

Introduction: Nutritional and Functional Roles of Eggs in the Diet

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For years, eggs have been held up as a powerhouse of nutrition. This reputation has been due to eggs' exceptional nutrition profile as a nutrient-dense food containing high quality protein and a substantial amount of many essential vitamins and minerals. Unfortunately their position on the nutrition pedestal fell with the discovery that they are also a source of dietary cholesterol. The most recent scientific research not only returns eggs to their golden past, but elevates their position as a functional food and ultimately provides more reasons than ever to consume eggs.

In February 2000, scientists convened at a conference in Amelia Island, Florida, to discuss the latest research about the role of eggs in disease prevention and the promotion of health. This supplement of the *Journal of the American College of Nutrition (JACN)* presents compelling scientific evidence about eggs' functional food attributes, reaffirms that eggs have a minimal effect on blood cholesterol levels and presents new research on the contribution of eggs to the American diet. For health professionals, this issue provides a new scientifically based viewpoint on eggs and their role in health and nutrition, a viewpoint that should be imparted to all consumers in an effort to ensure optimal health and well-being.

Egg Nutrition

It is well known that eggs constitute a rich array of nutrients. They long have been promoted for their high quality protein. Egg also provide a high nutrient density in proportion to their energy content. As shown in Table 1 eggs contribute only 1.3% of the total calories in the American diet but substantial amounts of high quality protein, folate and riboflavin as well as a number of other nutrients in excess of its caloric contributions. Eggs are a good source (10 to 19 percent of the Daily Value [DV]) of six nutrients and an excellent source (20+% of the DV) of five nutrients (Table 2). Few foods are as nutrient-dense, and eggs are among the few food sources of vitamins D and K.

The nutrient density of eggs makes them a valuable contributor to the overall nutritional balance of the diet (Table 2) and, as an economical source of high quality protein, an important component in the diets of the elderly, low-income families, growing children and people limiting calories for weight loss purposes. In this issue, Won O. Song and Jean M. Kerver highlight that among egg consumers, eggs contributed 10% to 20% of dietary folate and 20% to 30% of vitamins A, E and B-12. The fact that non-consumers of eggs were more likely to fall short of the EAR or the RDA for vitamins A, E and B-12 demonstrates the important role eggs can play in ensuring nutrient adequacy.

As a high protein food, eggs appear in a food group with beef, poultry, fish, legumes and other animal and vegetable protein sources on the Food Guide Pyramid. They are well recognized among consumers as a top source of protein. Certain groups of consumers, namely athletes, may place great importance on protein. Yet a dichotomy exists as to the proper balance of protein and carbohydrates among athletes. In this supplement, Peter W. R. Lemon discusses the need to educate athletes about dietary protein, given that their protein needs are greater than those of their inactive peers. This discussion helps put dietary protein in perspective for various groups of consumers.

More recently, research has shown that eggs supply significant amounts of carotenoids that may play a role in disease prevention. Jeffrey Blumberg and colleagues have demonstrated that eggs are a source of highly bioavailable forms of the carotenoids lutein and zeaxanthin. These antioxidant-like compounds have been shown to help in the prevention of macular degeneration, a leading cause of blindness in the elderly, and have been associated with lower risk of cataract extraction. Consumers may not yet be aware that egg yolks are rich in highly bioavailable forms of both these antioxidants, nor that these antioxidants convey potential health benefits.

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Table 1. Contributions of Eggs to the American Diet

Nutrient	% Contribution	Nutrient	% Contribution
Kcal	1.3	Protein	3.9
Total Fat	2.0	Saturated Fat	1.7
Riboflavin	6.4	Vitamin A	4.3
Vitamin E	4.3	Folate	5.1
Vitamin B ₆	2.1	Vitamin B ₁₂	3.7
Zinc	2.8	Iron	2.4
Calcium	1.7	Cholesterol	33.2

Data from NHANES III [1]

Another less familiar nutrient in eggs is choline, a compound which is critical for brain and memory development *in utero* and early in life. Choline was mentioned in earlier editions of the RDAs [2], but only recently were formal dietary recommendations made [3]. Because research on choline is somewhat limited, and study findings have not yet caught the attention of journalists and reporters, consumers know little about choline or its food sources, including eggs. Steven H. Zeisel points out the potential, but not yet studied, importance of choline to pregnant women to ensure normal development of the fetal brain. Eggs could be recommended to pregnant women as a rich source of choline.

The Changing Heart Disease Message

Information about cholesterol and heart disease began being publicized in the 1960s, with the first observations linking diet to heart disease. In the early 1970s, the American Heart Association published its first recommendations on diet. Among them was a suggested limitation on dietary cholesterol to less than 300 mg/day. High cholesterol foods like eggs and shellfish were highlighted as foods to minimize in the diet.

Consumers have been and continue to be concerned about cholesterol in foods, in good measure a result of 40 years of communication regarding high cholesterol foods, blood cholesterol levels and heart disease. What consumers may not realize is how little effect changes in dietary cholesterol intake have on blood levels. A paper by Donald J. McNamara summarizes 166 cholesterol feeding studies conducted over the past 40 years on 3,500 subjects. He shows that for every 100 mg decrease in dietary cholesterol, plasma total cholesterol drops by 2.2 mg/dL or about 1%. McNamara also notes that the high levels of dietary cholesterol in many of these studies far exceed the

Table 1. RDA of Major Nutrients from Two Large Eggs

Nutrient	% Daily Value	Nutrient	% Daily Value
Food Energy	6%	Protein	20%
Riboflavin	30%	Folate	12%
Vitamin B ₁₂	16%	Vitamin K	62%
Vitamin D	12%	Iron	8%
Vitamin A	12%	Phosphorous	16%
Vitamin E	6%	Selenium	34%
Vitamin B ₆	8%	Zinc	8%

approximately 250 mg/day consumed by the average American [4]. Additionally, the diets in many of the earlier studies on cholesterol and heart disease were not only high in cholesterol but were also high in fat, saturated fat and animal products, and low in fruits, vegetables and whole grains, dietary factors known to influence circulating cholesterol levels and vascular disease risk. Given the functional components of fruits, vegetables and whole grains, it is essential that these foods be included whenever the effects of diet on health and disease are studied.

Recent studies have cast further doubt on the relationship between dietary cholesterol and heart disease. Steven Kritchevsky and David Kritchevsky review recent epidemiological studies relating dietary factors to incidence of heart disease. The authors note that research has not established a significant independent relationship between dietary cholesterol and LDL or total serum cholesterol levels, incidence of heart disease or heart disease deaths. Furthermore, data fail to show a relationship between egg consumption and either serum cholesterol levels or heart disease incidence. Recent research using an endpoint of heart disease and stroke rather than serum cholesterol levels calls into question the need to limit a high cholesterol food like eggs. In their analysis of data from prospective epidemiological studies, Hu *et al.* [5] found that consumption of up to one egg a day was not related to heart disease or stroke risk.

The papers in this issue, along with emerging research, support the importance of educating patients and consumers on changing views in the area of diet and disease prevention, in light of emerging research and new findings on the absence of health risks from dietary cholesterol and new studies showing health benefits from egg consumption.

Eggs as a Functional Food

Eggs can be classified as a functional food, a hot button for today’s consumer. Definitions of ‘functional foods’ has been put forth by several organizations. According to the Institute of Food Technologists, functional foods provide additional physiological benefit beyond that of meeting basic nutritional needs [6]. The International Life Sciences Institute of North America further specifies that functional foods have physiologically active components that give them their functional properties [7]. The American Dietetic Association (ADA) defines several categories of functional foods, among them, unmodified whole foods with physiologically active components [8]. Whole foods that have not been enriched or fortified with functional ingredients fit ADA’s definition. Among the foods cited by ADA as functional whole foods are tomatoes for their lycopene, tea for its polyphenols and fermented dairy products for their probiotics. The position of ADA recognizes that ‘functional foods, including whole foods and fortified, enriched, or enhanced foods, have a potentially beneficial effect on health when consumed as part of a varied diet’ [8]. Eggs fit ADA’s definition of a functional food: they are a whole food with active

components. The article by Clare M. Hasler looks at the functional foods trend and the contributions eggs can make to the functional foods category.

Consumers are becoming more familiar with the concept of functional foods. A 1998 telephone survey conducted by the International Food Information Council (IFIC) found that 74% of adults surveyed could name a food or food component that was associated with health benefits [9]. The list included broccoli, oranges, carrots, and garlic, but, not surprisingly, eggs were not on the list. However, the new egg message may slowly be reaching consumers. Linda Gilbert notes in her paper that regular egg consumption has been increasing steadily; thirty percent of shoppers surveyed in 1999 eat eggs at least twice a week, compared to 23% in 1992. Gilbert's research suggests that, as consumers become more aware of the beneficial compounds in eggs, they will include eggs in their diet more often.

Health professionals can help consumers develop a positive attitude toward functional foods. A survey conducted for the International Food Information Council found that, while unmotivated consumers were skeptical of information on diet and health, they would be open to functional food components if added to or present in foods they already eat and like [10]. However, it is important to educate the consumer on the importance of a balanced, healthful diet rather than on single nutrients or functional components.

A Shift in the Egg Paradigm

The time has come to change consumer attitudes about how eggs can contribute to overall health rather than incorrectly positioning them as a risk factor in heart disease. Scientists, medical professionals and communicators are challenged with changing consumer attitudes and behaviors about eggs. Beliefs and behaviors can stem from cultural influences rather than from nutrition science. For example, many consumers link eating spinach to strength because a cartoon sailor's muscles popped up every time he ate a can of spinach. The association of eggs with heart disease stemmed from observational studies, but its perpetuation is driven by more culture and public health than by science.

The egg is the latest in a long line of foods to evoke consumer fear, as noted in this issue by William Alex McIntosh. He cites the 1960s as the first time that consumers were told to limit or avoid eggs, despite a lack of research on whether eggs themselves elevated blood cholesterol. Eggs have become a symbol of the negative aspects of the American diet, and fear among the American population of eating eggs may be resulting from a lack of consensus in the scientific community and the widespread marketing of low cholesterol foods.

The media have helped publicize the egg-heart disease message. McIntosh points out that news articles on eggs overwhelmingly have focused on the egg-cholesterol-heart disease connection. In contrast, home and hearth magazines mention

eggs most in the context of recipes. New research findings on the functionality of eggs will allow health professionals to communicate positive messages about eggs and health to the media.

The time is right to change the egg message. Consumer concern about cholesterol levels in foods is steadily declining, according to a 1999 survey by the Food Marketing Institute (FMI). In 1990, 44 percent of consumers surveyed reported being very or somewhat concerned about cholesterol levels. That number dropped steadily to 18 percent in 1999. Of note, consumer concern did jump in 1996, presumably related to media coverage of diet and cholesterol rather than to new research findings. The steady drop in concern about dietary cholesterol is reflected in consumer behavior. FMI found that the percentage of shoppers who sought out and purchased low cholesterol food products dropped from 70 percent in 1996 to 60 percent in 1999 [11].

What should be today's image of eggs? For the consumer, the most essential image is probably that eggs taste good. Taste is highly important to consumers, according to the 1999 annual survey conducted for FMI [11]. In fact, nutrition is becoming increasingly less important to consumers. Just under half of consumers surveyed reported that they are very concerned about nutrition, down from a peak of 62 percent in 1994. The second image needing change is that eggs be recognized as a nutritious food which also has health benefits beyond basic nutrition. The concept of eggs as a 'functional food' is new to many and requires a change in the perception of role of eggs in the diet. And finally, the evidence that eating eggs is unrelated to heart disease risk needs to be widely disseminated to health professionals and the public so that everyone can benefit from including eggs in the diet.

REFERENCES

1. Federation of American Societies of Experimental Biology: 'Report on nutrition monitoring in the United States.' Washington, DC: US Government Printing Office, 1995.
2. Subcommittee on the Tenth Edition of the RDAs, Food and Nutrition Board, Commission on Life Sciences, National Research Council: 'Recommended Dietary Allowances,' 10th ed. Washington, DC National Academy Press, 1989.
3. Institute of Medicine and National Academy of Sciences USA: 'Dietary Reference Intakes for Folate, Thiamin, Riboflavin, Niacin, Vitamin B12, Pantothenic Acid, Biotin, and Choline.' Washington DC: National Academy Press, 1998.
4. U.S. Department of Agriculture, Agricultural Research Service. 1997. Data tables: Results from USDA's 1994-96 Continuing Survey of Food Intakes by Individuals and 1994-96 Diet and Health Knowledge Survey.
5. Hu FB, Stampfer MJ, Rimm EB, Manson JE, Ascherio A, Colditz GA, Rosner BA, Spiegelman D, Speizer FE, Sacks FM, Hennekens CH, Willett WC: A prospective study of egg consumption and risk of cardiovascular disease in men and women. *JAMA* 281:1387-1394, 1999.

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6. Hasler CM: Functional foods: Their role in disease prevention and health promotion. *Food Technology* 52:63–70, 1998.
7. Clydesdale FM: ILSI North America Food Component Reports. *Crit Rev Food Sci* 39:203–316, 1999.
8. Position of The American Dietetic Association: Functional foods. *JADA* 99:1278–1285, 1999.
9. International Food Information Council: Quantitative Research. 1998 Telephone Survey.
10. International Food Information Council: Qualitative Research. 1999 Consumer Focus Groups.
11. Food Marketing Institute: 'Trends in the United States. Consumer Attitudes & the Supermarket, 1999.' Washington DC: Food Marketing Institute, 1999.

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