NOTE ON THE NITROGEN-TO-PROTEIN CONVERSION FACTOR FOR WHEAT FLOUR[1]

R. TKACHUK

The amount of total protein in wheat flour is usually determined by multiplying its Kjeldahl nitrogen content by the factor 5.7. This factor seems to be based on the amount and the nitrogen content of gliadin and glutenin present in wheat flour (1). There are a number of objections to this basis. First, gliadin and glutenin represent only about 78 to 80% of the total flour proteins, and second, it is very difficult to isolate them quantitatively in a pure form, the isolation being further aggravated by the fact that gliadin and glutenin purity remains undefined. These objections and difficulties, coupled with the observation that there are many different proteins present in gliadin and glutenin (2,3) and in the water-soluble proteins (3,4), each containing a different amount of nitrogen, suggest that the present nitrogen conversion factor of 5.7 may not be accurate.

Proteins are high polymers of amino acid residues, amino acid residues being defined as amino acids minus the elements of water. Accordingly, an accurate method of determining the protein/nitrogen factor for proteins is to divide the weight of the amino acid residues present by the weight of nitrogen contained in them. A similar calculation may be made for a protein-containing material like flour, since 97% or more of the total nitrogen in flour is derived from protein (amino acid) sources (5). Such a calculation, based on fundamental scientific principles, has apparently never been carried out for wheat, or other cereals. When relatively complete amino acid composition data were made available for six different flours (5), an opportunity presented itself to carry out this calculation, and the results are reported in this Note.

[1]Manuscript received August 16, 1965. Paper No. 253 of the Grain Research Laboratory, Board of Grain Commissioners for Canada, Winnipeg 2, Manitoba, Canada. Presented in part at the 50th annual meeting, Kansas City, Mo., April 1965.

TABLE I

CALCULATION OF THE PROTEIN-NITROGEN FACTOR FOR A HARD RED SPRING FLOUR

		Weight[a] Nitrogen	Weight[a] Amino Acid Residue[b]
	μm./g.	*mg./g.*	*mg./g.*
Tryptophan	42	1.18	7.82
Lysine	147	4.12	18.84
Histidine	154	6.47	21.12
Ammonia	2,600	36.43	41.66
Arginine	233	13.06	36.39
Aspartic acid	329	4.61	36.74
Threonine	255	3.57	25.78
Serine	540	7.57	47.02
Glutamic acid	2,796	39.17	317.93
Proline	1,222	17.12	118.67
Glycine	499	6.99	28.47
Alanine	357	5.00	25.37
Cystine	88	2.47	17.98
Valine	402	5.63	39.85
Methionine	121	1.70	15.87
Isoleucine	333	4.67	37.68
Leucine	584	8.18	66.08
Tyrosine	182	2.55	29.70
Phenylalanine	357	5.00	52.54
		175.49	985.51

[a] Per g. protein (N. × 5.7).
[b] 985.51 ÷ 175.49 = 5.62. In this calculation the amounts of glutamic and aspartic acids present were estimated to be 263 μm. per g. protein [(2,796 + 329) — 2,600 = 525; 525 ÷ 2 = 263], the remainder considered to exist in their amide form.

A sample calculation for a commercial blend of a hard red spring (HRS) flour is shown in detail in Table I. For a given amount of total flour protein, the weight of amino acid residues present is 985.51 mg., and the corresponding weight of nitrogen is 175.49 mg. The protein-to-nitrogen factor is then equivalent to:

$$\frac{985.51}{175.49} \text{ or } 5.62.$$

In a similar manner, the protein-to-nitrogen factor was calculated for five other flours; the results are presented in Table II. It is seen that an average value of 5.62 is obtained, and that all flours give values in very close agreement to the average value, except for the single slightly higher figure of 5.68 for the poor-quality experimental HRS flour, RL-2520. Although the new factor of 5.6 does not differ greatly from the factor of 5.7 currently in use, the value of 5.6 should represent the ratio of flour protein to flour nitrogen more accurately.

Using the factor of 5.7 for the endosperm portion of the wheat proteins, Jones obtained a factor of 5.83 for converting the percentage of wheat into protein (6). If the factor of 5.6 as obtained in the

TABLE II
PROTEIN/NITROGEN FACTOR FOR FLOURS

FLOUR	WEIGHT RECOVERED FROM "1 GRAM" OF FLOUR PROTEIN (N × 5.7)			PROTEIN/ NITROGEN FACTOR
	Amino Acid Residue	Nitrogen		
	mg.	*mg.*		
HRS, commercial blend	985.4	175.5		5.62
HRS, Selkirk variety	923.9	165.5		5.58
HRS, experimental variety, RL-2520	984.9	173.3		5.68
Alberta red winter, commercial blend	909.1	162.2		5.61
Ontario white winter, commercial blend	937.4	167.9		5.58
Amber durum, Western Canadian composite	906.6	162.2		5.59
			Av.	5.61

present study is the correct value for wheat flours, then by analogy the corresponding factor for wheat should be 5.7. This factor is identical with the value currently in use for wheat, when the wheat is used for food. However, it is significantly different from the value of 6.25, which is presently applied to wheat that is used for animal feedstuffs. Accordingly, the value of 5.7 should be used for wheat in all instances.

Literature Cited

1. OSBORNE, T. B. The proteins of the wheat kernel, p. 103. Carnegie Institute of Washington: Washington, D.C. (1907).
2. WOYCHIK, J. H., BOUNDY, JOYCE A., and DIMLER, R. J. Amino acid composition of proteins in wheat gluten. J. Agr. Food Chem. **9:** 307–310 (1961).
3. GRAHAM, JANET S. D. Starch-gel electrophoresis of wheat flour proteins. Aust. J. Biol. Sci. **16:** 342–349 (1963).
4. NIMMO, C. C., O'SULLIVAN, MARY T., MOHAMMAD, A., and PENCE, J. W. Fractionation and zone electrophoresis of proteins of water-soluble materials of flour. Cereal Chem. **40:** 390–398 (1963).
5. TKACHUK, R. Amino acid composition of wheat flours. Cereal Chem. **43:** 207–223 (1966).
6. JONES, D. B. A new factor for converting the percentage of nitrogen in wheat into that of protein. Cereal Chem. **3:** 194–198 (1926).