"NATURAL" FOODS ARE NOT CARCINOGEN-FREE

The holiday season is a good time to remember that the American food supply is by far the best in the world—and the best it has been in the history of this country. It is the best not only in terms of its abundance and variety, but also in terms of its safety. Our diet—like diets around the world—is made up of water, macronutrients (carbohydrates, proteins, and fats), micronutrients (vitamins and minerals), and tens of thousands of other naturally occurring chemicals. A few of these latter chemicals either have been shown to cause cancer in laboratory rodents in research studies or have been shown to be "mutagens" when tested with bacteria. Mutagens, because they can damage DNA—genetic material—are often thought of as "possible animal carcinogens." Mutagen tests such as the Ames test are often used as quick indicators to predict how likely a chemical is to cause cancer.

Back in 1958, when the United States Congress passed legislation (the so-called Delaney amendment to the 1938 Food, Drug, and Cosmetics Act) to keep "carcinogens" out of our processed food supply, it was assumed that carcinogens (a) were rarely found in foods and (b) were put there by humans, either purposely, through food additives, or inadvertently, in the form of pesticide residues. The Delaney amendment banned from American food any artificial substance that could be shown to cause cancer in lab animals—no matter how small the amount of the substance in a food or how high the dose given to test animals. Some progress has been made since 1958, however: In 1996 the Food Quality Protection Act removed the scientifically untenable "zero-risk" requirement from the approval process for pesticides. This narrowed the scope of the irrationally restrictive Delaney clause.[1]

In the 40+ years since Delaney was passed, it has become clear that many naturally occurring chemicals—chemicals that are plentiful in our food supply—cause cancer in rodents when fed in high doses over a lifetime. Furthermore, scientists Bruce N. Ames and Lois Swirsky Gold have analyzed human exposure to chemicals, both natural and man-made (synthetic), that have been classified as "rodent carcinogens." The researchers have concluded that when ranked on an index (the HERP Index) that compares human exposure to the dose that increases tumors in rodents, the possible cancer hazard to humans from the background of dietary intake of nature's own rodent carcinogens ranks high in comparison to the possible hazard from residues of synthetic pesticides or additives.

Human dietary intake of nature's pesticides is about 10,000 times higher than human intake of synthetic pesticides that are rodent carcinogens. In other words, consumers who choose to worry about eating chemicals shown to cause cancer in rodents (and ACSH does not recommend that you worry about this hypothetical risk) should understand that the human diet is full of naturally occurring rodent carcinogens.

Present scientific knowledge suggests that residues of synthetic rodent carcinogens in our diet are unlikely to pose a risk of cancer in the quantities we consume on a daily, monthly, or yearly basis. The data are inadequate to allow us to evaluate human risk at low doses, and the uncertainties are enormous.

We hear much about "carcinogens" in our food. But the media use the designation "carcinogen" most frequently in conjunction with man-made rodent carcinogens—substances such as Alar (a fruit-ripening chemical), saccharin (a synthetic, noncaloric sweetener), and BHA (butylated hydroxyanisole, a synthetic antioxidant). What ACSH will demonstrate in this menu is that chemicals that are rodent carcinogens, or that are suspected of being such, abound in nature.

Many of these naturally occurring rodent carcinogens are natural pesticides—chemicals that plants produce to repel or kill predators. Of the approximately 10,000 such natural pesticides occurring in the diet, only about 60 have been tested in rodent experiments.[2] These chemicals are found in a wide variety of our food plants: Brussels sprouts, cantaloupe, cauliflower, cherries, chili peppers, cocoa, garlic, grapes, kale, lentils, lettuce, and radishes—to name just a few that are not in our Holiday Menu.[2]

The consumption of small doses of rodent carcinogens, whether of natural or synthetic origin, is quite unlikely to pose a cancer hazard to humans. When you understand that carcinogens and mutagens are everywhere in Mother Nature's own food supply, you can see the absurdity of panicking over tiny levels in the food supply of synthetic chemicals (such as pesticide residues) that are "carcinogens" when fed in large doses over a lifetime to rodents. If you chose to believe that every rodent carcinogen was also a potential human carcinogen, and if you then chose to extrapolate directly from rodent to human, the background of naturally occurring chemicals that people consume at levels close to the rodent-carcinogenic dose would still cast doubt on the importance for human cancer of synthetic chemical residues.

Note, for example, on the Holiday Menu that the bread in the stuffing contains furfural, a rodent carcinogen. But when you take into account the difference in body weight between a human and a rodent, you will see that, based on the carcinogenicity data available from the laboratory, a person would have to eat 82,600 slices of bread to consume an amount of furfural equal to the amount that increased the risk of cancer in rodents.

Here's a calculation relating the rodents' risk to yours[3]:

1 slice white bread contains 167 µg (micrograms) furfural.
Rodent carcinogenic dose of furfural =
197 mg (milligrams)/kg (kilogram) body wt/day,
which is the same as 197,000 µg/kg/day.
Equivalent human dose (for a 70 kg person, about 155 pounds) =
$\frac{197{,}000 \times 70}{167}$ = 82,600 slices of bread/day.

When looking at this example, remember the conditions of the animal studies: Doses are fed every day of the rodent's life (usually two years). To get an equivalent carcinogenic dose, a human would have to consume those 82,600 slices of bread every day for years.

The primary risk factor in holiday meals—other than the risk of food poisoning from the improper handling or preparation of food—is getting too much of a good thing. A hungry holiday eater can easily consume 2,000-plus calories at one sitting. A consistent intake of excessive calories contributes to obesity, with its attendant higher risk of heart disease. Interestingly, excessive caloric intake has been called the "most striking" carcinogen in rodent carcinogenicity studies. Body weight is a good predictor of a rat's risk of cancer as shown in comparisons of rats on calorie-restricted diets and rats permitted to eat all they want.

In our quest to reduce our cancer risk by manipulating our diet, we should focus on dietary imbalances in what we eat, not on trace chemicals. Numerous epidemiological studies have indicated that people who consume a diet high in fruits and vegetables have a lower risk for various types of cancer. This is true in spite of the fact that natural chemicals that are also rodent carcinogens occur abundantly in many of these same fruits and vegetables. Note that the populations studied lowered their risks even though their food presumably contained synthetic pesticide residues. High fruit and vegetable consumption was still protective against cancer.

The foods on our Holiday Menu are healthful and wholesome despite the presence in them of some of Mother Nature's own chemicals that have been shown to be carcinogenic in high-dose rodent tests.

NATURAL VERSUS SYNTHETIC

The presumption that natural chemicals are not hazardous but synthetic ones are has no scientific support. Substances should be evaluated according to their human carcinogenic potential, not according to their origin—and to do so requires more biological information than can be provided by a rodent cancer test.

Naturally occurring rodent carcinogens are present in far greater amounts in our food supply than are pesticide and other chemical residues (the much-publicized rodent carcinogens). As we enjoy our holiday dinner, we should remember the benefits that scientific research has brought to American agriculture and food technology. Science has made our food safer, more nutritious, more attractive, more abundant, more widely available, and more enjoyable—and has done so at relatively low cost. The American food supply is truly the envy of the world!

If national regulatory policies lead to a reduction in the number of agricultural chemicals available to farmers, food production could drop—and food prices increase. Such a situation could actually increase cancer rates if people faced with higher food costs were to choose to eat fewer fruits and vegetables.

Epidemiological evidence now confirms that a generous intake of fruits and vegetables reduces the risk of cancer. It would be ironic, indeed, if misplaced fervor about removing supposed carcinogens—synthetic chemicals—from our food supply were to result in decreased consumption of the very foods thought to be protective against cancer.

ACSH'S REVIEW OF THE LITERATURE ON NATURALLY OCCURRING CARCINOGENS LEADS US TO THREE GENERAL CONCLUSIONS

First, it would be unrealistic to attempt to remove from our food supply every known trace of every natural chemical that tests positive in a high-dose rodent test. Even human carcinogens may be neither toxic nor carcinogenic at very low doses. Imagine, for example, the unrealistic expectation of "zero exposure" to sunlight—a skin carcinogen. Even though we know sunlight can, in high doses, cause human cancers, would we want to dispense with the skin's production of vitamin D under sunlight? It is important to emphasize that with natural carcinogens, as with synthetic compounds, the "dose makes the poison."

Second, scientists are just scratching the surface in their quest to identify nature's own rodent carcinogens. It is already evident that we should reject the presumptions—one might almost call them superstitions—that the label "natural" means "safe and free of rodent carcinogens" and that "synthetic" substances are the only rodent carcinogens. No scientific evidence supports these beliefs.

Indeed, a recent review of rodent carcinogen studies demonstrated that of chemicals tested for their cancer-causing potential, 57% of the naturally occurring ones and 59% of the synthetic ones were evaluated as positive: virtually identical percentages![4]

It is also important to realize that because of our initial regulatory bias against synthetic chemicals, we have examined many more of them in rodent carcinogen tests than we have naturally occurring chemicals—even though 99.99% of the chemicals humans are exposed to are natural.

Third, the increasing body of evidence documenting the carcinogenicity (at least under laboratory conditions) of common, everyday substances found in nature highlights the contradiction we Americans have created up to now in our regulatory approach to carcinogens. This contradiction can be seen most clearly in the huge discrepancy that exists between the weight we have placed on synthetic carcinogens—we've been trying to purge the country of them—and, at the same time, the relative lack of attention we have given to natural carcinogens. We have largely ignored natural carcinogens, and have similarly ignored the fact that the carcinogenicity rate in rodent experiments is virtually the same for both naturally

ARE THERE "POISONS" IN OUR FOOD SUPPLY?

The focus of the ACSH holiday menu is on "carcinogens," defined here as chemicals, either natural or synthetic, that cause cancer in rodents when consumed in large amounts. A related topic, however, is that of "poisons," technically known as toxicants. Just as it is scientifically unwarranted to believe that the food supply is free of natural rodent carcinogens and mutagens, it is equally unrealistic to equate "natural" with safe. Foods abound in natural chemicals that are toxic or potentially toxic—because all chemicals will be toxic at some dose.

Toxicologists have confirmed that food naturally contains a myriad of chemicals traditionally thought of as "poisons." Potatoes contain solanine, arsenic, and chaconine. Lima beans contain hydrogen cyanide, a classic suicide substance. Carrots contain carototoxin, a nerve poison. And nutmeg, black pepper, and carrots all contain the hallucinogenic compound myristicin.

Moreover, all chemicals, whether natural or synthetic, are potential toxicants at high doses but are perfectly safe when consumed in low doses. Take common table salt, for example: This everyday chemical, when consumed in excess, can cause elevations in blood pressure in sensitive individuals; a couple of tablespoonsful can kill a small child. Selenium, a mineral essential in the human diet, can cause nausea and nerve changes when chronically consumed in excess. The familiar stimulant caffeine is also a toxicant if consumed in high doses (say, 50 to 100 cups of coffee per day). Supplements of the essential mineral iron all too often cause poisoning in children.

When it comes to toxicants in the diet—natural or synthetic—the dose makes the poison.

NATURALLY OCCURRING MUTAGENS AND CARCINOGENS FOUND IN FOODS AND BEVERAGES

(*continued from page 3*)

ETHYL ACRYLATE *(pineapple)*—rodent carcinogen

ETHYL BENZENE *(coffee)*—rodent carcinogen

ETHYL CARBAMATE *(bread, rolls, red wine)*—mutagen and rodent carcinogen

FURAN AND FURAN DERIVATIVES *(bread, onions, celery, mushrooms, sweet potatoes, rolls, cranberry sauce, coffee)*—many are mutagens

FURFURAL *(bread, coffee, nuts, rolls, sweet potatoes)*—furan derivative and rodent carcinogen

HETEROCYCLIC AMINES *(roast beef, turkey)*—mutagens and rodent carcinogens

HYDRAZINES *(mushrooms)*—mutagens and rodent carcinogens

HYDROGEN PEROXIDE *(coffee, tomatoes)*—mutagen and rodent carcinogen

HYDROQUINONE *(coffee)*—rodent carcinogen

D-LIMONENE *(black pepper, mangos)*—rodent carcinogen

4-METHYLCATECHOL *(coffee)*—rodent carcinogen

METHYL EUGENOL *(basil, cinnamon, and nutmeg in apple and pumpkin pies)*—rodent carcinogen

PSORALENS *(celery, parsley)*—mutagens; rodent and human carcinogens

QUERCETIN GLYCOSIDES *(apples, onions, tea, tomatoes)*—mutagens and rodent carcinogens

SAFROLE *(nutmeg in apple and pumpkin pies, black pepper)*—rodent carcinogen

occurring and synthetic carcinogens. Of the thousands of natural pesticides identified, fewer than 100 have been investigated adequately in rodent tests.[2]

All of our efforts to reduce risks of cancer should:

- focus first and foremost on substances and conditions of exposure that have been shown in human epidemiological studies to cause cancer. The use of tobacco (particularly cigarettes), overexposure to sunlight, and dietary imbalances are examples of "cancer risk factors" well studied in humans, not just in laboratory rodents.[5]
- emphasize dietary patterns, such as increasing consumption of fruits and vegetables, that have been shown in human epidemiological studies to decrease cancer risk.
- reject "carcinogen-of-the-week" scares—those hyped indictments of artificial sweeteners, pesticides, food colorings, and other synthetic ingredients that at high doses cause cancer in rodents.
- demand that our government's regulatory efforts to reduce cancer risk be based on sound science, not on emotion or on the sort of neo-Luddite ideologies that reject our technological, industrial way of life.

1 The Food Quality Protection Act of 1996 actually moved regulation of pesticide residues on processed foods from section 409 of the Food, Drug, and Cosmetic Act, where the Delaney clause is placed, to section 408. The effect of this change is that the provisions of the Delaney clause no longer apply to pesticide residues, although they do still apply to food additives.

2 Gold LS, Slone TH, Ames BN. Prioritization of possible carcinogenic hazards in food. In: Tennant DR, ed. Food Chemical Risk Analysis. London: Chapman & Hall; 1997:269–295.

3 Data for calculations obtained from: Gold LS, Slone TH, Stern BR, Manley NB, Ames BN. Possible carcinogenic hazards from natural and synthetic chemicals: setting priorities. In: Cothern CR, ed. Comparative Environmental Risk Assessment. Boca Raton, FL: Lewis Publishers; 1993:209–235.

4 Gold LS, Slone TH, Ames BN. What do animal cancer tests tell us about human cancer risk?: Overview of analyses of the carcinogenic potency database. Drug Metab Rev. 1998;30(2):359–404.

5 ACSH does not here reject the use of animal testing for the prediction of human cancer risk, but rather calls for common sense in assessing the results of such tests (for details, see the ACSH booklet *Of Mice and Mandates*). Further research is needed to establish the mechanisms by which different chemicals, whether natural or synthetic, cause cancer. Without such work we have no sound scientific basis for extrapolating from high-dose rodent tests to the much lower doses typically seen in human exposures. ACSH specifically rejects extrapolating from high-dose rodent cancer tests to predict cancer risk in humans. ACSH notes, however, that a chemical, whether natural or synthetic, that causes cancer in many animal species (not just in rodents) at many levels of exposure and in many experiments should be given regulatory attention. ACSH notes further that consideration should be given to setting human tolerance levels to such an animal carcinogen. This rational and reasonable approach is now followed by government agencies in the case of one natural (and usually unavoidable) carcinogen, aflatoxin, a substance produced by a fungus that grows naturally on peanuts, corn, and other products. The Food and Drug Administration, noting the potency of this human carcinogen, has set reasonable and workable limits for human exposure to it.

MENU ANALYSIS PREPARED BY ACSH STAFF, DIRECTORS, AND SCIENTIFIC ADVISORS, WITH TECHNICAL ASSISTANCE FROM DR. RUTH KAVA, DIRECTOR OF NUTRITION, AND DR. LEONARD FLYNN, SCIENTIFIC CONSULTANT.
ART DIRECTOR: YELENA POMBOCKAYA. REPRINT 2004—5000 © ACSH

Vegetables

BROCCOLI SPEARS
allyl isothiocyanate

BAKED POTATO
ethyl alcohol, caffeic acid

SWEET POTATO
ethyl alcohol, furfural

Rolls with Butter

acetaldehyde, acrylamide, benzene, ethyl alcohol, benzo(a)pyrene, ethyl carbamate, furan derivatives, furfural

Desserts

PUMPKIN PIE
benzo(a)pyrene, coumarin, methyl eugenol, safrole

APPLE PIE
acetaldehyde, caffeic acid, coumarin, estragole, ethyl alcohol, methyl eugenol, quercetin glycoside, safrole

Fruit Tray

FRESH APPLES, GRAPES, MANGOS, PEARS, PINEAPPLE
acetaldehyde, benzaldehyde, caffeic acid, d-limonene, estragole, ethyl acrylate, quercetin glycosides

Beverages

RED WINE, WHITE WINE
ethyl alcohol, ethyl carbamate

COFFEE
benzo(a)pyrene, benzaldehyde, benzene, benzofuran, caffeic acid, catechol, 1,2,5,6-dibenz(a)anthracene, ethyl benzene, furan, furfural, hydrogen peroxide, hydroquinone, d-limonene, 4-methylcatechol

TEA
benzo(a)pyrene, quercetin glycosides

JASMINE TEA
benzyl acetate

The American Council on Science and Health (ACSH) is an independent, non-profit consumer education organization concerned with issues related to food, nutrition, chemicals, pharmaceuticals, lifestyle, the environment, and health. ACSH combats the hype, scares, and exaggerations in health reports by putting risks in perspective, with the help of some four hundred scientific and medical experts.

Reach us with questions or donations at:

AMERICAN COUNCIL ON SCIENCE AND HEALTH
1995 Broadway, 2nd floor
New York, NY 10023-5860

Tel. 212-362-7044
Toll Free: 866-905-2694
Fax. 212-362-4919
ACSH@acsh.org

ACSH.org
HealthFactsAndFears.com
Riskometer.org
TheScooponSmoking.org

Holiday Dinner Menu

"No human diet can be free of naturally occurring chemicals that are rodent carcinogens. Of the chemicals that people eat, 99.99% are natural."

—Dr. Bruce Ames and Dr. Lois Swirsky Gold, University of California, Berkeley

AMERICAN COUNCIL ON SCIENCE AND HEALTH
Dr. Elizabeth M. Whelan, President

Appetizers

CREAM OF MUSHROOM SOUP
hydrazines

Fresh Relish Tray

CARROTS
aniline, caffeic acid

CHERRY TOMATOES
benzaldehyde, caffeic acid, hydrogen peroxide, quercetin glycosides

CELERY
caffeic acid, furan derivatives, psoralens

Assorted Nuts

MIXED ROASTED NUTS
aflatoxin, furfural

Green Salad

TOSSED LETTUCE AND ARUGULA WITH BASIL-MUSTARD VINAIGRETTE
allyl isothiocyanate, caffeic acid, estragole, methyl eugenol

Entrees

ROAST TURKEY
heterocyclic amines

BREAD STUFFING
(with onions, celery, black pepper & mushrooms)
acrylamide, ethyl alcohol, benzo(a)pyrene, ethyl carbamate, furan derivatives, furfural, dihydrazines, d-limonene, psoralens, quercetin glycosides, safrole

CRANBERRY SAUCE
furan derivatives
or

PRIME RIB OF BEEF WITH PARSLEY SAUCE
benzene, heterocyclic amines, psoralens

NATURALLY OCCURRING MUTAGENS AND CARCINOGENS FOUND IN FOODS AND BEVERAGES

ACETALDEHYDE *(apples, bread, coffee, meat, tomatoes)*—mutagen and potent rodent carcinogen

ACRYLAMIDE *(bread, rolls)*—rodent and human neurotoxin; rodent carcinogen

AFLATOXIN *(nuts)*—mutagen and potent rodent carcinogen; also a human carcinogen

ALLYL ISOTHIOCYANATE *(arugula, broccoli, mustard)*—mutagen and rodent carcinogen

ANILINE *(carrots)*—rodent carcinogen

BENZALDEHYDE *(apples, coffee, tomatoes)*—rodent carcinogen

BENZENE *(butter, coffee, roast beef)*—rodent carcinogen

BENZO(A)PYRENE *(bread, coffee, pumpkin pie, rolls, tea)*—mutagen and rodent carcinogen

BENZOFURAN *(coffee)*—rodent carcinogen

BENZYL ACETATE *(jasmine tea)*—rodent carcinogen

CAFFEIC ACID *(apples, carrots, celery, cherry tomatoes, coffee, pears, grapes, lettuce, mangos, potatoes)*—rodent carcinogen

CATECHOL *(coffee)*—rodent carcinogen

COUMARIN *(cinnamon in pies)*—rodent carcinogen

1,2,5,6-DIBENZ(A)ANTHRACENE *(coffee)*—rodent carcinogen

ESTRAGOLE *(apples, basil)*—rodent carcinogen

ETHYL ALCOHOL *(bread, red wine, white wine, rolls, tomatoes)*—rodent and human carcinogen

(*continued on page 6*)