



ARTICLE

Caffeine: A vitamin-like nutrient, or adaptogen

Questions about tea and coffee, cancer and other degenerative diseases, and the hormones.

There is a popular health-culture that circulates mistaken ideas about nutrition, and coffee drinking has been a perennial target of this culture. It is commonly said that coffee is a drug, not a food, and that its drug action is harmful, and that this harm is not compensated by any nutritional benefit. Most physicians subscribe to most of these “common sense” ideas about coffee, and form an authoritative barrier against the assimilation of scientific information about coffee.

I think it would be good to reconsider coffee’s place in the diet and in health care.

Coffee drinkers have a lower incidence of thyroid disease, including cancer, than non-drinkers.

Caffeine protects the liver from alcohol and acetaminophen (Tylenol) and other toxins, and coffee drinkers are less likely than people who don’t use coffee to have elevated serum enzymes and other indications of liver damage.

Caffeine protects against cancer caused by radiation, chemical carcinogens, viruses, and estrogens.

Caffeine synergizes with progesterone, and increases its concentration in blood and tissues.

Cystic breast disease is not caused by caffeine, in fact caffeine’s effects are likely to be protective; a variety of studies show that coffee, tea, and caffeine are protective against breast cancer.

Coffee provides very significant quantities of magnesium, as well as other nutrients including vitamin B1.

Caffeine “improves efficiency of fuel use” and performance: JC Wagner 1989.

Coffee drinkers have a low incidence of suicide.

Caffeine supports serotonin uptake in nerves, and inhibits blood platelet aggregation.

Coffee drinkers have been found to have lower cadmium in tissues; coffee making removes heavy metals from water.

Coffee inhibits iron absorption if taken with meals, helping to prevent iron overload.

Caffeine, like niacin, inhibits apoptosis, protecting against stress-induced cell death, without interfering with normal cell turnover.

Caffeine can prevent nerve cell death.

Coffee (or caffeine) prevents Parkinson’s Disease (Ross, et al., 2000).

The prenatal growth retardation that can be caused by feeding large amounts of caffeine is prevented by supplementing the diet with sugar.

Caffeine stops production of free radicals by inhibiting xanthine oxidase, an important factor in tissue stress.

Caffeine lowers serum potassium following exercise; stabilizes platelets, reducing thromboxane production.

One definition of a vitamin is that it is an organic chemical found in foods, the lack of which **causes** a specific **disease**, or group of diseases. A variety of substances that have been proposed to be vitamins haven't been recognized as being essential, and some substances that aren't essential are sometimes called vitamins. Sometimes these issues haven't had enough scientific investigation, but often nonscientific forces regulate nutritional ideas.

The definition of "a disease" isn't as clear as text-book writers have implied, and "causality" in biology is always more complex than we like to believe.

Nutrition is one of the most important sciences, and should certainly be as prestigious and well financed as astrophysics and nuclear physics, but while people say "it doesn't take a brain surgeon to figure that out," no one says "it doesn't take a nutritionist to understand that." Partly, that's because medicine treated scientific nutrition as an illegitimate step-child, and refused throughout the 20th century to recognize that it is a central part of scientific health care. In the 1970s, physicians and dietitians were still ridiculing the idea that vitamin E could prevent or cure diseases of the circulatory system, and babies as well as older people were given "total intravenous nutrition" which lacked nutrients that are essential to life, growth, immunity, and healing. Medicine and science are powerfully institutionalized, but no institution or profession has existed for the purpose of encouraging people to act reasonably.

In this environment, most people have felt that subtleties of definition, logic and evidence weren't important for nutrition, and a great amount of energy has gone into deciding whether there were "four food groups" or "seven food groups" or a "nutritional pyramid." The motives behind governmental and quasi-governmental nutrition policies usually represent something besides a simple scientific concern for good health, as when health care institutions say that Mexican babies should begin eating beans when they reach the age of six months, or that non-whites don't need milk after they are weaned. In a culture that discourages prolonged breast feeding, the effects of these doctrines can be serious.

After a century of scientific nutrition, public nutritional policies are doing approximately as much harm as good, and they are getting worse faster than they are getting better..

In this culture, what we desperately need is a recognition of the complexity of life, and of the political-ecological situation we find ourselves in. Any thinking which isn't "system thinking" should be treated with caution, and most contemporary thinking about health neglects to consider relevant parts of the problem-system. "Official" recommendations about salt, cholesterol, iron, unsaturated and saturated fats, and soybeans have generally been inappropriate, unscientific, and strongly motivated by business interests rather than by biological knowledge.

Definitions have rarely distinguished clearly between nutrients and drugs, and new commercial motives are helping to further blur the distinctions.

Essential nutrients, defensive (detoxifying, antistress) nutrients, hormone-modulating nutrients, self-actualization nutrients, growth regulating nutrients, structure modifiers, life extension agents, transgenerationally active (imprinting) nutrients--the line between nutrients and biological modifiers often depends on the situation. Vitamins D and A clearly have hormone-like properties, and vitamin E's effects, and those of many terpenoids and steroids and bioflavonoids found in foods, include hormone-like actions as well as antioxidant and pro-oxidant functions. The concept of "adaptogen" can include things that act like both drugs and nutrients.

Some studies have suggested that trace amounts of nutrients could be passed on for a few generations, but the evidence now indicates that these transgenerational effects are caused by phenomena such as "imprinting." But the hereditary effects of nutrients are so complex that their recognition would force nutrition to be recognized as one of the most complex sciences, interwoven with the complexities of growth and development.

The idea that poor nutrition stunts growth has led to the idea that good nutrition can be defined in terms of the rate of growth and the size ultimately reached. In medicine, it is common to refer to an obese specimen as “well nourished,” as if quantity of food and quantity of tissue were necessarily good things. But poisons can stimulate growth (“hormesis”), and food restriction can extend longevity. **We still have to determine basic things such as the optimal rate of growth, and the optimal size.**

Nutrition textbooks flatly describe caffeine as a drug, not a nutrient, as if it were obvious that nutrients can't be drugs. Any of the essential nutrients, if used in isolation, can be used as a drug, for a specific effect on the organism that it wouldn't normally have when eaten as a component of ordinary food. And natural foods contain thousands of chemicals, other than the essential nutrients. Many of these are called nonessential nutrients, but their importance is being recognized increasingly. The truth is that we aren't sure what they “aren't essential” for. Until we have more definite knowledge about the organism I don't think we should categorize things so absolutely as drugs or nutrients.

The bad effects ascribed to coffee usually involve administering large doses in a short period of time. While caffeine is commonly said to raise blood pressure, this effect is slight, and may not occur during the normal use of coffee. Experimenters typically ignore essential factors. Drinking plain water can cause an extreme rise in blood pressure, especially in old people, and eating a meal (containing carbohydrate) lowers blood pressure. The increased metabolic rate caffeine produces increases the cellular consumption of glucose, so experiments that study the effects of coffee taken on an empty stomach are measuring the effects of increased temperature and metabolic rate, combined with increased adrenaline (resulting from the decrease of glucose), and so confuse the issue of caffeine's intrinsic effects.

In one study (Krasil'nikov, 1975), the drugs were introduced directly into the carotid artery to study the effects on the blood vessels in the brain. Caffeine increased the blood volume in the brain, while decreasing the resistance of the vessels, and this effect is what would be expected from its stimulation of brain metabolism and the consequent increase in carbon dioxide, which dilates blood vessels.

In the whole body, increased carbon dioxide also decreases vascular resistance, and this allows circulation to increase, while the heart's work is decreased, relative to the amount of blood pumped. But when the whole body's metabolism is increased, adequate nutrition is crucial.

In animal experiments that have been used to argue that pregnant women shouldn't drink coffee, large doses of caffeine given to pregnant animals retarded the growth of the fetuses. But simply giving more sucrose prevented the growth retardation. Since caffeine tends to correct some of the metabolic problems that could interfere with pregnancy, it is possible that rationally constructed experiments could show benefits to the fetus from the mother's use of coffee, for example by lowering bilirubin and serotonin, preventing hypoglycemia, increasing uterine perfusion and progesterone synthesis, synergizing with thyroid and cortisol to promote lung maturation, and providing additional nutrients.

One of the most popular misconceptions about caffeine is that it causes fibrocystic breast disease. Several groups demonstrated pretty clearly that it doesn't, but there was no reason that they should have had to bother, except for an amazingly incompetent, but highly publicized, series of articles--classics of their kind--by J. P. Minton, of Ohio State University. Minton neglected to notice that the healthy breast contains a high percentage of fat, and that the inflamed and diseased breast has an increased proportion of glandular material. Fat cells have a low level of cyclic AMP, a regulatory substance that is associated with normal cellular differentiation and function, and is involved in mediating caffeine's ability to inhibit cancer cell multiplication. Minton argued that cAMP increases progressively with the degree of breast disease, up to cancer, and that cAMP is increased by caffeine. A variety of substances other than caffeine that inhibit the growth of cancer cells (as well as normal breast cells) act by *increasing* the amount of cyclic AMP, while estrogen lowers the amount of cAMP and increases cell growth. Minton's argument should have been to use more caffeine, in proportion to the degree of breast disease, if he were arguing logically from his evidence.

Caffeine's effect on the breast resembles that of progesterone, opposing estrogen's effects.

Many studies over the last 30 years have shown caffeine to be highly protective against all kinds of carcinogenesis, including estrogen's carcinogenic effects on the breast. Caffeine is now being used along with some of the standard cancer treatments, to improve their effects or to reduce their side effects. There are substances in the coffee berry besides caffeine that protect against mutations and cancer, and that have shown strong therapeutic effects against cancer. Although many plant substances are protective against mutations and cancer, I don't know of any that is as free of side effects as coffee.

To talk about caffeine, it's necessary to talk about uric acid. **Uric acid, synthesized in the body, is both a stimulant and a very important antioxidant, and its structure is very similar to that of caffeine.** A deficiency of uric acid is a serious problem. Caffeine and uric acid are in the group of chemicals called purines.

Purines (along with pyrimidines) are components of the nucleic acids, DNA and RNA, but they have many other functions. In general, substances related to purines are stimulants, and substances related to pyrimidines are sedatives.

When the basic purine structure is oxidized, it becomes in turn hypoxanthine, xanthine, and uric acid, by the addition of oxygen atoms. When methyl groups (CH_3) are added to nitrogens in the purine ring, the molecule becomes less water soluble. Xanthine (an intermediate in purine metabolism) has two oxygen atoms, and when three methyl groups are added, it becomes trimethyl xanthine, or caffeine. With two methyl groups, it is theophylline, which is named for its presence in tea. We have enzyme systems which can add and subtract methyl groups; for example, when babies are given theophylline, they can convert it into caffeine.

We have enzymes that can modify all of the methyl groups and oxygen atoms of caffeine and the other purine derivatives. Caffeine is usually excreted in a modified form, for example as a methylated uric acid.

One of the ways in which uric acid functions as an "antioxidant" is by modifying the activity of the enzyme xanthine oxidase, which in stress can become a dangerous source of free radicals. Caffeine also restrains this enzyme. There are several other ways in which uric acid and caffeine (and a variety of intermediate xanthines) protect against oxidative damage. Coffee drinkers, for example, have been found to have lower levels of cadmium in their kidneys than people who don't use coffee, and coffee is known to inhibit the absorption of iron by the intestine, helping to prevent iron overload.

Toxins and stressors often kill cells, for example in the brain, liver, and immune system, by causing the cells to expend energy faster than it can be replaced. There is an enzyme system that repairs genetic damage, called "PARP." The activation of this enzyme is a major energy drain, and substances that inhibit it can prevent the death of the cell. Niacin and caffeine can inhibit this enzyme sufficiently to prevent this characteristic kind of cell death, without preventing the normal cellular turnover; that is, they don't produce tumors by preventing the death of cells that aren't needed.

The purines are important in a great variety of regulatory processes, and caffeine fits into this complex system in other ways that are often protective against stress. For example, it has been proposed that tea can protect against circulatory disease by preventing abnormal clotting, and the mechanism seems to be that caffeine (or theophylline) tends to restrain stress-induced platelet aggregation.

When platelets clump, they release various factors that contribute to the development of a clot. Serotonin is one of these, and is released by other kinds of cell, including mast cells and basophils and nerve cells. Serotonin produces vascular spasms and increased blood pressure, blood vessel leakiness and inflammation, and the release of many other stress mediators. Caffeine, besides inhibiting the platelet aggregation, also tends to inhibit the release of serotonin, or to promote its uptake and binding.

J. W. Davis, et al., 1996, found that high uric acid levels seem to protect

against the development of Parkinson's disease. They ascribed this effect to uric acid's antioxidant function. Coffee drinking, which *lowers* uric acid levels, nevertheless appeared to be much more strongly protective against Parkinson's disease than uric acid.

Possibly more important than coffee's ability to protect the health is the way it does it. The studies that have tried to gather evidence to show that coffee is harmful, and found the opposite, have provided insight into several diseases. For example, coffee's effects on serotonin are very similar to carbon dioxide's, and the thyroid hormone's. Noticing that coffee drinking is associated with a low incidence of Parkinson's disease could focus attention on the ways that thyroid and carbon dioxide and serotonin, estrogen, mast cells, histamine and blood clotting interact to produce nerve cell death.

Thinking about how caffeine can be beneficial across such a broad spectrum of problems can give us a perspective on the similarities of their underlying physiology and biochemistry, expanding the implications of stress, biological energy, and adaptability.

The observation that coffee drinkers have a low incidence of suicide, for example, might be physiologically related to the large increase in suicide rate among people who use the newer antidepressants called "serotonin reuptake inhibitors." Serotonin excess causes several of the features of depression, such as learned helplessness and reduced metabolic rate, while coffee stimulates the *uptake* (inactivation or storage) of serotonin, increases metabolic energy, and tends to improve mood. In animal studies, it reverses the state of helplessness or despair, often more effectively than so-called antidepressants.

The research on caffeine's effects on blood pressure, and on the use of fuel by the more actively metabolizing cells, hasn't clarified its effects on respiration and nutrition, but some of these experiments confirm things that coffee drinkers usually learn for themselves.

Often, a woman who thinks that she has symptoms of hypoglycemia says that drinking even the smallest amount of coffee makes her anxious and shaky. Sometimes, I have suggested that they try drinking about two ounces of coffee with cream or milk along with a meal. It's common for them to find that this reduces their symptoms of hypoglycemia, and allows them to be symptom-free between meals. Although we don't know exactly why caffeine improves an athlete's endurance, I think the same processes are involved when coffee increases a person's "endurance" in ordinary activities.

Caffeine has remarkable parallels to thyroid and progesterone, and the use of coffee or tea can help to maintain their production, or compensate for their deficiency. Women spontaneously drink more coffee premenstrually, and since caffeine is known to increase the concentration of progesterone in the blood and in the brain, this is obviously a spontaneous and rational form of self-medication, though medical editors like to see things causally reversed, and blame the coffee drinking for the symptoms it is actually alleviating. Some women have noticed that the effect of a progesterone supplement is stronger when they take it with coffee. This is similar to the synergy between thyroid and progesterone, which is probably involved, since caffeine tends to *locally* activate thyroid secretion by a variety of mechanisms, increasing cyclic AMP and decreasing serotonin in thyroid cells, for example, and also by lowering the systemic stress mediators.

Medical editors like to publish articles that reinforce important prejudices, even if, scientifically, they are trash. The momentum of a bad idea can probably be measured by the tons of glossy paper that have gone into its development. Just for the sake of the environment, it would be nice if editors would try to think in terms of evidence and biological mechanisms, rather than stereotypes.

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