Evaluation of the Nutrient Composition of Wheat. II. Proximate Analysis, Thiamin, Riboflavin, Niacin, and Pyridoxine[1,2]

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ABSTRACT

Wheats from five market classes with four subclasses of white wheat, comprising 406 samples, 231 varieties, and representing three crop years and 49 growing locations were evaluated for proximate and vitamin composition (thiamin, riboflavin, niacin, and pyridoxine). All values except moisture were expressed on a dry weight basis. Moisture had a range of 7.8–14.8%, with an overall mean of 11.4 ± 0.23%. Differences in moisture were significant only by year. Protein had a range of 8.3–19.3%, with an overall mean of 13.85 ± 0.16%. Differences in protein were significant by year, by class, and by growing location. Ash content ranged from 1.17 to 2.96%, with an overall mean of 1.8 ± 0.23%. Differences in ash content were significant by year, class, and growing location. Carbohydrate content (nitrogen-free extract) ranged from 65.4 to 78.9%, with an overall mean of 72.4 ± 0.18%. Differences in carbohydrate were significant only by class. Thiamin ranged from 0.33 to 0.65 mg/100 g, with an overall mean of 0.46 ± 0.005 mg/100 g. Differences in thiamin content were significant by year, class, and growing location. Riboflavin ranged from 0.10 to 0.17 mg/100 g, with an overall mean of 0.13 ± 0.001 mg/100 g. Differences in riboflavin were significant by class and by location. Niacin ranged from 3.8 to 9.3 mg/100 g, with an overall mean of 5.5 ± 0.07 mg/100 g. Differences in niacin content were significant only by year. Pyridoxine ranged from 0.16 to 0.79 mg/100 g, with an overall mean of 0.46 ± 0.009 mg/100 g. Pyridoxine varied significantly by year and by class. Growing location exerted an influence sufficient to reduce the components of Centurk wheat from Alliance, NE, and Bozeman, MT, to a level that would prohibit Generally Recognized as Safe status if they were submitted as a substitute for Centurk.

Senti and Rizek (1975) addressed the problem of maintenance of nutrient levels in horticultural crops and concluded that "development of new crop varieties with improved agronomic characteristics is one of the factors which contributes to increased agricultural production." Furthermore, they noted that the nutrient composition of new crop varieties must be monitored in order to evaluate their potential impact on the dietary intake of population groups. Such an evaluation can be based on the nutrients for which a food makes a significant contribution to the mean national intake. A significant contribution was defined as 5% of the mean national intake by the Task Group on Generally Recognized as Safe (GRAS) status of new plant varieties. Additionally, a change of 20% in the content of a nutrient or an increase of 10% of a toxicant was defined as significant by the Food and Drug Administration. Senti and Rizek (1975) also noted that current FDA regulations, specifically Title 21 of the Code of Federal Regulations 121.3, will not permit GRAS status to a new variety if "significant alteration of composition by breeding or selection" has taken place and if the "change may reasonably be expected to alter to a significant degree the nutritive value or the concentration of toxic constituents therein."

Wheat is an important source of protein, thiamin, niacin, vitamin B_6 (pyridoxine), and magnesium, providing 14.2, 9.7, 8.3, 5.4, and 14.5% of the national per capita average intake, respectively (Senti and Rizek 1975). As a result of a need for a broad baseline of information on the composition of a wide range of varieties and classes of wheat, a cooperative project involving the University of Idaho, Oregon State University, and Washington State University was funded by the National Wheat Institute. This article reports the proximate composition (except for fat), thiamin, riboflavin, niacin, and pyridoxine content of varieties and classes of wheat from commercially used seed lines and from new and potential releases. Lipid composition was reported previously (Davis et al 1980). This information will help to establish a broad baseline of nutrient composition information on wheat that should be of value for wheat breeders, enforcement agencies, nutritionists, and all others with an interest in the nutrient composition of wheat.

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MATERIALS AND METHODS

Samples

The samples include those described previously (Davis et al 1980) plus an additional 116 samples, giving a total of 406. The sampling procedure resulted in samples of 231 varieties from 49 growing locations. The sampling resulted in only a few varieties replicated in numerous locations for more than one crop year. Thus, statistical analyses for variety or location effects should be considered only as indicators or trends. Five market classes of wheat with four subclasses of white wheat were evaluated: hard red winter (HRW), hard red spring (HRS), soft red winter (SRW), durum, and the white wheats—soft white winter (SWW), soft white spring (SWS), hard white winter (HWW), and hard white spring (HWS).

Methods

Samples were sealed in moisture-proof bags and stored at −10° C. Samples were ground for 2 min in a Chemical Rubber Company micromill just before analysis. The samples were analyzed as rapidly as possible to minimize changes that might occur during storage. A sample was considered to be one variety from one location for one crop year. All results were expressed on a dry weight basis.

Moisture, protein, and ash were determined on ground whole wheat samples in duplicate using AOAC methods 14.003, 14.026, and 14.018, respectively (1970). Fat has been previously reported (Davis et al 1980). Carbohydrates were calculated by differences, including previously reported fat values. Thiamin, riboflavin, niacin, and total pyridoxine, with pyridoxine as a standard, were determined using AOAC (1970) methods 39.024–39.029, 39.040–39.042, 39.080–39.081, and 39.142–39.147, respectively. These analyses were done at the Oregon State University analytical laboratory.

Analysis of variance (ANOVA) was done by computer using the Harvey Procedure of the Statistical Analysis system (Harvey 1977). Least significant differences were calculated according to Steel and Torrie (1960) only in instances where significant F values were found.

RESULTS AND DISCUSSION

Results of analysis for proximate composition are presented in Table I and of vitamin analysis in Table II. Where individual varieties are discussed, the material in parentheses identifies the variety, class, location, and year, in that order.

Moisture

Moisture values had an overall mean of 10.4 ± 0.11% and ranged from 7.8 (Blueboy, SRW, Blacksburg, VA, 1974) to 14.8% (VHO 73073, HRS, Pullman, WA, 1975). Differences were significant by year, with 1975 wheats having significantly more moisture (10.9%) than the other two years had. This was not surprising because 1975 was a wet harvest year. The high moisture content of the 1975 wheats, coupled with differences in lipid constituents (Davis et al 1980), and an elevated amylase content [6] suggest that germination had started to take place in some of the 1975 wheat samples.

Protein

Protein content ranged from 8.3% (OWW68-134-IM6, SWW, Pullman, WA, 1975) to 19.3% (SD 2289 and SD 2254, HRS, Brookings, SD, 1975). Differences in protein content were significant by year, by class, and by growing location. Wheat from the 1973 crop had a range of protein from 10.4% (Gaines, SWW, Corvallis, OR) to 16.5% (Adams, SWS, Corvallis, OR) with an average of 13.0%. In 1974 the range was from 8.40% (Nugaines, SWW, Pendleton, OR) to 18.4% (Olaf, HRS, St. Paul, MN), with an average of 13.3%, and in 1975 the range was from 8.3% (OWW68-134-IM6, SWW, Pendleton, OR) to 19.3% (SD 2254, HRS, Brookings, SD). The range of values is greater than that reported by Kulp et al (1980) but also encompasses a wider variety of wheats, some of which are new high-protein lines. Additionally, samples used by Kulp et al (1980) were blends taken from commercial mills. This range of values is quite similar to that reported by Holland and Ritchie (1941) of 11.84–21.48% for soft wheat and No. 3 hard amber durum, respectively. By class, HRS wheats, with an average of 15.5 ± 0.24%, had the highest protein content, followed closely by durum, with 15.4 ± 0.45%. Other average protein values were 14.2, 14.1, 13.0, 12.8, 12.1, and 11.5% for SWS, HRW, HWS, SRW, HWW, and SWW, respectively.

[6]Unpublished data.

TABLE I
Wheat—Proximate Composition (%) by Class and by Year[a,b]

Class or Subclass[c]	Year	No. of Samples	H_2O	Protein	Ash	Carbohydrate
SWW	1973	22	9.48 ± 0.26	12.35 ± 0.23	1.55 ± 0.04	74.68 ± 0.22
	1974	35	9.94 ± 0.08	11.27 ± 0.20	1.73 ± 0.04	75.29 ± 0.24
	1975	49	11.41 ± 0.23	11.37 ± 0.25	1.73 ± 0.03	74.12 ± 0.24
	All	106	10.52 ± 0.20	11.54 ± 0.25 a	1.69 ± 0.04 c	74.63 ± 0.24 a
	80% of mean		8.41	9.23	1.35	59.70
SWS	1973	7	9.62 ± 0.60	13.52 ± 0.67	1.68 ± 0.07	72.80 ± 0.54
	1974	6	8.93 ± 0.16	14.54 ± 0.88	2.10 ± 0.06	71.60 ± 1.37
	1975	5	10.17 ± 0.27	14.80 ± 0.45	1.99 ± 0.09	71.35 ± 0.47
	All	18	9.54 ± 0.41	14.22 ± 0.70 b	1.91 ± 0.07 b	72.00 ± 0.89 c
	80% of mean		7.63	11.37	1.52	57.60
HWW	1973	3	9.43 ± 0.85	12.73 ± 0.14	1.55 ± 0.09	74.18 ± 0.31
	1974	3	9.77 ± 0.30	11.49 ± 1.22	1.78 ± 0.15	75.73 ± 0.57
	Both	6	9.60 ± 0.64	12.11 ± 0.87 d	1.66 ± 0.12 c	74.96 ± 0.46 a
	80% of mean		7.68	9.69	1.33	59.96
HRW	1973	7	9.79 ± 0.55	14.17 ± 0.36	1.62 ± 0.06	72.59 ± 0.40
	1974	57	9.28 ± 0.10	13.94 ± 0.18	1.88 ± 0.03	73.02 ± 0.18
	1975	60	11.04 ± 0.16	14.26 ± 0.21	1.81 ± 0.03	71.66 ± 0.23
	All	124	10.16 ± 0.18	14.11 ± 0.21 b	1.83 ± 0.03 c	72.34 ± 0.22 c
	80% of mean		8.12	11.29	1.47	57.87
HRS	1973	7	9.38 ± 0.45	13.63 ± 0.26	1.51 ± 0.06	73.01 ± 0.33
	1974	18	10.24 ± 0.35	15.23 ± 0.40	1.85 ± 0.11	70.94 ± 0.56
	1975	78	10.36 ± 0.20	15.79 ± 0.18	2.01 ± 0.03	70.18 ± 0.25
	All	103	10.27 ± 0.25	15.54 ± 0.24 a	1.95 ± 0.05 b	70.51 ± 0.33 d
	80% of mean		8.22	12.44	1.56	56.40
SRW	1974	6	9.39 ± 0.42	12.45 ± 0.74	1.98 ± 0.05	73.30 ± 0.85
	1975	10	11.90 ± 0.37	12.97 ± 0.41	2.02 ± 0.03	71.68 ± 0.40
	Both	16	10.96 ± 0.39	12.78 ± 0.56 c	2.00 ± 0.04 a	72.29 ± 0.61 c
	80% of mean		8.98	10.22	1.60	57.83
HWS	1974	2	9.78 ± 0.14	12.36 ± 1.70	1.83 ± 0.13	74.66 ± 1.86
	1975	3	9.36 ± 0.22	13.41 ± 0.16	1.60 ± 0.06	73.60 ± 0.13
	Both	5	9.53 ± 0.19	12.99 ± 0.08 c	1.69 ± 0.09 d	74.02 ± 1.18 b
	80% of mean		7.62	10.39	1.35	59.22
Durum	1974	7	10.65 ± 0.30	14.68 ± 0.66	1.98 ± 0.06	71.28 ± 0.77
	1975	21	11.20 ± 0.43	15.62 ± 0.34	1.99 ± 0.02	70.14 ± 0.67
	Both	28	11.06 ± 0.40	15.39 ± 0.45 a	1.99 ± 0.04	70.42 ± 0.70 d
	80% of mean		8.85	12.31	1.59	56.34
All	1973	46	9.53 ± 0.19 b	13.03 ± 0.19 c	1.57 ± 0.03 c	73.79 ± 0.20
	1974	134	9.66 ± 0.08 b	13.34 ± 0.17 b	1.85 ± 0.02 b	73.28 ± 0.20
	1975	226	10.92 ± 0.11 a	14.30 ± 0.15 a	1.89 ± 0.02 a	71.66 ± 0.17
	All	406	10.35 ± 0.11	13.84 ± 0.16	1.74 ± 0.02	72.44 ± 0.18
	80% of mean		8.78	11.07	1.47	57.95

[a]Results are expressed as mean ± SEM on a dry weight basis.
[b]Values with a column followed by different letters are significantly different at the 0.05 level, using least significant differences.
[c]SWW = soft white winter, SWS = soft white spring, HWW = hard white winter, HRW = hard red winter, HRS = hard red spring, SRW = soft red winter, HWS = hard white spring.

Among the high-protein lines was Lancota, which was released in 1975. Johnson (1978) reported 13.9–17.9% protein in Lancota from four growing locations. We observed 13.9% protein in Lancota from Alliance, NE, 1975. Centurk, another high-protein wheat, ranged from 10.9 (Wauneta, NE) to 15.6% protein (Altus, OK) in the 1974 crop, with 11 growing locations. In the 1975 crop, Centurk from four growing locations ranged from 10.7 (Alliance, NE) to 17.4% protein (Bushland, TX). Johnson (1978) reported 10.0–15.6% protein in Centurk representing four growing locations.

Ash

Ash content ranged from 1.17 (Luke and Nugaines, SWW, Walla Walla, WA, 1973) to 2.96% (Sentinel, HRW, Mead, NE, 1974). Significant differences were found in ash due to year, class, and location. The range in 1973 was from 1.17 (Luke and Nugaines, SWW, Walla Walla, WA) to 1.94% (Nugaines, SWW, Corvallis, OR), with a mean of 1.57%. In 1974 the mean was 1.85%, with a range from 1.37 (Luke, SWW, Pullman, WA) to 2.96% (Sentinel, HRW, Mead, NE). The range in 1975 was from 1.26 (VHO 73324, SWW, Pullman, WA) to 2.56% (MN 11-64-27, HRS, St. Paul, MN), with a mean of 1.89%. The overall mean was 1.74%. Of the classes, SRW (2.00%) and durum (1.99%) had the greatest amount of ash, followed by HRS (1.95%), SWS (1.91%) and HWS (1.69%).

Holland and Ritchie (1941) reported a range of 1.72–2.40% ash in wheats; Keagy et al (1980) reported 1.84 for hard and 1.87% for soft wheats; and Kent (1975) reported 1.8% ash in wheat. Thus, our overall mean was similar to those of Keagy et al (1980) and Kent (1975), although our range was greater.

Carbohydrate

Carbohydrate content ranged from 65.4% (Olaf, HRS, St. Paul, MN, 1973) to 78.9% (OWW68-134-IM6, SWW, Pendleton, OR, 1975). Differences in carbohydrate content were significant only by

TABLE II
Wheat—Vitamins B_1, B_2, Niacin, and B_6 by Class and by Year [a,b]

Class or Subclass[c]	Year	No. of Samples	Vitamins (mg/100 g) Thiamin	Riboflavin	Niacin	Pyridoxine
SWW	1973	22	0.45 ± 0.01	0.12 ± 0.002	5.59 ± 0.11	0.41 ± 0.02
	1974	35	0.45 ± 0.01	0.11 ± 0.001	5.19 ± 0.10	0.34 ± 0.01
	1975	49	0.46 ± 0.01	0.12 ± 0.002	5.19 ± 0.08	0.48 ± 0.01
	All	106	0.45 ± 0.01 c	0.12 ± 0.002 c	5.27 ± 0.09	0.42 ± 0.07 d
	80% of mean		0.36	0.09	4.22	0.33
SWS	1973	7	0.46 ± 0.02	0.13 ± 0.006	5.91 ± 0.22	0.49 ± 0.07
	1974	6	0.50 ± 0.01	0.14 ± 0.006	6.00 ± 0.25	0.35 ± 0.041
	1975	5	0.48 ± 0.03	0.14 ± 0.006	4.68 ± 0.22	0.53 ± 0.03
	All	18	0.48 ± 0.02 b	0.14 ± 0.006 a	5.60 ± 0.23	0.45 ± 0.05 c
	80% of mean		0.38	0.11	4.48	0.36
HWW	1973	3	0.47 ± 0.02	0.12 ± 0.007	5.47 ± 0.46	0.44 ± 0.08
	1974	3	0.41 ± 0.03	0.11 ± 0.003	4.33 ± 0.003	0.26 ± 0.06
	Both	6	0.44 ± 0.03 d	0.12 ± 0.005 c	4.90 ± 0.33	0.35 ± 0.07 f
	80% of mean		0.55	0.10	3.92	0.28
HRW	1973	7	0.52 ± 0.02	0.13 ± 0.001	5.84 ± 0.16	0.37 ± 0.05
	1974	57	0.42 ± 0.01	0.13 ± 0.001	5.07 ± 0.08	0.41 ± 0.01
	1975	60	0.48 ± 0.01	0.13 ± 0.001	5.34 ± 0.10	0.52 ± 0.01 c
	All	124	0.45 ± 0.01 c	0.13 ± 0.001 b	5.24 ± 0.10	0.46 ± 0.02
	80% of mean		0.36	0.10	4.20	0.37
HRS	1973	7	0.49 ± 0.01	0.13 ± 0.002	5.17 ± 0.16	0.49 ± 0.05
	1974	18	0.45 ± 0.01	0.13 ± 0.003	5.30 ± 0.14	0.38 ± 0.01
	1975	78	0.50 ± 0.01	0.14 ± 0.002	5.57 ± 0.10	0.57 ± 0.01
	All	103	0.49 ± 0.01 a	0.14 ± 0.002 a	5.50 ± 0.11	0.53 ± 0.02 a
	80% of mean		0.39	0.11	4.40	0.42
SRW	1974	6	0.48 ± 0.02	0.13 ± 0.003	6.70 ± 0.65	0.38 ± 0.02
	1975	10	0.51 ± 0.01	0.13 ± 0.005	6.20 ± 0.14	0.38 ± 0.02
	Both	16	0.50 ± 0.015 a	0.13 ± 0.004 b	6.45 ± 0.41	0.38 ± 0.02 e
	80% of mean		0.40	0.10	5.16	0.30
HWS	1974	2	0.36 ± 0.02	0.12 ± 0.005	4.45 ± 0.45	0.32 ± 0.02
	1975	3	0.45 ± 0.02	0.13 ± 0.000	5.00 ± 0.40	0.58 ± 0.03
	Both	5	0.41 ± 0.02 e	0.13 ± 0.003 b	4.78 ± 0.42	0.48 ± 0.03 b
	80% of mean		0.33	0.10	3.82	0.38
Durum	1974	7	0.39 ± 0.01	0.13 ± 0.006	6.53 ± 0.15	0.37 ± 0.04
	1975	21	0.48 ± 0.01	0.14 ± 0.003	7.59 ± 0.19	0.51 ± 0.02
	Both	28	0.46 ± 0.01 c	0.14 ± 0.004 a	7.32 ± 0.18	0.48 ± 0.03 b
	80% of mean		0.37	0.11	5.86	0.38
All	1973	46	0.47 ± 0.02 b	0.13 ± 0.001	5.61 ± 0.08 a	0.43 ± 0.02 b
	1974	134	0.43 ± 0.01 c	0.12 ± 0.001	5.29 ± 0.07 b	0.38 ± 0.01 c
	1975	226	0.48 ± 0.01 a	0.13 ± 0.001	5.62 ± 0.07 a	0.52 ± 0.01 a
	All	406	0.46 ± 0.01	0.13 ± 0.001	5.51 ± 0.07	0.46 ± 0.01
	80% of mean		0.37	0.10	4.41	0.37

[a] Results are expressed as mean ± SEM on a dry weight basis.
[b] Values within a column followed by different letters are significantly different at the 0.05 level, using least significant differences.
[c] SWW = soft white winter, SWS = soft white spring, HWW = hard white winter, HRW = hard red winter, HRS = hard red spring, SRW = soft red winter, HWS = hard white spring.

class. HWW (75.0%) and SWW (74.6%) had the highest amount of carbohydrate. The classes with highest protein content appeared to have the lowest carbohydrate content, as would be expected. The 74.1–78.6% "soluble carbohydrate" reported by Kent (1975) is within the range of carbohydrate reported in this article.

Thiamin

The overall mean thiamin content was 0.46 mg/100 g. The range was from 0.33 mg/100 g (Scout 66, HRW, Mead, NE, and Adams, HWS, Sherman County, OR) to 0.65 mg/100 g (Itana, HRW, Aberdeen, ID). Significant differences were due to crop year, class, and growing location. In 1973 the range was from 0.37 (McDermid, SWW, Corvallis, OR) to 0.58 mg/100 g (Franklin, HRW, Pendleton, OR), with a mean of 0.47 mg/100 g. The range in 1974 was from 0.33 (Scout 66, HRW, Mead, NE, and Adams, HWS, Sherman County, OR) to 0.57 mg/100 g (Wanser, SWW, Sherman County, OR), with a mean of 0.43 mg/100 g. The range in 1975 was from 0.36 (Eagle, HRW, Manhattan, KS, and NY 5954-35, SWW, Ithaca, NY) to 0.65 mg/100 g (Itana, HRW, Aberdeen, ID), with a mean of 0.48 mg/100 g. SRW wheats had the highest thiamin content (0.50 mg/100 g) and HWS the lowest (0.41 mg/100 g). The overall mean of 0.46 mg/100 g was very close to the 0.466 mg/100 g reported by Keagy et al (1980) for thiamin in wheat grain.

Riboflavin

The overall mean for riboflavin was 0.13 ± 0.001 mg/100 g. The range was from 0.10 (McDermid, SWW, Corvallis, OR, 1973; Coulee, HWW, Pomeroy, WA, 1975; Luke, SWW, Pendleton, OR; and McDermid, SWW, Pullman, WA, 1974) to 0.17 mg/100 g (SD 2403 and SD 2068, HRS, Brookings, SD, 1974). Differences were significant by class and by location. Although class means were statistically different, the range was only from 0.11 to 0.14 mg/100 g. Keagy et al (1980) reported 0.113 or 0.118 mg/100 g, depending on the method of analysis, both less than the overall mean reported in this study but well within the range observed in these wheats. Keagy et al (1980) reported a significant correlation ($r = 0.61$) between protein content and riboflavin content of wheat grain. Perhaps the relatively large number of high protein wheats in this study skewed the riboflavin content so that the mean was higher than in a more "normal" distribution of wheat samples.

Niacin

Niacin had a range of 3.8 (MT 734, HRS, Bozeman, MT, 1975, and Winoka, HRW, Conrad, MT, 1975) to 9.3 mg/100 g (Wells, durum, Fargo, ND, 1975) and 9.1 mg/100 g (Crosby, durum, Fargo, ND, 1975). The overall mean for niacin was 5.5 ± 0.07 mg/100 g. Differences in niacin content were significant only by year, with 1974 having significantly less (5.29 mg/100 g) than the other two years (5.61 in 1973 and 5.62 in 1974). Kent (1975) reported that Manitoba wheat had 7.0 and English wheat 5.0 mg/100 g. The wheats evaluated in our study had a larger range than reported by Kent but encompassed a greater variety of samples.

Total Pyridoxine

Total pyridoxine ranged from 0.16 (Yamhill, SWW, Pendleton, OR, 1974) to 0.79 mg/100 g (Inia 66, HRS, Davis, CA, 1975), with an overall mean of 0.46 ± 0.009 mg/100 g. Pyridoxine varied significantly by year and by class. Wheats from 1975 had the greatest amount of pyridoxine (0.52 mg/100 g), whereas 1974 wheats had the lowest amount (0.38 mg/100 g). This overall mean is markedly higher than the 0.315 mg/100 g reported by Kent (1975). Keagy et al (1980) reported lower values than those reported by others and no significant correlations with grain ash or grain protein. The lower pyridoxine values were attributed by Keagy et al (1980) to an alteration in the analytical method.

Sprouting was associated with an increase of thiamin, riboflavin, and niacin in peas and beans when the data of Fordham et al (1979) were calculated to a dry weight basis. The high levels of amylase activity in some of our samples,[7] the increased levels of some lipid constituents (Davis et al 1980), and the higher levels of lysine[7] all suggest that germination had started in some of these samples. This may help explain why we observed higher mean values for riboflavin than those reported by Keagy et al (1980), for niacin than those reported by Kent (1975), and for pyridoxine than those reported by Keagy et al (1980) or Kent (1975). Additionally, Keagy et al (1980) reported that modifications of the analytical method, especially in extraction of pyridoxine, can result in as much as a 50% increase in pyridoxine values.

Location Effects

Statistically significant location effects were detected for protein, ash, and thiamin, and significant interactions for location and class were found for carbohydrate and riboflavin when all classes and locations were subjected to analysis of variance. Centurk wheat was grown in 11 locations in 1974 and four locations in 1975. The

[7] Unpublished data.

TABLE III
Proximate Analysis and Vitamin Content of Centurk Wheat from 11 Locations in the 1974 Crop and Four Locations in the 1975 Crop[a,b]

		Analysis (%)				Vitamins (mg/100 g)			
Year	Location	H_2O	Protein	Carbohydrate	Ash	Thiamin	Riboflavin	Niacin	Pyridoxine
1974	Manhattan, KS	9.6	12.4 gh	74.1	2.1 b	0.39 g	0.12	5.4	0.36
	Ft. Collins, CO	10.0	12.8 fgh	71.4	1.7 de	0.54 abc	0.12	4.3	0.47
	Bozeman, MT	9.0	14.9 bc	72.5	1.9 bc	0.34 h	0.11	4.1	0.34
	Clay Center, NE	9.1	14.0 cde	72.4	1.9 bc	0.39 g	0.13	5.4	0.52
	Grant, NE	10.4	12.0 h	74.1	1.8 cd	0.39 g	0.15	5.1	0.45
	McCook, NE	10.5	14.3 cd	70.8	2.3 a	0.49 de	0.15	5.6	0.39
	Mead, NE	8.8	13.7 def	73.7	1.8 cd	0.39 g	0.12	4.9	0.37
	No. Platte, NE	9.0	14.1 cd	73.2	1.7 de	0.40 fg	0.13	5.2	0.40
	Wauneta, NE	9.7	10.9 i	75.5	2.0 ab	0.39 g	0.12	5.3	0.37
	Altus, OK	8.6	15.6 b	72.1	1.6 e	0.54 abc	0.13	5.6	0.36
	Goodwell, OK	8.0	14.2 cd	74.5	1.6 e	0.50 cde	0.12	5.3	0.37
1975	Alliance, NE	9.7	10.7 i	75.9	1.4 f	0.51 bcd	0.12	5.2	0.63
	Bushland, TX	11.1	17.4 a	67.9	1.7 de	0.57 a	0.14	4.5	0.42
	Ft. Collins, CO	9.2	14.2 cd	73.1	1.6 e	0.55 ab	0.13	5.5	0.68
	Manhattan, KS	9.8	13.2 efg	73.4	1.9 bc	0.46 e	0.14	5.9	0.52
	Mean ± SD	9.5 ± 0.81	13.6 ± 1.74	73.0 ± 1.98	1.8 ± 0.23	0.46 ± 0.08	0.13 ± 0.01	5.15 ± 0.50	0.44 ± 0.10
	80% of mean	7.6	10.9	58.4	1.44	0.37	0.10	4.12	0.35
	Number below 80% of mean	0	1	0	1	1	0	1	1

[a] Results are the mean of two analyses expressed on a dry weight basis.
[b] Values within a column followed by different letters are significantly different at the 0.05 level using the LSD.

proximate and vitamin composition of those samples are presented in Table III. Using least significant differences, we determined that the 17.4% protein in Centurk from Bushland, TX, was significantly greater than in wheat from any other location. Conversely, the 10.7% protein in Centurk from Alliance, NE, was significantly less than in Centurk wheat from any other location. However, even with this large range of values, only the sample from Alliance, NE, had less than 80% of the mean value for Centurk wheat.

The ash content of the Centurk sample from McCook, NE, was greatest (2.3%), and that from Alliance, NE (1.4%) was significantly less than Centurk from the other growing locations. Again, only one sample, that from Alliance, NE, had less than 80% of the mean value for Centurk wheat.

Thiamin content of Centurk from Bushland, TX (0.57 mg/100 g) was statistically greater than in Centurk wheat from any other location, and coversely, thiamin in Centurk from Bozeman, MT, 1974, was statistically less (0.34 mg/100 g) than that from any other location. Only one sample, that from Bozeman, had less than 80% of the mean value for Centurk wheat.

Although location effects were not significant for niacin and pyridoxine, one location for each produced less than 80% of the mean value for Centurk wheat; that location was Bozeman, MT (0.41 mg/100 g of niacin and 0.34 mg/100 g of pyridoxine).

Title 21 of the Code of Federal Regulations 121.3 prohibits GRAS status for new varieties that do not provide 80% or more of any nutrient for which that plant is considered to be a significant source when compared to the variety the new one is intended to replace. Thus, Centurk from Alliance or Centurk from Bozeman would not be given GRAS status if they were being submitted as "new varieties" to replace the old Centurk.

Interestingly, the nutrients for which wheat is a significant source—protein, thiamin, niacin, pyridoxine—are nearly constant in Centurk wheat from various locations, whereas the lipid constituents of the same samples were highly variable (Davis et al 1980).

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