some vitamin deficiencies, specifically vitamin B complex, but also vitamins A and D[6]. Beverages such as coffee and tea may also affect absorption when taken in excess, as both contain caffeic acid, tannic acid and salicylic acid, all of which have known anti-thiamine activity.[7]

Along these lines, experimental evidence is beginning to show that many vitamins may be rendered inert or non-absorbable by the action of anti-vitamin factors present in foods. Some examples include fat soluble vitamins D and E, which are vulnerable to the effects of anti-vitamin factors present in soybeans[8], haricot beans[9] and alfalfa.[10] And the bioavailability of water-soluble vitamin B_1 (thiamine) is susceptible to an inactivating enzyme thiaminase, present in a large number of fish and shellfish[11], as well as blueberries, black currants, brussels sprouts, red cabbage[12] and some mushrooms.[13] A similar list of antagonist foods could be compiled for other B vitamins and vitamin C. The presence of various metals consumed in food—for example, zinc,[14] copper and iron[15]—can also diminish the availability of vitamins by forming poorly absorbable complexes.

Minerals are also susceptible to compromised absorption due to dietary factors. For example, the availability of calcium, a basic mineral in bones, is limited by the calcium chelating agent oxalic acid, which is present in such plants as rhubarb and spinach and also in cocoa, coffee and tea.[16]

Zinc is another example where absorption is significantly affected by what foods are eaten. Plant-based foods such as cereals that contain phytic acid make it especially difficult for zinc to be absorbed by the body[17]—phytic acid forms complexes with metals such as iron, zinc, copper and manganese, making them less available for gastrointestinal absorption. The absorption of zinc and manganese may also be decreased by insoluble fibers (i.e., cereals[18]), while absorption of selenium and manganese may be decreased by soluble fibers from vegetables and fruits.[19]

Poor bioavailability of certain trace elements may also be caused by a competitive interaction among microelements, including interactions between manganese-copper, sodium-potassium, copper-zinc, cadmium-zinc, iron-zinc and manganese-iron.[20]

Old And New Ways To Improve Nutrient Availability

The complexity of nutrient interactions, which may lead to nutrient depletion, is perhaps the single most significant factor that prevents the invention of the "ideal diet." In an attempt to counteract nutritional deficiencies, the logical and all-too-common response has been to increase the amount of particular nutrients to overcome shortcomings of their bioavailability. Although "more" may be advisable in cases of marked vitamin deficiencies, it seems ill-advised in many instances of supplementary or preventive uses of a nutrient. In fact, large doses of a nutrient may actually cause a deficiency, as previously noted, of other, equally important nutrients. Additionally, the increased supplementation of certain nutrients, for example carotenoids, leads to the decreasing rate of their gastrointestinal absorption.[21]

Hence, mega-dose nutrient supplementation may be an inappropriate solution to nutritional deficiencies. A step in the right direction, however, may be to supply nutrients in sufficient quantity to the body by increasing the intensity or "efficacy" of their gastrointestinal absorption.

The key word is *efficacy*, meaning to obtain more nutritional value from less food. This challenge has led to the creation of a new category of food supplements, which we propose to call thermonutrients. These supplements assist gastrointestinal nutrient absorption and can be exemplified by a formula consisting of an alkaloid called piperine—obtained from the fruits of the black pepper plant.

In Ayurveda, the ancient Indian system of medicine, certain spices like black pepper, long pepper and ginger are used to improve the digestibility of other foods and medicines. The preparation of the three herbs, in equal proportions, is known in Ayurveda as "Trikatu," which translates as "three acrids."

Recent studies conducted by Sabinsa Corp., a raw materials supplier in Piscataway, N.J., have shown that the active principle in black pepper is the alkaloid piperine. But although Trikatu has been used successfully for thousands of years, further study shows that the effect of raw pepper on nutrient absorption appears negligible in comparison to the effect of pure piperine in the equivalent amount.

There is a catch, however: It appears that timing is an essential element in assisting nutrient absorption. Studies indicate that even large doses of piperine that cannot be released in time to interact with the nutrient absorption process will have no effect on nutrient absorption. Hence, placing piperine in the "right place at the right time" in the digestive tract with a nutrient can result in enhanced nutrient absorption. Once the window of opportunity for piperine-nutrient interaction has been missed, however, nutrient absorption is not enhanced.

In three separate clinical trials sponsored by Sabinsa, healthy volunteers were administered piperine in a pure form known as Bioperine® along with other selected nutrients: A one-time trial of six volunteers evaluated the absorption of vitamin B_6; a 14-day study of 12 volunteers evaluated the absorption of beta carotene, and a six-week trial of 10 volunteers evaluated the absorption of selenium (in the form of selenomethionine). Each of these studies compared subjects given Bioperine® along with the selected nutrient to subjects that were given the nutrient alone. Vitamin B_6 was administered in a one-time dose of 100 mg, beta carotene was administered at a dose of 15 mg/day, and selenium was administered at 50 mcg/day. Bioperine® was administered at 5 mg per dose, an amount up to seven times less than the estimated amount of piperine that the average U.S. citizen would ingest in a day.

Results showed that gastrointestinal absorption of all the studied nutrients, as evaluated by blood levels, increased significantly when administered with Bioperine® as com- ▶

pared to the control groups receiving a supplement alone: Vitamin B_6 resulted in 2.5 times higher blood levels two hours after supplement ingestion; blood levels of beta carotene increased by 60 percent over the control levels; and blood levels of selenium resulted in a 30 percent increase.

One of the most important concerns of enhancing the absorption of nutrients with piperine is safety, specifically whether enhanced nutrient absorption would result in an excess of the nutrient in the body. These trials did not produce any side effects in participants as evaluated by participating patients and the supervising physicians. The nutrient levels in the blood, although significantly increased, did not approach dangerous levels. For example, although blood levels of selenium increased by 30 percent, they were still within normal limits throughout the six weeks.

Curiously, piperine administration increased exclusively the levels of the supplemented nutrient without affecting the levels of other nutrients delivered with daily food. For example, blood levels of non-supplemented vitamins C and E were not affected by the inclusion of Bioperine®. This observation points to the fact that piperine needs to be simultaneously available with a particular nutrient to achieve enhanced absorption.

Based on the results of these clinical studies as well as earlier research, it is hypothesized that piperine facilitates nutrient absorption by increasing the body's metabolic rate—actually creating a "demand" for the "supply" of a broad range of nutrients that naturally contribute to metabolism. The demand is created because increased metabolism is associated with an increase in heat or thermal energy that further facilitates the metabolic rate and increases its need for fuel.

Piperine is the pungent principle that produces black pepper's heat effect. Biochemically speaking, this may actually serve as a means to increase the heat, or thermal energy, required for an increase in metabolic rate and the corresponding need for increased nutrient absorption.

Due to its particular mechanism, piperine is an example of a thermonutrient. It should be noted, however, that the "hot taste" phenomenon, although an important aspect of a thermonutrient, is not its sole feature. Capsaicin, for example, a hot-tasting principle of cayenne peppers, does not appear to improve nutrient bioavailability.[22]

Securing adequate absorption of nutrients appears to be the key to collective and individual nutrition and health. Maintaining, and where possible enhancing, adequate absorption throughout life means fewer problems during older age—and holds the promise of a further extension of life expectancy. NSN

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