Plant Proteins Responsible for Fiber Strength in Cotton

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ABSTRACT

Enzymes and proteins of two lines of cotton differing in fiber strength were studied. The study revealed that activity of glucan synthetase and peroxidase in these lines increased with maturity, while the activity of B-(1-3)-glucanase and cellulase decreased. Specific enzymatic activity of peroxidase and glucan synthetase in line L-175 was higher than that in line L-466 characterized by lower fiber strength. The activity of glucanase decreased in relation to fiber strength. On investigating the water soluble protein fraction of cotton fiber, polypeptides with molecular weights of 28 and 39 kD were found and associated with fiber strength.

Introduction

It is known the plant proteins of various forms and sorts differ from each other by the presence or absence of individual components. The presence of proteins in hybrid plants, though absent in parents, can be due to the activation of genes that are repressed in the parent. It has been shown that genetic material in all cells of organism is similar but the mechanism of differentiation appearing in activity of separate sites of the genome in different organs, is still unknown /1-3/.

In cotton fiber as well as in any plant cell, there are various proteins that take part in general metabolism, especially, in synthesis of glucoside polymers. Among numerous protein systems, the most interesting are peroxidase, glucanase and glucan synthetase. The purpose this study was to investigate proteins in cotton plant lines that differ in fiber strength and to investigate peroxidase, glucanase, cellulase and glucan synthetase activity in these lines.

Material, Methods and Results

Disc-electrophoresis (anode) in 10% PAAG in a fiber of L-175 line with higher fiber strength, revealed three isoforms of peroxidase with OEP 95, 66 and 58, but the line L-466 with lower fiber strength, has a fourth wide minor zone with OEP 115 that is not present in line L-175. By comparing isoperoxidases spectra in the investigated line with regard to fiber ripening (development), it was shown that they differ both in relative electrophoretic mobility and in colour intensity. However, comparison of peroxidase activity in lines L-175 and L-466 revealed that the specific activity in line L-175 appeared to be higher than in line L-466 (Table 1). Thus, activity of peroxidase isosymes may not be specified by protein quantity but by the catalytic state of enzyme.

Cotton plants were treated with industrial concentration of PIX to study the influence of a stress factor on the stability of isolated proteins typical of line L-175 (39 and 28 kD). Results showed that the polypeptides typical of line L-175 that may be responsible for quality of cotton fiber, are preserved under the action of the foliar applied chemical

Cellulase activity in a fiber of 10- and 20-day age was determined according to coloured substrate. Activity of cellulase in a fiber of 10-day age in the investigated lines appeared to be higher than in that in a fiber of 20-day age. On comparison of two lines of cotton plant, it appeared that the line L-175 has much higher cellulase activity than the line L-466 which is equal to 470 and 510 conventional units/mg of protein, respectively.

Neither of the lines possed an absolute B-glucanase activity in supernatant obtained by buffer solution of low ion strength from developing 10- and 20-day old fiber. Extraction of enzyme with buffer systems with high ion strength, yielded fractions with small B-glucanase activity that corresponded to 0,0035-0,004 ME/mg of protein. Study of absolute endo-B-(1-3)-glucanase activity using soluble KM-cellulose as a substrate gave no sufficient differences between the lines due to low activity of enzyme. Application of laminarin as a substrate to determine exo-B-(1-3)-glucanase showed that in lines L-175 and L-466 it was within 29 and 38 ME/mg protein respectively.

Water- and salt soluble proteins, among them the basic are glycoproteids, were isolated to study tag proteins from fiber of cotton lines L-175 and L-466. The protein spectrums of fractions obtained were characterized by the number and intensity of peptides manifested. Differences were found in protein fractions of 20-day old fiber. Thus, the protein spectrum of line L-175 with stronger fiber is characterized by polypeptides with molecular weight of 39 and 28 kD in the water fraction and - 90; 39; 28 kD in the salt fraction. In water fraction of L-466 with weaker fiber, polypeptides 39 and 28 are not present, but the salt fraction was characterized by polypeptides with molecular weight of 58 and 52 kD.

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While investigating tag protein inheritance of line L-175 characterized by stronger fiber, hydrid were obtained between lines L-175 and L-466. Electrophoresis data shows bands 39 and 28 kD, probable marker proteins responsible for strength, passing from L-175 into offspring. Comparative study of glucan synthetase activity in the genetic lines and their hybrid shows that introduction of a mark into newly synthesized cellulose occurred more intensively in line L-175 whereas the formation of marked product in line L-466 occurred at lower velocity (391 and 1465 imp/min respectively). Cellulose biosynthesis in hybrid occurred at much higher velocity than in the parents (4235 imp/min).

On the basis of the results obtained, the conclusion may be drawn that the stronger fiber has a higher glucan synthethase activity and this is inherited by the offspring. Analogous data were obtained by determining peroxidase activity in parents and in the hybrid. Glucanase activity was higher by factor of 10 in parents and equal to 2,7 ME/mg protein in the hybrid. Comparative characteristics of activity in the investigated enzymes of cotton fiber of parents (L-175 and L-466) and hybrids are given in Figure 1.

Correlation of results obtained on protein stability, hybridization, electrophoretic analysis, biochemical characteristics of investigated lines leads to the conclusion that polypeptides with molecular weight of 39 and 28 kD belong to marker (tag) proteins responsible for a fiber strength.

References

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Table 1. General activity and component composition of peroxidase in growing cotton plant fiber in lines L-175 and L-466.

Cotton plant lines	General activity of peroxidase in nanocut			No. of components
	10-day fiber	20-day fiber	30-day fiber	
L-175	379.6	480.5	290.5	3
L-466	175.0	289.4	150.3	4

Figure 1. Comparative characteristics of enzymes activity of cotton plant of parents and hybrid forms.