THE AMINO ACID COMPOSITION OF WHEAT GRAIN AS RELATED TO ITS PROTEIN CONTENT

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ABSTRACT

Basic amino acids and protein content of 59 mature grain samples of wheat (Triticum aestivum) have been determined. The samples were obtained in different environmental conditions (fertilization, year of harvesting, location and conditions of wheat growth). Several of them also differed genetically: 12 varieties or cultivars have been studied. The protein content ranged from 9.1 to 20.6 per cent (in g of nitrogen x 6.25 per 100 g of grain dry matter). Whatever the cause of variation of protein content for each amino acid may be, linear relations are pointed out between amino acid percentages of the grain and crude protein content. Thus knowing only the protein content of a wheat grain sample enables to infer its basic amino acid composition. As for the amino acid levels of crude proteins, they are related to protein content by hyperbolic laws. When grain protein content increases, the whole protein of grain becomes much poorer in lysine, their arginine level also drops, whereas their histidine level remains constant.

I. INTRODUCTION

It is generally agreed that amino acid composition of mature wheat grain is changed according to protein level. For instance Lawrence et al. (1958) noticed very early that low protein wheats exhibit an inverse relationship between protein content and lysine in the protein. Many studies have been reported in the literature on a single cultivar (or a small number of cultivars) with which a more or less wide range of protein level was obtained by use of different conditions of fertilization or climate or also different locations and years of harvesting (Byers and Bolton, 1979; Eppendorfer, 1975 and 1978; McLroy et al., 1949; Sihlbom, 1962). Other studies deal with genetic differences and their possible interactions with amino acid composition of wheat grains (Diehl et al., 1978; Hepburn and Bradley, 1965; Johnson et al., 1979; Mattern et al., 1968; Müntz et al., 1979; Villegas et al., 1970; Vogel et al., 1976). This has been reviewed for wheat by Konzak (1977) and Porceddu et al. (1983), and also for several different species by Frey (1973), Mossé and Baudet (1983), Nelson (1979) and Röbbelen (1976).
Many of these results are confined to lysine which is indeed the most limiting essential amino acid for human beings and for cattle. For analytical reasons, they are sometimes confined to basic amino acids. Whatever amino acids may be determined, the general conclusion is that amino acid composition is related to protein level in wheat grain. However, several questions such as the magnitude of amino acid variations with protein level, the nature of the relationships involved, the respective weight of genome and of environment in such changes remain debated or unclear. With other species like barley it has been shown that basic amino acids obeyed a very simple law (Mossé and Baudet, 1969 and 1977b): the amino acid contents of the barley grain are linear functions of protein level. Similar relationships have been found in an oilseed like sunflower (Baudet et al., 1971) and in a legume seed like broad bean (Mossé and Baudet, 1977a and Baudet and Mossé, 1980). Thus homologous results could be expected in any species, particularly in cereals other than barley. The aim of the present work was to investigate this question in wheat grain.

II. MATERIAL AND METHODS

Initially, the choice of wheat samples was not really programmed in order to result in the present study. As a matter of fact, year after year, different samples happened to be analysed for their amino acids, either for checking the composition of samples used in plant breeding, or more frequently in order to know the composition of wheats after very different conditions of growth.

The 59 samples which have been analysed belong to 12 different varieties or cultivars. Two sets of samples were obtained from greenhouse grown wheats: the 11 samples of variety Aronde were obtained with the aim to cover a range of protein content as wide as possible and the 6 samples of variety Bastion in order to produce the highest possible protein content. All the others were harvested from field grown wheats during seven different years. Among the 9 samples of variety Cappelle, one was submitted to subsampling. Fractionation of the sample was first made according to the individual grain weight (from 20 to 25, 25 to 30, and so on up to 60 mg). This resulted in 8 different weight classes the grains of which were then distributed into 2 subclasses depending on their more or less mealy aspect, at least when the amount of grain was still sufficient (i.e. for 6 of the 8 weight classes). Hence it led to 14 subsamples differing by their protein level.

Analytical samples of 30 g were obtained by several successive uses of Prometer static divider. The weight of grains submitted to analyses was still much weaker for some of the 14 subsamples obtained from one Cappelle sample as described above. Samples were poured in liquid nitrogen just before grinding in a Prometer knife mill. After air equilibration, all aliquots for analysis were taken at the same time.

The dry matter content was determined by heating at 105° C for 24 hours. Nitrogen content was determined by a micro-kjeldahl procedure and data are the average of duplicate analyses. For basic amino acids, 300 mg of milled samples were hydrolysed for 24 and 48 hours in 300 ml of boiling HCl under reflux. For the 11 samples of variety Aronde, only one 24 hour-hydrolysis was carried out. Determinations were performed on short columns