

# BEEF FACTS:



## Nutrition

### Zinc: Dietary Sources and Bioavailability

Zinc, as a cofactor for numerous enzymes in the body, plays an important role in growth and development, wound healing, taste acuity and appetite, immune function, and gene expression (1-4). Although zinc is needed in only small amounts by the human body, some people are vulnerable to mild to moderate zinc deficiency (1). Zinc deficiency results not only from a diet low in zinc-rich foods such as meat, but also from intake of dietary components such as phytate in unrefined cereals that reduce zinc absorption or its availability to the body.

The Institute of Medicine, Food and Nutrition Board (1) has issued updated Recommended Dietary Allowances (RDAs) for zinc, as shown in Table 1.

**Table 1. Recommended Dietary Allowances (RDAs) for Zinc.<sup>1</sup>**

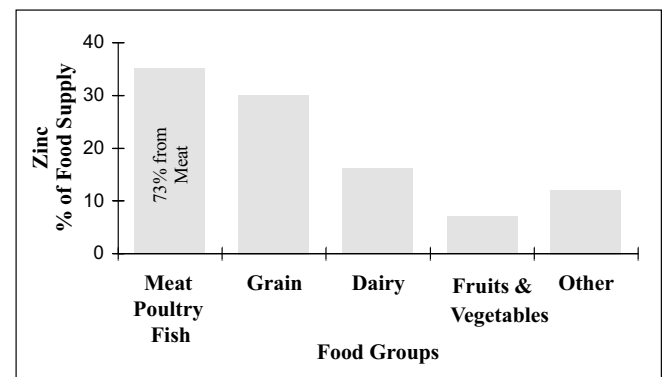
| Population      | Age (yr)   | Zinc (mg/day)  |
|-----------------|------------|----------------|
| Infants         | 0 – 6 mo.  | 2 <sup>2</sup> |
|                 | 7 – 12 mo. | 3              |
| Children        | 1 – 3      | 3              |
|                 | 4 – 8      | 5              |
|                 | 9 – 13     | 8              |
| Males           | 14 – >51   | 11             |
|                 | Females    | 14 – 18        |
| Pregnant Women  | 19 – >51   | 8              |
|                 | ≤18        | 13             |
| Lactating Women | 19 – 50    | 11             |
|                 | ≤18        | 14             |
|                 | 19 – 50    | 12             |

<sup>1</sup> Adapted from Institute of Medicine, Food and Nutrition Board (1).  
<sup>2</sup> Adequate Intake (AI). For healthy infants fed human milk, the AI is the mean intake.

### Food Sources of Zinc

Foods of animal origin such as meat, poultry, and fish (MPF) are the major source of zinc in the food supply (5). Over one-third (35%) of the zinc available in the U.S. food supply in 1997 came from MPF, while grain products contributed 30% and dairy products provided 16% (5, Figure 1). Meat, including beef, contributes 73% of the zinc available from MPF (5).

**Figure 1. Sources of Zinc Available in the U.S. Food Supply, 1997<sup>1</sup>**

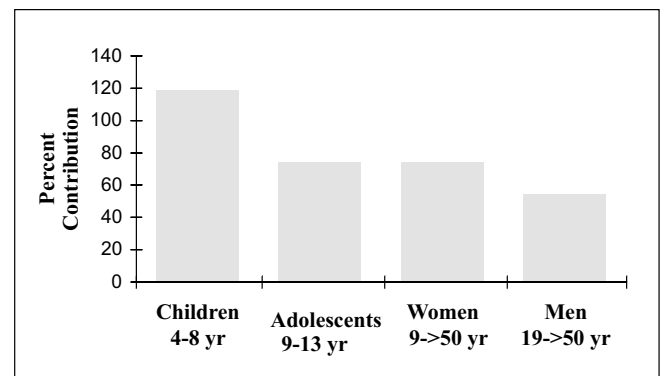


<sup>1</sup> Adapted from USDA, CNPP. Nutrient content of the U.S. Food Supply, 1909-97 (5).

In terms of *actual intake* of zinc, MPF provide more than one-half (53%) of the zinc consumed in the American diet (6). Meat in particular is an excellent source of zinc, although specific types of meats differ in their zinc content (Table 2.) (7). Beef is the number one source of zinc in the diet of U.S. children and adults (8,9).

A 3-ounce serving of beef contributes 118% of the zinc RDA for children 4-8 years, nearly three-quarters

**Figure 2. Percent Contribution of Beef (3 oz) to Zinc RDA (1,7)**



<sup>1</sup> Beef, composite of trimmed retail cuts, separable lean only, trimmed to 1/4" fat, all grades, cooked.

(74%) of the zinc RDA for adolescents and women, and over half (54%) of the RDA for men (1,7).

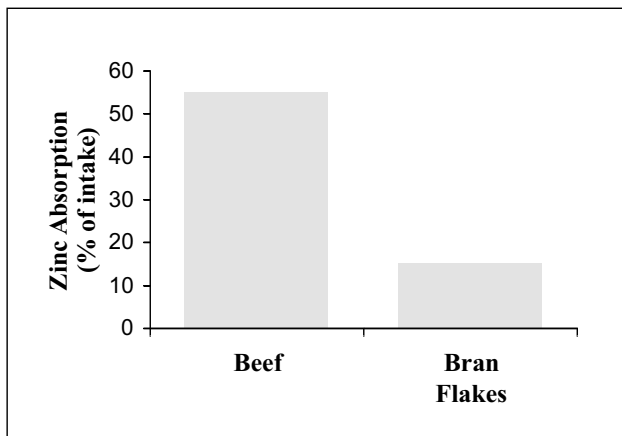
Cereals, grain products, fruits and vegetables contain less zinc than animal products (7). Further, the zinc from these foods is not as available to the body as animal sources of zinc (1,3,10). Sweets, fats and oils are relatively low in zinc and drinking water contains little of this nutrient (1,3).

## Factors Affecting Zinc Bioavailability

Many factors, both nondietary and dietary, influence the bioavailability of zinc (1,3,10-12). Among nondietary factors, a number of diseases (e.g., celiac disease, inflammatory bowel disease, gastrointestinal disorders) as well as certain drugs (e.g., corticosteroids) and excess alcohol intake reduce zinc absorption. The body's need for zinc also influences zinc absorption. The efficiency of zinc absorption is increased in zinc deficiency and reduced when zinc status is adequate (11). Aging does not appear to affect zinc absorption (1).

The composition of the diet or a meal can either increase or decrease the body's uptake of dietary zinc. The following dietary factors influence zinc bioavailability:

**Figure 3. Zinc Absorption From Beef & Cereal<sup>1</sup>**



<sup>1</sup>Adapted from Zheng, J.-J. et al. (13).

- **Meat.** Meat is a source of highly available zinc (3, 13). For example, in a study using beef, the bioavailability of zinc from this food was about four times greater than that from a high-fiber breakfast cereal when consumed by healthy adults (Figure 3.) (13). Increasing the amount of meat in the diet improves the bioavailability of zinc (14).

- **Phytate.** Phytate, found in plant-based foods such as whole grain cereals, legumes, and soy products, inhibits zinc absorption (1,10). Reducing phytate from these foods increases the availability of zinc (15).
- **Dietary Fiber.** Fiber per se does not have a major influence on zinc absorption (1). However, high fiber foods may contain other components such as phytate that inhibit zinc absorption.
- **Vegetarian Diets.** Not only can vegetarian diets be low in zinc, but the zinc may not be readily available to the body (1,16). A 35% reduction in the total amount of zinc absorbed was found in young women who consumed a lacto-ovo-vegetarian diet compared to a nonvegetarian diet (16). Phytate and other substances in plant foods in vegetarian diets can bind zinc and reduce its bioavailability. Vegetarians, especially strict vegetarians whose diets consist mainly of phytate-rich grains and legumes, may have as much as a 50% higher need for zinc than nonvegetarians (1). Individuals following vegetarian diets must make careful food choices to ensure that they meet their zinc needs.
- **Protein.** Dietary protein, particularly animal protein, and some amino acids may increase the bioavailability of zinc (1,3,10). However, the role of dietary protein in zinc absorption in humans is inconsistent due in part to other factors (e.g., phytate in soy protein). In general, zinc absorption is greater from a diet rich in animal protein than proteins of plant origin such as soy (3).
- **Other Nutrients.** Iron, calcium, and folic acid may influence the bioavailability of zinc (1). A competitive interaction between iron in supplements and zinc may limit zinc absorption, although no effect is observed when iron and zinc are consumed in a meal. The American Academy of Pediatrics, in recommending iron-fortified formula for infants who are formula-fed, acknowledges that there appears to be no adverse effect on zinc status (17).

The bioavailability of zinc may be impaired by interactions with nutrients such as calcium and folic acid. However, when adolescent females consumed 1,500 mg calcium/day, no adverse effects on zinc utilization were found (18). When zinc intake is adequate, intake of a calcium-rich diet has little effect on zinc absorption (1). Folate supplementation does not appear to adversely affect zinc status (1). More research is necessary to determine the significance of such interactions in humans (1).

**Table 2. Zinc Content of Selected Common Foods<sup>1</sup>**

| Food (3 oz, lean only)             | Zinc (mg) |
|------------------------------------|-----------|
| <b>Beef</b>                        |           |
| Shank crosscuts, simmered          | 8.9       |
| Sirloin, broiled                   | 5.5       |
| Ground, 85% lean, broiled          | 4.6       |
| <b>Pork</b>                        |           |
| Shoulder, blade, Boston roasted    | 3.7       |
| Tenderloin, fresh, loin, roasted   | 2.2       |
| <b>Lamb</b>                        |           |
| Leg, shank half, roasted, domestic | 4.3       |
| <b>Veal</b>                        |           |
| Sirloin, braised                   | 4.0       |
| <b>Chicken</b>                     |           |
| Dark meat, roasted                 | 2.4       |
| Light meat, roasted                | 1.1       |
| <b>Turkey</b>                      |           |
| Dark meat, roasted                 | 3.5       |
| <b>Seafood</b>                     |           |
| Flounder/sole, dry heat            | 0.5       |
| Tuna, light, canned in water       | 0.7       |
| Oysters, Pacific, 6 medium, raw    | 49.9      |
| <b>Food (serving or amount)</b>    |           |
| <b>Dairy Products</b>              |           |
| Milk, 1% lowfat, 1 cup             | 1.0       |
| Cheese, Cheddar, 1 oz.             | 0.9       |
| <b>Cereals</b>                     |           |
| Raisin bran (enrich), dry, 1 cup   | 2.2       |
| Oatmeal, cooked, 1/2c.             | 0.8       |
| Corn flakes (enrich), dry, 1 cup   | 0.2       |
| <b>Grains</b>                      |           |
| Brown rice, cooked, 1/2c.          | 0.6       |
| Whole wheat bread, 1 sl.           | 0.4       |
| Bagel, 1                           | 0.3       |
| <b>Fruits</b>                      |           |
| Banana, 1 med.                     | 0.2       |
| Apple, 1 med.                      | 0.1       |
| <b>Vegetables</b>                  |           |
| Peas, green, ckd, 1/2c.            | 0.8       |
| Broccoli, raw, 1/2c.               | 0.2       |
| Potato, baked w/skin, 1/2c.        | 0.2       |
| Carrots, 1 med.                    | 0.1       |
| Baked beans, canned, plain, 1/2c.  | 1.8       |
| <b>Meat Substitutes</b>            |           |
| Peanut butter, 2 Tbsp.             | 0.9       |
| Egg, whole, raw, 1                 | 0.6       |

<sup>1</sup> Adapted from U.S.D.A. (7).

## Summary

A low intake of zinc-rich foods and consumption of dietary components that reduce the bioavailability of zinc can lead to zinc deficiency. Meat such as beef contains high levels of zinc, which is readily available to the body. In contrast, plant-based foods such as whole-grain cereals, legumes, vegetables, and fruits contain less zinc than protein-based foods. Further, components such as phytate in plant-based foods can reduce the bioavailability of zinc. Individuals follow-

ing vegetarian diets may be at risk of zinc deficiency, particularly if careful food choices are not made. The Food Guide Pyramid (19) recommends 2 to 3 servings/day of foods from the Meat Group. Choosing beef for at least one of these servings makes a substantial contribution to zinc needs.

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