NUTRIENT COMPOSITION OF SELECTED WHEAT PRODUCTS[1]

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ABSTRACT

Commercial practices in processing and baking all types of wheat products in the U.S. and customary practices in baking around the world must be carefully considered in developing values for the Nutrient Data Bank and for the tables of food composition. The nutrient content of the flour ingredient has a marked effect on the nutrients in breads, crackers, pastry, and pastas. For baked products—cakes, cookies, etc.—which are lower in proportion of flour, nutrient content is greatly influenced by ingredients other than flour. Nutritive values for some wheat products have changed somewhat since U.S. Department of Agriculture *Handbook 8* was prepared in 1963. Breads are made with little or no milk today. Added calcium salts have altered the content of this mineral element. Crackers, cookies, and snack items are, in general, made with enriched flour. Cake mixes, most often formulated with enriched flour, vary between brands in several mineral elements. Foreign-type breads are commanding more interest today for the tables of food composition than in the past. Extraction rate of the flour, heat penetration, and added ingredients have the most marked effects on their nutrient content.

Today's commercial practices in processing and baking all types of wheat products in the U.S. must be carefully considered in developing values for the Nutrient Data Bank (NDB) and for the revision of *Agriculture Handbook No. 8*, "Composition of Foods: Raw, Processed, Prepared"(1). A multitude of factors can influence nutrient content of these foods. Of particular importance for future reference are customary practices in the preparation and processing of various wheat foods in different countries of the world. An NDB facility is being made ready for cooperation with the Food and Agriculture Organization, United Nations, to provide nutrient data on foods from different parts of the world.

FACTORS INFLUENCING NUTRIENT CONTENT

The base line for nutrient content of all wheat products which are high in proportion of flour depends largely on the nutrient content of the flour. Today's higher extraction rates for flour have influenced the content of several important nutrients. Important data on these flours will be invaluable for our future development of values for the revision of *Agriculture Handbook No. 8*.

Breads, crackers, pastry, and pastas contain a high proportion of flour. Other wheat products contain lesser amounts and show less influence of the nutrients in the flour ingredient and more influence of nutrients from other ingredients. Enriched flour, used in most commercially made processed and baked products today, contributes significantly to the levels of vitamins, thiamin, riboflavin, and niacin, and the mineral element, iron. Federal Standards of Identity for enriched white flour and enriched white bread which became effective in July 1975 specify the permissible levels of these added nutrients, although the proposed increased

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level for iron enrichment has been stayed pending further consideration by the Commissioner of the Food and Drug Administration. In recent years, particular attention has been given to the form of added nutrients used in the enriched or fortified product because of great differences in bioavailability. When principles can be established for bioavailability of the various forms of natural and added nutrients or interactions of nutrients in a food, nutritive values will be expressed on the appropriate basis.

In addition to the basic ingredient, flour, the types and amounts of other ingredients, used in either the formulations or as treatments, will influence nutrient content of the finished products. Other factors that can change nutrient content are fat absorption rate, as in frying of doughnuts, and water absorption as in cooking of pasta products. Temperature of baking or processing, type of heating equipment, and special treatments can have marked influences on nutrient content of the finished products. As expected, the nutrient content of cakes and of some types of cookies and crackers is greatly influenced by factors other than the flour ingredient.

The composition of processed wheat products, such as commercial bulgur, varies somewhat between samples of wheat (2). On the whole, the processing treatment causes a small reduction in protein, fat, and fiber. The moist-heat processing treatment causes a slight removal of protein-rich bran and oil-rich germ tissue which is reflected in the values. This parboiling treatment of wheat causes consistent increases in content of iron, copper, and calcium, as shown in Table I.

CHANGES IN NUTRIENT CONTENT SINCE THE 1960s

Until the past 5 to 10 years, most bread was made by conventional dough methods using 4 to 6% nonfat dry milk (NFDM). Because of a variety of factors that weaken the dough structure, continuous-mix breads were made with reduced levels of 1 to 2% NFDM. Nutritive values for breads in *Handbook 8* (1) reflect these formulations. Today, the prohibitive cost of NFDM for the baker has caused a rapid decrease in the frequency of use of NFDM and in the amount used in bread formulations. Many bakers are using reconstructed milks (3,4). Their use would be expected to make some change in the nutrient content of white bread, as indicated in Table II. The 1976 values reflect the use of reconstructed milks which are various combinations of caseinate, whey, and soy

TABLE I
Effects of Processing on Nutrients in Bulgur[a]

Food	Fe mg/100 g	Cu mg/100 g	Ca mg/100 g
Wheat	6.6	0.39	16.7
Bulgur	7.8	0.41	22.6

[a]Pence *et al.* (2).

flour. Some formulas contain NFDM. The increased calcium, iron, and fat levels can be attributed to the presence of the soy flour. A higher fat level in the formulation for bread can improve the flavor and crumb texture. Higher calcium content of present-day breads can be explained by the increased use of calcium caseinate, various calcium salts as dough improvers, and calcium propionate as a mold inhibitor.

For a number of products in the cookie and cracker category, changes in processing and in the use of enriched flour today significantly increase content of several nutrients in the finished product. Since 1963, when *Handbook 8* (1) was published, commercial practices have been modified to reduce moisture content and thus lengthen shelf life, often with the aid of butylated hydroxyanisole and butylated hydroxytoluene (BHA and BHT).

With the use of enriched flour, saltines now contribute significant amounts of Fe, thiamin, riboflavin, and niacin (Table III). The high value for calcium may be explained by the important contribution of yeast in the formulation. Pretzels also show dramatic increases in four of the above nutrients (Table IV). Another example of significant change in some nutrients with changes in processing practices today is shown for chocolate chip cookies in Table V. For the most part, the increase in nutrient content of saltines, pretzels, and chocolate chip cookies can be attributed to the almost universal use of enriched flour in these products.

TABLE II
Selected Nutrients in White Bread[a]

Nutrient	*Handbook 8* **(1963)**	**1976 Values**
Protein, g[b]	8.7	8.4 (7.8–9.1)
Fat, g	3.2	4.6 (4.0–5.0)
Ca, mg	84	121 (95–143)
Fe, mg	2.5	3.2 (1.9–4.1)
Mg, mg	22	21 (16–24)

[a]As-is moisture basis.
[b]N × 5.7.

TABLE III
Selected Nutrients in Saltines

Nutrient	*Handbook 8* **(1963)**[a] **mg/100 g**	**1976**[b] **Values mg/100 g**
Ca	21	164
Fe	1.2	4.8
Thiamin	0.01	0.45
Riboflavin	0.04	0.46
Niacin	1.0	3.9

[a]4% Moisture content.
[b]2% Moisture content.

DIFFERENCES IN NUTRIENT CONTENT AMONG BRANDS OR TYPES OF PRODUCTS

In a comparison of nutrient content of Brands A and B angel food cake mix, Ca, Fe, thiamin, and riboflavin differed significantly (Table VI), yet proximate components (not shown here) were about the same. Calcium and riboflavin values for Brand A were nearly twice those of Brand B. This difference between brands can be attributed to the presence of calcium phosphate and enzyme-modified soy protein in Brand A. The higher levels of Fe and thiamin in Brand B mix can be explained by the use of enriched flour in this brand and not in the other.

TABLE IV
Selected Nutrients in Pretzels

Nutrient	*Handbook 8* (1963)[a] mg/100 g	1976[b] Values mg/100 g
Fe	1.5	4.3
Thiamin	0.02	0.34
Riboflavin	0.03	0.25
Niacin	0.7	4.2

[a]4.5% Moisture content.
[b]2.3% Moisture content.

TABLE V
Selected Nutrients in Chocolate Chip Cookies[a]

Nutrient	*Handbook 8* (1963) mg/100 g	1976 Values mg/100 g
Fe	1.3	2.6
Thiamin	0.04	0.24
Riboflavin	0.07	0.40
Niacin	0.40	2.08

[a]Approximately 3% moisture content.

TABLE VI
Selected Nutrients in Angel Food Cake Mix[a]

Nutrient	Brand A mg/100 g	Brand B mg/100 g
Ca	146	76
Fe	0.32	0.54
Thiamin	0.01	0.03
Riboflavin	0.45	0.24

[a]As-is moisture basis.

Some examples of variability in mineral element content of banana cake mix are seen in Table VII. These two brands differ in kinds of ingredients. Brand A contains particles of dried fruit, whereas Brand B does not. Proximate components and the B-vitamins—thiamin, riboflavin, and niacin (not shown)—were about the same for the two brands.

Brand B white cake mix (Table VIII) was somewhat higher in fat, calcium, and phosphorus than Brand A. Ingredients in Brand B mix that can cause this variation were whey, nonfat dry milk, and egg yolk. In Table IX, fat content of Brand B yellow cake mix is shown to be higher than Brand A. Full-fat soy flour is used in the mix of higher fat content, whereas defatted soy flour is used in the other. Higher calcium and phosphorus contents in Brand A yellow cake mix, however, can be attributed to the use of nonfat dry milk, whey, and calcium caseinate in Brand A but not in Brand B.

DIFFERENCES IN COMPOSITION OF PASTA PRODUCTS

Table X shows values for selected nutrients in comparable samples of macaroni and noodles. The presence of egg solids in noodles can explain the

TABLE VII
Selected Mineral Elements in Banana Cake Mix[a]

Nutrient	Brand A	Brand B
Ca, mg	318	25
Fe, mg	2.09	1.34
P, mg	376	162

[a]As-is moisture basis.

TABLE VIII
Selected Nutrients in White Cake Mix[a]

Nutrient	Brand A	Brand B
Fat, g	9.8	12.7
Ca, mg	196	277
P, mg	308	347

[a]As-is moisture basis.

TABLE IX
Selected Nutrients in Yellow Cake Mix[a]

Nutrient	Brand A	Brand B
Fat, g	11.7	14.8
Ca, mg	175	82
P, mg	381	349

[a]As-is moisture basis.

higher levels of protein, fat, calcium, and vitamin A than of those nutrients in macaroni which customarily contain no egg. The widespread use of pasta products as meat extenders or primary ingredients in main dishes can account for increased interest in increasing protein and mineral element content of pastas. Glabe *et al.* (5) and Seibles (6) reported on nutrient content of macaroni made with added NFDM or whey protein. The use of either defatted or full-fat soy flour in pastas at the 15% level increases protein content up to 15 to 17% (7). Soy pastas have been accepted for use by the U.S. military establishments, government feeding programs, and school lunches.

NUTRIENT COMPOSITION OF FOREIGN-TYPE BREADS

As mentioned previously, the Consumer and Food Economics Institute of U.S. Department of Agriculture is interested in providing tables of food composition for international use as well as tables including ethnic foods for use in the U.S. Some examples of nutrient data on foreign-type breads are discussed here.

For Russian-type yeast-leavened breads, the mineral element content of Cu, Zn, and Mn was higher in breads made with medium-type rye flour than with light rye flour (8) (Table XI). Dark rye breads were highest in Mn. In medium and dark rye breads there was no difference in Cu content or Zn content.

In the Sudan, where wheat is in limited supply, scientists have experimented with a composite flour containing one part of stone-ground sorghum meal and nine parts of 82% extraction wheat flour (9). The protein content of bread made with this composite flour was 13.0% compared with 12.9% for breads made with all wheat flour. Cost savings and extension of the wheat supply appear to warrant

TABLE X
Nutrient Composition of Typical Macaroni and Noodles[a]

Nutrient	Macaroni	Noodles
Protein, g	12.3	13.7
Fat, g	1.8	5.0
Ca, mg	28	48
Vitamin A, IU	trace	44

[a]As-is moisture basis.

TABLE XI
Rye Bread (Russian)[a]

Flour Type	Cu mg/100 g	Zn mg/100 g	Mn mg/100 g
Light	0.21	0.03	0.40
Medium	0.58	0.08	1.30
Dark	0.54	0.08	1.60

[a]Barsargin *et al.* (8).

the use of the composite flour. Data on content of other nutrients in these breads are lacking. In continuing this research 5% peanut paste (ground peanuts including skins) was used to increase protein content of 13.5% in the composite flour mixture and replace an additional 5% of wheat flour. Breads made with this added protein source were not considered acceptable since the appearance of the peanut skins of the bread was objectionable.

Scientists of the Department of Food Science and Technology (10) in Alexandria, Egypt, studied effects of processing and cooking on nutritive value of their typical breads—balady, shamy, and fino. Balady, made with 87.5% extraction flour and baked only 1.5 min, was, as expected, highest in the B-vitamins, thiamin, riboflavin, and niacin (Table XII). The two breads made with 72% extraction flour—shamy and fino—were similar in content of these vitamins.

In other research (11), nutrient contents of several Iranian breads—sangak, taftoon, barbari, lavash, and village—were compared. Taftoon and village breads were made with whole-wheat flour; barbari and lavash with white flour; and sangak with a blend of these two flours. Village-type bread was lowest in protein (about 7%) since several ingredients other than flour were added in the dough-mixing of this Western-type bread. Protein content of the other breads, in general, was related to the type of flour and ranged between 8.2 and 9.3%. Breads made with white flour were lower in protein than those with all whole-wheat flour or with a blend of whole-wheat and white flour. Niacin content of these breads varied concomitantly with the extraction rate of the flour, 2.6 to 5.2 mg/100 g bread. Riboflavin values were nearly identical for all breads (.04 mg/100 g) except village bread for which the value was slightly higher (.06 mg/100 g). Thiamin for three of the breads ranged between 0.33 and 0.36 mg/100 g. Barbari, lowest in thiamin (.20 mg/100 g), is made using $NaHCO_3$ and is baked over hot gravel. Those two factors contribute to the destruction of thiamin. Also relatively low in thiamin was village bread (.26 mg/100 g), which reflected the dilution of the flour with other ingredients.

Since many Iranians are known to have a deficiency of vitamin A in their diets, the advisability of fortifying sangak was investigated at the Department of Human Ecology, University of Tehran (12). Vitamin A palmitate and vitamin A acetate were each used in combination with yeast in the preparation of these breads. Vitamin A acetate was more stable to the preparation procedures of these breads (74% retention), in contrast to 68% for vitamin A palmitate.

At the American University of Beirut, scientists in the Division of Food Technology and Nutrition investigated the effects of baking conditions on the

TABLE XII
Selected Nutrients in Egyptian Breads[a]

Egyptian Bread	Thiamin mg/100 g	Riboflavin mg/100 g	Niacin mg/100 g
Balady	0.362	0.100	2.217
Shamy	0.138	0.032	1.657
Fino	0.063	0.035	1.479

[a]Dry basis.

retention of thiamin, riboflavin, and niacin in Arabic breads (13) of the brown and the white types. Loss of niacin was negligible under all conditions of baking. Riboflavin decreased in baking between 10 and 20% in white Arabic breads and between 20 and 26% in brown Arabic breads. Thiamin loss was also greater for brown breads—31 to 43% compared to 25% for white Arabic breads. The losses of B-vitamins in Arabic breads are greater than in European-type breads because the former are thinner and are exposed to greater heat penetration.

Further research with white Arabic breads (14) supplemented with soybean flour and chickpea flour confirmed the improvement in protein content and the importance to residents in the Middle East. Levels of 4, 6, 8, and 10% soybean flour and 10, 20, 30, 40, and 50% chickpea flour were investigated. Soybean flour was processed, defatted, and steam-heated, and chickpea flour was made by grinding raw chickpeas. Lysine content of Arabic breads increased from 140 mg/g N for the control bread to 234 and 244 mg/g N upon the addition of 8 and 10% soybean flour and to 244 mg/g N upon the addition of 30% chickpea flour.

Nutrient content of chapaties, a staple food of India, has been investigated from time to time. Extraction rate and source of flour as well as variation in heat of processing affect nutrient content of the finished product. Scientists at the Indian Agricultural Research Institute in New Delhi (15) have been concerned about total and phytic phosphorus in chapati dough kept at 32° (±2)° C for 0 to 2 hr, commonly used prior to preparation of chapaties. Holding chapati dough caused no loss in phytic phosphorus. No destruction of phytic acid was found in baking chapaties at 450° F for 2.5 min. Future NDB research should consider the presence of phytic acid in foods in relation to the content of the mineral elements, P, Zn, and Fe.

Biancani (16) in Tunis compared zinc contents of flour and bran with zinc contents of comparable selected baked products such as bran pastry, egg pastry, biscuits, and bread sticks. From the ingredients added to bran, the zinc content of bran pastry increased 7%. Zinc in egg pastry was 33% higher than in the flour, bread sticks, 35% higher, and biscuits, 44% higher. These results confirm earlier findings relating to the effects of added ingredients on total nutrient content.

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