ABSTRACT

Increased interest in food, nutrition, and health has led to critical evaluation of the American diet by governmental, scientific, and consumer groups. The exact role of diet in health and disease continues to be debated. Over the years trends in consumption of foods and nutrients have developed. These issues are examined. Historically, animal products have played a key role in the overall health of Americans. The contributions of animal products to human nutrition are emphasized along with an introduction to the use of the concept of nutrient density.

SITUATION ANALYSIS

There has been increasing interest in and concern for the relationship between environment and health. This interest has been voiced both by those in government and by consumers (7, 17, 21, 27). Diet, as an integral component of our environment which can be modified, has received much of this increased attention as preventive measures are formulated to improve our quality of life. For example, in 1977 the US Senate Select Committee on Nutrition and Human Needs published, and subsequently republished with revisions, "Dietary Goals for the United States" (29, 31). If followed closely, these proposed goals would lead to widespread changes in food selection and eating patterns for many Americans (23, 24, 26). Basically, the goals promote decreased consumption of fat, sugar, salt, and alcohol and increased consumption of more complex carbohydrates (breads and cereals, fruits and vegetables). The changes proposed should be evaluated closely for potential benefit. This is especially critical as the dietary goals may serve as a template for a broader national nutrition policy in the future.

Members of the scientific and medical communities do not agree completely on the dietary goals, the way they were developed, or the expected benefits which might be derived from their adoption (10, 11, 12, 13, 14, 30). Indeed, this latter point is a major concern. As presented, the approach of the dietary goals may raise false hopes among consumers. If the promised results are not obtained, the public could be disillusioned with governmental nutrition and health programs and possibly even with the science of nutrition.

Depending upon the reference (12, 13, 29), changes in the food supply during this century have been associated with improving or deteriorating health. But the predominance of evidence agrees with Leveille (13) when he suggested that today's American diet is one of the best in the world. During the past half century in the United States, nutritional deficiency diseases have been reduced greatly, most infectious diseases are controlled effectively, infant and child mortality have decreased steadily, and life expectancy has increased by 20 years. The American diet has had an impact on these trends, and animal products have been and continue to be a prominent part of the American diet.

Animal products are indicted for their role in the major "killer diseases" of developed countries (coronary heart disease, cancer, stroke and hypertension, diabetes, and cirrhosis of the liver) (29). However, even critics of animal foods have to acknowledge that most of the nutrients consumed in the American diet in less than recommended amounts are provided...
by animal products. For example, calcium generally is not consumed in recommended amounts by the adult population, but 81% of the calcium in our diets is provided by animal products (75% from dairy products alone) (15).

WHAT DO STATISTICS REVEAL?

As indicated earlier, the incidence of infectious diseases and diseases from nutritional deficiency is decreasing in the United States while the incidence of certain chronic diseases has been increasing in recent years, especially with the greater number of people living longer. Life expectancy has increased 53% in 75 yr (47.3 yr (1900) to 72.5 yr (1975)) (36).

Trends in nutrition and diets in the United States have been reviewed (3, 6). While the available supply of total calories and calories derived from protein have remained fairly constant, the proportion of calories from fat has increased and the proportion of calories from carbohydrates has decreased. The decreased consumption (disappearance) of total carbohydrate also represented a shift in the kind of carbohydrate. Following the 1920's the use of refined sugar increased and has been maintained while the use of starch and more complex carbohydrates has continued to decline.

Total fat consumption (disappearance) has increased along with a change in the type of fat. There has been only a small change in saturated fatty acids in the food supply since the early 1900's, however, increased use of polyunsaturated fatty acids has been marked. Daily intake of dietary cholesterol has risen only about 1% since the turn of the century. This is attributed largely to the increased total intake (disappearance) of meat and poultry products. However, use of specific products such as eggs, lard, and butter has declined during this period. Calcium, vitamin C, and vitamin A are more plentiful in our food supply than 65 yr ago. The enrichment of flour with iron, riboflavin, niacin, and thiamin markedly improved the availability of these nutrients since 1941. Early in this century about one-half of the protein came from animal products. In 1972 roughly 70% of the protein supply came from meat, poultry, fish, dairy products, and eggs.

Long-term trends in consumption (disappearance) of major commodities are explained by trends of nutrients. Since 1909 amounts of cereal products have declined, and meat, poultry, and fish have increased. Dairy products (including butter) increased until the mid-40's and since have leveled off. Consumption (disappearance) of fruits and vegetables increased through the mid-40's and has decreased since.

Gortner (6) examined the data for who is consuming the various food products. For instance, consumption (disappearance) of dairy products declines after age 8 for females but stays high for males through age 19. Apparent consumption of animal products does not change greatly for females from the teens through adult life; however, it continues to increase for men through age 34.

To develop an effective national policy on food, nutrition, and health, the above mentioned changes in consumption of food and nutrients over time are relevant. However, it is also essential to have some idea of the nutritional and health status of the US population in relation to their nutrient needs. Surveys such as the USDA Household Food Consumption Survey of 1965 (33), the HEW Ten-State Nutrition Survey of 1968 to 1970 (34), and the HEW Health and Nutrition Examination Survey (HANES) (35) reveal that in a society as affluent as the United States there still exist populations with inadequate nutrient intake. The nutrients most frequently identified as being consumed in marginal or in less than recommended amounts are iron, calcium, vitamin A, riboflavin, and vitamin C. Animal foods are excellent sources of four of these nutrients (iron, calcium, vitamin A, and riboflavin).

NUTRIENT CONTRIBUTIONS

See Table 1 for a summary of the contributions of meat, eggs, and dairy products to available nutrient supplies. In comparison to other food groupings (15), animal foods are excellent sources of many of the nutrients. One notable example is protein (meat, eggs, and dairy products provide about 69% of the available supply). Animal protein is higher in nutritional quality than is plant protein, because the assortment and amount of amino acids in animal protein more closely matches needs of the human body.

Animal products can be used to upgrade the nutritional quality of plant sources of food by
TABLE 1. Contribution of meat, eggs, and dairy products to the food supply (1978).a

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Meatb</th>
<th>Eggs</th>
<th>Dairyc</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food energy (kcal)</td>
<td>19.8</td>
<td>1.8</td>
<td>11.2</td>
<td>32.8</td>
</tr>
<tr>
<td>Protein</td>
<td>42.3</td>
<td>4.8</td>
<td>22.1</td>
<td>69.2</td>
</tr>
<tr>
<td>Fat</td>
<td>33.6</td>
<td>2.8</td>
<td>12.5</td>
<td>48.9</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>.1</td>
<td>.1</td>
<td>6.7</td>
<td>6.9</td>
</tr>
<tr>
<td>Calcium</td>
<td>3.9</td>
<td>2.2</td>
<td>74.6</td>
<td>80.7</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>28.3</td>
<td>5.0</td>
<td>35.0</td>
<td>68.3</td>
</tr>
<tr>
<td>Iron</td>
<td>30.6</td>
<td>4.7</td>
<td>2.5</td>
<td>37.8</td>
</tr>
<tr>
<td>Magnesium</td>
<td>14.2</td>
<td>1.2</td>
<td>21.7</td>
<td>37.1</td>
</tr>
<tr>
<td>Vitamin A value</td>
<td>22.8</td>
<td>5.7</td>
<td>13.3</td>
<td>41.8</td>
</tr>
<tr>
<td>Thiamin</td>
<td>26.0</td>
<td>2.0</td>
<td>8.7</td>
<td>36.7</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>24.4</td>
<td>4.6</td>
<td>39.3</td>
<td>68.3</td>
</tr>
<tr>
<td>Niacin</td>
<td>45.1</td>
<td>.1</td>
<td>1.4</td>
<td>46.6</td>
</tr>
<tr>
<td>Vitamin B₆</td>
<td>47.4</td>
<td>1.8</td>
<td>10.5</td>
<td>59.7</td>
</tr>
<tr>
<td>Vitamin B₁₂</td>
<td>70.6</td>
<td>7.8</td>
<td>20.1</td>
<td>98.5</td>
</tr>
<tr>
<td>Ascorbic acid</td>
<td>1.1</td>
<td>.0</td>
<td>3.8</td>
<td>4.9</td>
</tr>
</tbody>
</table>

aFrom USDA (15).
bMeat (including pork fat cuts), poultry, and fish.
cDairy products, excluding butter.

virtue of this high quality protein and also due to excellent B-vitamin content and iron in highly available form. Proteins of grains are generally low in lysine, and corn is low in tryptophan while milk and meat are good sources of lysine and tryptophan. Cereal grains are low in calcium while milk is high in calcium. The efficiency of animals in producing human food must be evaluated in terms of nutrient needs (18, 25). For instance, ruminants, by utilizing roughages, can be noncompetitive with man for food supplies. In addition, the ruminant produces a high quality food product (i.e., meat and milk). By utilizing animal protein sources to meet a portion of the human needs for protein, less total dietary protein would be required than if plant foods were the sole source of protein.

HEALTH CONCERNS

A number of conditions of health and disease have been associated with the presence or absence of animal foods in the diet of populations (29, 30). These data, however, have little relevance to individuals within such populations. For these conditions, the evidence should be examined to put the entire issue in perspective. Some people are at greater risk of developing certain disease than other people. A dietary treatment for a certain disease may benefit some individuals but not the entire population. Nutrients, interactions among and between nutrients, and other components of the diet most likely have a greater effect on specific conditions of health and disease than do specific foods. For this reason it is misleading to suggest that any single food is good or bad relative to certain health conditions. Examples of health concerns often associated with consumption of animal products are coronary heart disease, cancer, obesity, iron-deficiency anemia, and bone disease.

Coronary Heart Disease (CHD)

The main discussion in CHD centers around the amount and kind of dietary fat and the relationship of this diet component to serum cholesterol (a risk factor for CHD). The effectiveness of dietary change alone to control CHD is not agreed upon by all scientists (30). Several epidemiological studies within homogenous populations have failed to demonstrate significant associations between individual nutrient intakes and either blood lipids or CHD risk within that population (5). While some drug treatments may lower cholesterol in serum modestly and reduce the incidence of nonfatal heart attacks in subjects with initially high serum cholesterol, the effectiveness of this lowering on mortality from CHD was not demonstrated (22). Likewise, the use of dietary manipulations to decrease cholesterol in blood and in turn delay or prevent the incidence of CHD, remains an area of active research. As an example, the National Heart, Lung, and Blood Institute currently is supporting large clinical trials aimed at evaluating the effect of diet and other variables on the primary risk factors in CHD. One of the questions as yet unanswered is whether specific lowering of blood cholesterol through changes in diet of the average American will prevent CHD (28). If one compares the amounts of fat provided by animal and vegetable sources in 1909 and 1978 (Table 2), total dietary fat has increased due largely to increased consumption of vegetable fat (15).

Cancer

In recent years the relationship of diet to
TABLE 2. Fat provided by animal and vegetable sources.\textsuperscript{a}

<table>
<thead>
<tr>
<th>Year</th>
<th>Animal fat (g/capita/day)</th>
<th>Vegetable fat (g/capita/day)</th>
<th>Total fat (g/capita/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1909 to 1913</td>
<td>103.5</td>
<td>21.3</td>
<td>124.8</td>
</tr>
<tr>
<td>1978</td>
<td>91.2</td>
<td>67.9</td>
<td>159.1</td>
</tr>
</tbody>
</table>

\textsuperscript{a}From USDA (15).

Various forms of cancer have been examined (2, 20). Almost no food has been exempt from examination since diet represents an environmental factor which can be modified in studies of cancer. Generally, diet is believed to influence organ susceptibility and response to other causative cancer factors (2, 20). At this point, various foods or nutrients are not believed to be carcinogens themselves. Epidemiological studies show incidence of certain forms of cancer correlates with diets high in animal foods such as meat. However, these same diets tend to be low in fiber. It is conceivable that what the diet does not contain could be just as critical as what it does contain. To date, most studies on diet and cancer have been with animals, and results often have been conflicting (2). For instance, a given nutrient in various amounts may exhibit both protective and enhancing effects on certain cancers. Future research with selected populations (such as Mormons and Seventh-Day Adventists) should offer unique opportunities to examine the relationship of diet and nutrition to cancer. These groups have lower than average incidence for many cancers; however, their consumption of various animal products often equals or exceeds the national average.

Iron-Deficiency Anemia

Surveys have indicated an inadequate iron intake by some segments of the population (young children and young women) (33, 34, 35). Animal products such as meat are excellent sources of dietary iron in a form which has high bioavailability (16).

Bone Disease

Decreased density of skeletal bone (osteoporosis) and alveolar bone (periodontal disease) in advancing age resulting in bone fractures indicate that calcium intake and/or dietary factors affecting bone development may be lacking (1). Or, there may be an excessive intake or altered ratio of factors adversely affecting bone integrity (32). Of all foods, dairy foods are the major dietary source of calcium (75\% in 1978) (15).

Relative to these latter two health concerns, recommendations to increase dairy food consumption for its bioavailable calcium and to increase meat consumption for its bioavailable iron would go far in fulfilling our inadequate or marginal nutritional status of these nutrients.

Obesity

The trend to overconsumption and decreased physical activity has made obesity the most widespread nutritional problem in the US. This condition also represents the common denominator of many nutrition-related public health problems (30). It is a risk factor in CHD, cancer, hypertension, atherosclerosis, diabetes, arthritis, and other diseases. To control body weight one must control excessive calorie intake and/or increase caloric expenditure (i.e., exercise). In controlling calorie intake the question is often where to cut back on calories in the diet. The wisest choice is to consider sources of nutrients in relation to calories. Animal products provide many essential nutrients in relatively large amounts in relation to total calories provided. Thus, animal products have high nutrient density. On the other hand, fats, oils, sugars, and sweeteners provide a large proportion of total calories but few additional nutrients. These foods would have low nutrient density. Thus, to control obesity, intake of low nutrient-dense foods should be decreased.

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Bone Disease

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**Nutrition Education**

Since 1943 the "Recommended Dietary Allowances" (RDA) established by the Food and Nutrition Board, NAS-NRC, have provided what might be considered national nutritional guidelines. These nutrient allowances are revised periodically (9th edition to be published in 1979). The RDA are intakes of essential nutrients adequate to meet the known nutritional needs of practically all healthy persons in the US (4). Over the years they have served...
as valuable national guidelines for nutrition upon which to base successful programs of nutrition education.

Many years ago USDA and National Dairy Council (NDC) started to group foods with similar nutrient content to facilitate teaching nutrition (19). The major groupings include milk, meat, fruit-vegetable, and grain. Foods not included in these four food groups supply few nutrients except carbohydrate and fat and, thus, are categorized as "others". They complement but do not replace foods from the four food groups. The recommended number of servings from the four food groups is designed to meet the RDA for most nutrients with calories consistent with desirable body weight. A daily dietary pattern meeting the RDA for established nutrients usually can be achieved with about 1200 kcal. If needed, additional energy can be obtained from more servings from the four food groups or servings from "others". The food grouping system provides a simple and effective way to encourage recommended servings of a wide variety of foods to achieve a nutritionally adequate diet.

**NUTRIENT DENSITY**

An important concept in formulating diets is to obtain the recommended nutrients in adequate amounts with a minimum intake of calories. To do this one would choose foods with a high proportion of nutrients to calories, nutrient-dense foods. As was mentioned earlier, animal foods are some of the most nutrient-dense foods. However, no one group of foods represents the best source of all nutrients. Thus, variety in the diet is essential.

Nutritionists are working continually to devise improved methods for evaluating nutrient contributions of various foods. The concept of nutrient density has received increased attention (8, 9). The Index of Nutritional Quality (INQ) as reported by Hansen and colleagues represents one approach to utilizing nutrient density. The INQ of a food for a particular nutrient is the ratio of the percent of the nutrient allowance to the percent of the energy allowance provided by a serving of the food (Table 3). The INQ is useful in determining the relative adequacy of a food as a source of a certain nutrient. For instance, an INQ > 1 indicates that an amount of the food which would supply the total energy allowance would supply more than the recommended amount of that nutrient. A 4 means that the recommended amount for that nutrient would be met at 25% of the total energy allowance from that food. This is an example of how nutrient density can be considered in constructing calorie-restricted diets. Conversely, an INQ < 1 indicates that a food is not a major source of the nutrient since consumption of the food in excess of caloric recommendations would be needed to meet the recommended allowance.

The INQ, while being a significant step forward, does need further refinement. For example, bioavailability of nutrients and amount of food needed are not considered. Table 4 shows the INQ for several animal products for the nutrients required on nutrition labeling.

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**TABLE 3. Calculation of Index of Nutritional Quality (INQ).**

<table>
<thead>
<tr>
<th>INQ</th>
<th>% of nutrient allowance</th>
<th>% of energy allowance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole milk Calcium (Ca) INQ =</td>
<td>Milk Ca/USRDA Ca</td>
<td>291 mg/1000 mg</td>
</tr>
<tr>
<td></td>
<td>Milk kcal/kcal RDA</td>
<td>150 kcal/2300 kcal</td>
</tr>
<tr>
<td>Whole milk Vitamin C (C) INQ =</td>
<td>Milk C/USRDA C</td>
<td>2.29 mg/60 mg</td>
</tr>
<tr>
<td></td>
<td>Milk kcal/kcal RDA</td>
<td>150 kcal/2300 kcal</td>
</tr>
</tbody>
</table>

*Adapted from Hansen et al. (8).*
### TABLE 4. Index of Nutritional Quality (INQ). a

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Milk</th>
<th>Skim milk</th>
<th>Plain yogurt</th>
<th>Cheddar cheese</th>
<th>Ice cream</th>
<th>Hamburger (very lean)</th>
<th>Bacon</th>
<th>Pork loin</th>
<th>Beef liver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>1.9</td>
<td>3.6</td>
<td>3.0</td>
<td>2.2</td>
<td>.7</td>
<td>4.4</td>
<td>1.6</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Vitamin A Act.</td>
<td>1.0</td>
<td>2.6</td>
<td>.5</td>
<td>1.2</td>
<td>.9</td>
<td>.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin C</td>
<td>.5</td>
<td>.9</td>
<td>.5</td>
<td>.5</td>
<td>1</td>
<td>1.1</td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thiamin</td>
<td>.9</td>
<td>1.7</td>
<td>1.1</td>
<td>.1</td>
<td>3</td>
<td>.7</td>
<td>1.4</td>
<td>6.4</td>
<td>1.7</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>3.6</td>
<td>6.5</td>
<td>4.6</td>
<td>1.3</td>
<td>1.7</td>
<td>1.5</td>
<td>.8</td>
<td>1.6</td>
<td>24.7</td>
</tr>
<tr>
<td>Niacin</td>
<td>.2</td>
<td>.3</td>
<td>.2</td>
<td>.2</td>
<td>1</td>
<td>3.2</td>
<td>1.1</td>
<td>2.9</td>
<td>8.2</td>
</tr>
<tr>
<td>Calcium</td>
<td>4.5</td>
<td>8.2</td>
<td>6.7</td>
<td>4.2</td>
<td>1.5</td>
<td>1.1</td>
<td>.1</td>
<td>.1</td>
<td>.1</td>
</tr>
<tr>
<td>Iron</td>
<td>.1</td>
<td>.1</td>
<td>.2</td>
<td>.2</td>
<td>1</td>
<td>2.1</td>
<td>.8</td>
<td>1.9</td>
<td>4.9</td>
</tr>
</tbody>
</table>

a Based on U.S. RDA, 2300 kcal energy requirement and USDA - HGB #72, 1977 nutrient data.

### FUTURE NEEDS

Although animal products currently represent excellent sources of nutrients, they can be improved. As with any natural foodstuff, many beneficial nutrient interactions still undiscovered potentially exist among animal products and between animal products and other foods. Further research should document these benefits for human health. The animal industry should be aware of consumer needs and wants. For instance, fortified or modified products may be desired for certain populations. There continues to be a tremendous need for effective nutrition education which stresses caloric moderation and emphasizes consumption of a variety of foods.

### CONCLUSION

Animal products occupy a unique position in human nutrition. They are nutrient dense and represent convenient sources of highly bioavailable nutrients. The overall quality and quantity of their nutrient profile upgrade the lower quality of foods from plants. Animal products are fundamental to the achievement of a nutritionally adequate diet. They have contributed in a major way to our present quality of life and nutritional well-being.

### REFERENCES


OUR INDUSTRY TODAY