ABSTRACT

Lysine has been established as being the first limiting amino acid in wheat as it is for most cereal grains for meeting protein nutritional needs of humans. Therefore, it would seem reasonable that wheat cultivar providing grain containing lysine at highest levels per unit of protein would also be of highest protein nutritional quality. Amino acid proportionality patterns are not the same in all fractions of the wheat kernel and these fractions are not equally digestible by the human. Because of the poor digestibility of the bran-germ layers in comparison to the endosperm fraction, lysine contents of the endosperm layer are probably far more important in determining protein quality than are the bran-germ layers. Therefore, extracted wheat flour lysine content is a much better predictor of protein quality for the human than is the lysine content of whole wheat flour regardless of which type of flour is actually to be consumed. Data collected in this laboratory comparing protein quality evaluations of whole and extracted flours from several wheat cultivars using chemical, small animal, adult human and adolescent human assays support this conclusion.

INTRODUCTION

The enthusiasm generated by the discoveries of the nutritional effects of the opaque-2 and flourly-2 genes on the protein quality of maize awakened scientists to the possibilities of nutritional improvement of other cereals (Mertz et al., 1964; Nelson, 1965). It has been well established that lysine is the first limiting amino acid in wheat as well as the first limiting amino acid in several other grains (Kies and Fox, 1970a; Kies, 1972). Therefore, it is not surprising that massive efforts have been undertaken to identify gene materials in wheat and other cereals for protein and lysine differences which might lead to improvement in protein quality and quantity of the cereal species (Inglett, 1972). While increase in quantity of lysine is important in the improvement of wheat protein quality, a second question also has to be addressed. What is the protein and lysine bioavailability from theoretically improved products?

The terminology bioavailability of protein from cereals, or for that matter, from any food product, is really simply new terminology for a
reawakening of interest in an old question - that of explaining why sometimes even if protein is present in desirable amounts with a desirable amino acid proportionality pattern the physiological/biochemical response is less than would be expected. Actually this question involves two separate, but related sets of problems: 1) problems associated with the actual digestion (the breaking down) of protein into absorbable units, the timing for absorption of this digestion product, and the absorption mechanism itself; and 2) problems with utilization and metabolism of amino constituents following absorption. Although these definitions are by no means universally accepted, bioavailability refers only to the first of these set of problems while the terminology bioutilization refers to the second set of problems.

In a series of studies conducted in this laboratory, various problems associated with bioavailability of protein from wheat have been conducted. Predictions of protein quality of ground whole wheat flours based on chemical analysis were verified in mouse bioassays; this was also true using human bioassays when the whole wheat flours were from cultivars of closely related genetic lines (Kies, 1975; Kies et al., 1978). However, predictions from chemical assays did not hold true when breads baked from ground whole wheat flours of widely different cultivar lines were evaluated by human bioassay techniques.

Results suggested that differences in digestibility and bioavailability of protein from the different wheat materials for the human were the cause. When ground whole wheat flours and extracted wheat flours were compared by mouse bioassay, chemical assay values tended to accurately predict actual protein values as determined by this type of bioassay. In human bioassays, chemical assays did predict actual protein values of the extracted wheat flours but not of the ground whole wheat flours. Extracted wheat flours always were better digested in the human subjects than were their ground whole wheat flour counterparts. However, this was not true of the mice. The two types of bioassays were not identical since the flours were fed in the form of bread in the human bioassays while mice received the flours in a non-heat-treated form. Never-the-less, these results suggested that lysine from the bran and germ were probably not available to the human although they evidently were to the mouse.

The objective of the last study in this series was to compare the protein value of whole wheat flour, extracted wheat flour, and lysine enriched extracted flour from two lines of winter wheat for human adults.

**EXPERIMENTAL PLAN**

As shown in Table 1, the 35-day study was divided into a nitrogen depletion period, a nitrogen adjustment period, and 6 experimental periods of 5-days each. During the nitrogen depletion period, nitrogen intake was maintained at 1.12 g N/day in order to deplete subjects who customarily consume relatively high protein diets to the low protein content necessary for research evaluations. This technique in this laboratory has been found to reduce time required for subjects to reach a steady state of nitrogen excretion. The depletion period was followed by a nitrogen adjustment period during which the same level of nitrogen was fed from a mixture of all 6 flour types used in the following experimental periods.