Nutrient Composition of Selected Wheats and Wheat Products. V. Carbohydrate

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ABSTRACT

One hundred samples of consumer wheat products were collected and composited to study location effects on their carbohydrate content. The samples were readily available brands of ten products from two cities in five geographical areas of the United States. Reducing and nonreducing sugars, starch, lactose, pentosans, crude fiber, hemicellulose, cellulose, and lignin were determined on those products containing measurable amounts of the constituents. Similar products from different geographical areas did not differ significantly in carbohydrate constituents. Results for the ten products are given. Changes in carbohydrate composition were determined on hard wheat, hard wheat flour, conventional- and continuous-mix white breads; soft wheat, soft wheat cake and cracker flours, cakes and crackers; and durum wheat, semolina, and macaroni. Constituent increases in flours over wheats from which they were milled, and in products over flours from which they were prepared, indicated addition of the constituent from another source or changes due to processing or preparation, or both; conversely, decreases indicated losses due to processing or preparation, or both. No differences were obtained between the air-classified and conventional milling methods for the total solids and carbohydrate content of the flour.

Approximately 80% of flours and cereal products consumed in the United States comes from wheat products and these products contribute about 37% of the total carbohydrates in the diet (1). Multinutrient composition data for wheat products are very limited and the need for this type of data by nutritionists, dietitians, and other food workers is obvious. Carbohydrate fractions such as crude fiber, cellulose, hemicellulose, and lignin were determined in products containing whole wheat to show their proportion of the total carbohydrates in relation to that of the starches and sugars.

To obtain this information, studies were initiated on the effect of location on the multinutrient content of composites of the most typical, readily available brands of ten consumer wheat products from two cities in five geographical areas in the United States (100 samples). Studies were also initiated on the changes in the multinutrient composition of grains from different geographical areas in the United States, and their products, consisting of 56 samples: (a) hard wheats, hard wheat flours, conventional- and continuous-mix white breads; (b) soft wheats, soft wheat cake, soft wheat cracker flours, cakes, and crackers; and (c) durum wheats, semolinas, and macaroni. This paper is a report on their carbohydrate composition. More detailed information is given in a paper (2) which includes description of the samples, constitutents determined, and collecting, processing, preparing, storing, and distributing the samples.

[1]Retired.

MATERIALS AND METHODS

Total solids, reducing sugar, and starch were determined in all of the products; nonreducing sugar in all products except in the samples of consumer-available breads; lactose–which is an indication of added nonfat dry milk solids–in the breads, biscuit mix, doughnuts, and cake; and pentosans, crude fiber, hemicellulose, cellulose, and lignin in the whole-wheat products including whole-wheat bread, the three cereals, and the wheats.

Modified official assay methods were used for determining reducing sugar, nonreducing sugar, starch lactose, and pentosans (3). Crude fiber was determined by the official AOAC method (4). Hemicellulose, cellulose, and lignin fractions were determined by the neutral-detergent and acid-detergent method of Van Soest and Wine (5). The results for these three fractions are uncorrected for residual nitrogen and the lignin fraction may contain a small amount of cutin.

RESULTS AND DISCUSSION

Location differences for the constituents on the ten consumer-available wheat products were nonsignificant; therefore, results of product by location are not included in this paper (Table I).

Hamburger rolls were higher in reducing sugar; conventional- and continuous-mix breads in starch; and conventional-mix bread in lactose content than were the other breads. To prevent the raised dough from falling just prior to baking, the ingredients for continuous-mix dough contain less milk solids than do those for conventional-mix dough. This is reflected in lower lactose content of breads from the continuous-mix process. However, lactose values for the two processes did not differ greatly.

Wheat flakes cereal was higher in reducing and nonreducing sugar content and lower in starch, pentosan, and fiber fraction content than were the other cereals.

Data in Table II show the effects of milling wheat to flour and producing typical products from each flour under controlled conditions of formula and processing (2). No significant differences among the wheats in any of the carbohydrate constituents except starch were found. The starch content of soft wheat was the highest and durum wheat the lowest. Analyses by Farrell et al. (6) resulted in averages for starch content of 66.4% for seven hard wheats and 66.9% for two soft wheats (dry basis), compared with 63.2% for five hard wheats and 66.2% for four soft wheats of this study. There was a larger variation in the nonreducing sugar content of the wheats than in the other carbohydrate fractions.

There were significant differences among the flours in reducing sugar and starch. Semolina had the most reducing sugar and hard wheat flour the least with cake and cracker flour being the same. Cake and cracker flour had the most starch with hard wheat and semolina flour the least. Farrell et al. (6) obtained averages of 80.3 and 78.2% (dry basis) starch for the seven hard and two soft wheat flours milled from the aforementioned wheats, compared with 75.7 and 79.5%, respectively, for this study. There was a larger variation in the nonreducing sugar content of the flours than in their reducing sugar.

Conventional- and continuous-mix bread were different only in reducing sugar and lactose with the continuous-mix having the most reducing sugar and the least lactose.

TABLE I. TOTAL SOLIDS AND CARBOHYDRATE CONTENT OF WHEAT PRODUCT[a]
(dry weight basis)

Product	No. of Samples	Total Solids %	Reducing Sugar as Dextrose %	Non-reducing Sugar as Sucrose %	Starch %	Lactose %	Pentosans %	Crude Fiber %	Hemi-cellulose %	Cellulose %	Lignin %
Flour	10	87.3	0.35±0.03[b,c]	1.48±0.26	76.5±1.1	d	d	d	d	d	d
Biscuit mix	10	90.4	3.29±0.26	1.40±0.65	61.5±1.6	1.45±0.36	d	d	d	d	d
Conventional-mix bread	10	62.9	7.45±1.04	d	61.6±0.9	2.20±0.38	d	d	d	d	d
Continuous-mix bread	10	62.1	7.86±0.77	d	61.1±2.2	1.66±0.38	d	d	d	d	d
Hamburger rolls	10	65.0	10.03±1.28	d	57.6±0.6	1.41±0.32	d	d	d	d	d
Whole wheat bread	10	61.0	8.76±1.88	d	48.4±1.7	1.80±0.49	6.35±0.20	2.21±0.25	4.97±0.47	2.49±0.22	0.81±0.
Doughnuts	10	75.8	4.05±1.08	15.86±1.18	45.8±1.5	2.33±0.47	d	d	d	d	d
Whole wheat cereal to cook	10	90.6	0.70±0.05	3.12±0.69	64.8±1.6	d	7.02±0.74	2.14±0.20	5.99±0.31	2.12±0.40	0.98±0.
Shredded wheat cereal	10	92.0	1.09±0.33	2.68±0.20	63.2±1.3	d	7.14±0.42	2.66±0.16	7.11±0.50	2.94±0.45	0.76±0.
Wheat flakes cereal	10	95.2	6.89±1.00	8.12±0.91	44.3±0.7	d	6.24±0.36	1.97±0.11	4.07±0.56	2.08±0.24	0.85±0.

[a]Ten city means.

[b]Standard deviation.

[c]Maltose.

[d]Not measurable.

TABLE II. TOTAL SOLIDS AND CARBOHYDRATE CONTENT OF WHEATS→FLOURS→PRODUCTS
(dry weight basis)

Product	No. of Samples	Total Solids %	Reducing Sugar as Dextrose %	Non-reducing Sugar as Sucrose %	Starch %	Lactose %	Pentosans %	Crude Fiber %	Hemi-cellulose %	Cellulose %	Lignin %
Hard wheat	5	89.0	0.55±0.02[a]	2.92±0.20	63.2±1.7	[b]	7.62±0.23	2.47±0.18	6.45±0.19	2.71±0.32	0.67±0.06
Hard wheat flour	5	86.4	0.19±0.03[c]	1.45±0.16	75.7±0.8	[b]	[b]	[b]	[b]	[b]	[b]
Conventional-mix bread	5	62.7	6.97±0.61	0.39±0.04	62.6±0.5	2.60±0.05	[b]	[b]	[b]	[b]	[b]
Continuous-mix bread	5	63.6	8.69±0.84	0.33±0.03	62.0±0.7	2.06±0.09					
Soft wheat	4	89.3	0.55±0.02	3.25±0.26	66.2±1.1	[b]	7.27±0.39	2.54±0.14	6.29±0.43	2.30±0.08	0.54±0.17
Soft wheat cake flour	6	88.0	0.27±0.02	1.66±0.17	80.2±1.3	[b]	[b]	[b]	[b]	[b]	[b]
Cake	6	73.7	3.40±0.23	34.58±0.88	24.7±0.8	2.11±0.05	[b]	[b]	[b]	[b]	[b]
Soft wheat cracker flour	7	88.2	0.27±0.02	1.90±0.27	78.9±1.7	[b]	[b]	[b]	[b]	[b]	[b]
Crackers	7	95.3	0.83±0.11	0.27±0.06	67.8±1.0						
Durum wheat	2	89.5	0.59±0.00	3.03±0.06	61.2±0.5	[b]	7.43±0.00	2.77±0.01	6.24±0.32	2.71±0.07	0.60±0.02
Semolina	2	85.6	0.37±0.00	1.77±0.05	73.4±0.7	[b]	[b]	[b]	[b]	[b]	[b]
Macaroni	2	90.4	2.19±0.20	1.91±0.09	70.7±0.0	[b]	[b]	[b]	[b]	[b]	[b]

[a]Standard deviation.

[b]Not measurable.

[c]Maltose.

Table II shows the influence of milling the wheats to produce the flours, and of preparing the products from the flours. When the four types of flour were milled from the three types of wheat, decreases in reducing and nonreducing sugar and increases in starch occurred in all the flours. Hemicellulose, cellulose, and lignin made up about 10% of the whole wheat. There was no significant difference among the three types of wheat, hard, soft, and semolina. Pentosans which are an indication of hemicellulose and some cellulose were about 7% and crude fiber which is mostly cellulose and lignin was about 2.5%. Conventional- and continuous-mix breads prepared from hard wheat flour had large increases in reducing sugar, and decreases in nonreducing sugar and starch. Cake prepared from soft wheat cake flour showed an increase in reducing sugar, a very large increase in nonreducing sugar (sucrose added), and a large decrease in starch. Crackers prepared from soft wheat cracker flour had an increase in reducing sugar and a decrease in nonreducing sugar and starch. Macaroni prepared from semolina increased in reducing sugar but little change occurred in nonreducing sugar and starch. In general, constituent increases in flours over wheats from which they were prepared indicate addition of the constituent from another source or changes due to processing or preparation, or both; conversely, decreases indicate losses due to processing and preparation, or both.

There were no significant differences in any of the carbohydrates between the air-classified and conventional-milled flours.

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[Received March 28, 1969. Accepted June 1, 1970]