

ELECTROPHORETIC CHARACTERISTICS OF THE ALCOHOL-SOLUBLE PROTEINS OF THE SEEDS OF MAIZE LINES CULTIVATED IN UZBEKISTAN

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We have investigated the electrophoretic compositions of the zeins of various lines and forms of maize cultivated in Uzbekistan. It has been found that, according to their electrophoretic spectra, the zeins of the various lines and forms of maize differ from one another with respect to the presence of a number of major and minor components, which makes their biochemical marking possible. The electrophoretic analysis of the zeins of individual seeds showed the presence of various biotypes among the lines studied. Components of the zeins have been identified the presence of which correlates with the anthocyan coloration of maize seeds.

The alcohol-soluble fraction of maize seed proteins is represented mainly by zeins, which make up about 40-50% of the total amount of the reserve proteins of the endosperm and can be extracted with 60-70% ethanol or isopropanol. The zeins are heterogeneous proteins and are divided into several groups in terms of molecular mass. The molecular masses of the main zein fractions are 27, 22, 19, 16, 15, and 10 kDa. On the basis of structural similarities, this group of proteins is classified as α - (22 and 19 kDa), β - (15 kDa), γ - (16-27 kDa), and δ - (10 kDa) zeins [1, 2].

The zeins are coded by a family of more than 100 genes [3], and genetic polymorphism therefore arises. This phenomenon permits the use of the electrophoretic spectra of zeins in order to mark individual lines and forms of maize for their biochemical identification, and also for determining degrees of hybridity of the seeds of cultivated forms of hybridized plants [4, 5].

We have investigated in polyacrylamide gel the electrophoretic compositions of the zeins of seeds of maize lines cultivated in Uzbekistan. In the electrophoretic spectra of various lines of maize we revealed from 8 (Kkh 809) to 16 (Érkin-1) major components, the electrophoretic mobilities of which ranged from 0.14 to 0.55 (Fig. 1). The electrophoretic spectra shown in the figure characterize the general pattern of the electrophoregrams for the maize lines studied since the zeins were isolated from flour prepared by grinding 20 seeds. The main fractions of the electrophoregrams, found in almost all the lines studied, contained components with electrophoretic mobilities of 0.22, 0.25, and 0.30. The lines studied differed in the compositions of both the major and the minor components, and the differences between the electrophoretic spectra of the maize forms were reliably reproducible.

It is known that, to obtain high yields of maize, use is made of the heterosis effect, based on interline crossing. Consequently, individual seeds of each line may differ from one another according to their parental form and hybridity. It is convenient to investigate these differences by the electrophoresis of the zeins.

In a study of zeins extracted from individual seeds it was established that a number of maize lines are heterogeneous in terms of the electrophoretic spectra of the proteins. Thus the line Uz 306 AMV was separated into two, differing by their levels of components with the mobilities 0.14, 0.17, 0.27, and 0.32 (60 and 40%), line Gk 26M was also separated into two with respect to the levels of the components 0.14, 0.16, 0.34, and 0.47 (45 and 55%), line Gk 13 into three with respect to the components 0.14, 0.16, 0.17, 0.19, 0.25, 0.34, 0.39, and 0.41 (40, 27, and 33%), line Uz 203 M into two with respect to the levels of components with mobilities of 0.16, 0.22, 0.29, and 0.41 (80 and 20%), and line Uz 205 MV into three with respect to the levels of the components 0.16, 0.17, 0.19, 0.30, 0.36, and 0.45 (47, 26, and 27%).

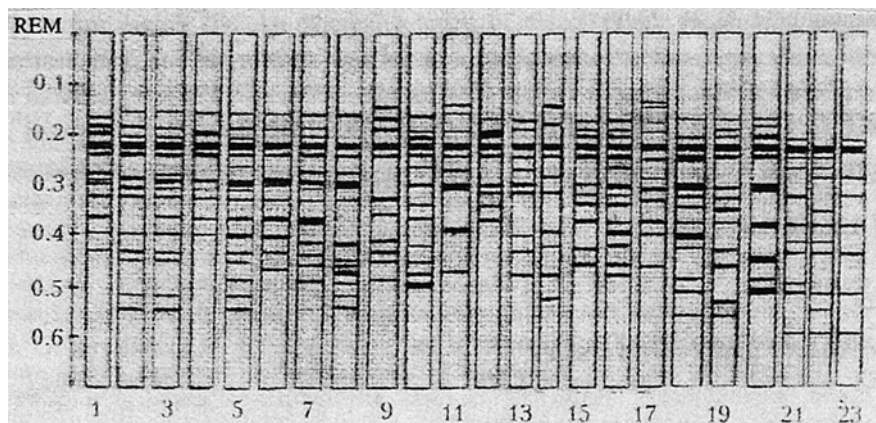


Fig. 1. Scheme of the electrophoregrams of the alcohol-soluble proteins of the seeds of various lines and forms of maize: 1) V73; 2) L-1204; 3) L-1205; 4) MO 17; 5) Érkin-1; 6) Érkin-500; 7) sugary form; 8) supersugary form; 9) Gk 26M; 10) Kkh 746; 11) Gk 13; 12) Kkh 809; 13) Uz 205MV; 14) Uz 203M; 15) Gn 12; 16) Gn 39; 17) Uz 306AMV; 18) Gn 188; 19) Gn 294; 20) Gn 268; 21) form with white seeds; 22) form with yellow seeds; 23) form with dark blue seeds.

We then studied the electrophoretic spectra of the zeins of individual seeds of various forms of maize differing in speed of ripening, sugar content, anthocyan coloration, etc. For example, among the forms of maize investigated we found cobs containing seeds with different anthocyan colorations. Having separated these seeds by color, we subjected part of them to electrophoretic analysis, while another part was sown to obtain a new generation. These plants gave cobs with seeds of the corresponding color.

Electrophoresis of the zein fractions of the seeds showed that the plants with yellow and dark blue seeds were more or less homogeneous, while polymorphism was observed in the zeins of plants with white seeds. The polymorphism in the zeins of plants with cobs of white seeds consisted in the levels of components with electrophoretic mobilities of 0.22, 0.26, and 0.39. Nevertheless, clear differences were observed in the amounts of individual components between these three groups of plants. Thus, common for all of them were components with electrophoretic mobilities of 0.220, 0.360, 0.420, 0.500, and 0.580.

The zeins of the white and the yellow seeds included components with mobilities of 0.245, 0.265, and 0.390, not present in the seeds with a dark blue anthocyan coloration, while the zeins of the white seeds and the seeds with the dark blue anthocyan coloration included components with mobilities of 0.200 and 0.320, not in the yellow seeds, and lacked the components with mobilities of 0.340 and 0.540 that were present in the yellow seeds. A common feature of the seeds with the yellow and the dark blue anthocyan colorations was the presence of a component with a mobility of 0.290 and the absence of a component with a mobility of 0.480. Consequently, the differences detected correlate with the colorations of the seeds of these lines and can be used as marker indices.

The results obtained permit the hypothesis of the existence of an interrelationship of the genes coding the enzymes for the synthesis of the anthocyan coloration in maize seeds with zein loci.

Definite differences were revealed in a study of the electrophoretic spectra of the zeins of individual seeds of sugary and supersugary forms, and consisted in the presence of a series of components in regions with electrophoretic mobilities of 0.20, 0.28, 0.30, 0.36, and 0.50. Both maize lines were heterogeneous according to the electrophoretic compositions of individual seeds, although in the sugary form, in contrast to the supersugary form, there were components with mobilities of 0.18, 0.20, and 0.36, and no components with mobilities of 0.49 and 0.54.

Thus, the electrophoretic composition of the zeins is specific for the seeds of each line and biotype of maize, which may be of particular applied value in the prediction of the crop yield or of economically valuable indices of maize.

EXPERIMENTAL

The seeds of the various lines and forms of maize were provided by A. I. Massino.

The zeins were extracted from finely ground maize seed flour with 70% ethanol in a ratio of flour to 70% ethanol of 1:10 (weight/volume). The ethanol treatment of the fractions after centrifugation and electrophoretic separation of the zeins on plates of polyacrylamide gel was conducted by the method described in [4]. The relative electrophoretic mobilities of the individual bands were calculated by the use of the dye Pyronine Y.

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