Lesson 4:
Emerging Applications of Plant Biotechnology

The field of plant biotechnology is one of the most rapidly developing areas of biotechnology. The pace of growth is due to several factors, but the most important reasons are the potential for high profits and the relative simplicity of plant manipulation through recombinant DNA technology. As plant biotechnology continues to advance, the list of products developed through its application will grow. Some of these products are examined in this lesson. Biofuels and biopolymers, for example, are two of the most promising products currently under development. The needs of the plant products industry will influence the future of plant biotechnology.

Biofuels

Biofuels are combustible substances derived from organic sources. Nearly all biofuels are plant-derived. Several types of biofuels exist. Alcohol-based fuels are made by fermenting plant materials. Gasohol is one example; it is a fuel composed of 10 percent alcohol and 90 percent gasoline. Gasohol with a 10 percent ethanol (a type of alcohol) blend is available to motorists in many gas stations across the country. Normally, the ethanol blend is slightly higher in price than the regular petroleum fuel. Researchers are searching for plants that can be modified to produce ethanol more economically.

Plant oil-based fuels, or biodiesels, are made from seeds with a high oil content. Most of these fuels are the result of the addition of methanol (wood alcohol) to the plant oil and the removal of a sticky substance called glycerine. Soybean and rapeseed oils are most commonly used in the production of biodiesel. Biodiesel can be used as a fuel by itself, or it can be blended with petroleum diesel fuel. It is a cleaner-burning fuel that produces less wear on an engine than petroleum diesel. The challenge facing those seeking to increase the use of biodiesel is its cost, which is currently nearly four times the cost of petroleum diesel. Scientists are looking for ways to engineer plants to produce larger quantities of oil and to require less extensive processing to produce biodiesel.

Another type of biofuel is biogas. Methane gas is a byproduct derived from the anaerobic (oxygen-free) digestion of plant materials and/or animal waste by microorganisms. Many people in India and China use small-scale methane production chambers to supply fuel for cooking and lighting. Although methane gas has some limitations as a fuel because it cannot be easily transported or compressed into a liquid, researchers are examining the possibility of developing plants that would produce crop residue that is more useful for methane production. Microorganisms are also being examined to see if they can be modified to better digest crop residues and produce more methane.

Biopolymers

Biopolymers are complex chemical compounds produced by living things. Biopolymers from genetically engineered plants may be useful in a variety of industries. Several different groups of biopolymers are used for a variety of applications.

Carbohydrates are one group of biopolymers. All plants produce carbohydrates, but not all plants are a good source of food-grade carbohydrates. Modified corn starch is one of the plant carbohydrates most widely used in foods because it is a cheap source of starch. However, it breaks down when heated in a microwave oven. Researchers are looking at ways that the corn plant can be modified to produce a starch that can be heated. Another important carbohydrate molecule is sugar. Scientists are researching the possibility of genetically altering potato plants so that their leaves will have a high sugar content. The plants could then be used as a source of sugar.

Fatty acids are a second type of biopolymer. Researchers are working on modifying corn and canola to produce oils with an altered level of fatty acids. They may contain a high level of either saturated or unsaturated fatty acids, depending on which is needed for a given application.

Another kind of biopolymer is high-value pharmaceutical proteins. Two examples of human health products that are proteins are insulin and blood plasma. Plants provide the potential for such proteins to be produced at a lower cost than currently available.

A fourth group of biopolymers is industrial enzymes. Enzymes are needed for brewing to aid in fermentation, in the paper industry to process and bleach paper, and in the livestock industry as a feed additive to aid in digestion in animals. These types of enzymes are needed in large quantities, and scientists are trying to modify plants to provide these enzymes at a low price.

Another type of biopolymer being researched is bioplastics. Plants naturally have a very small amount of the chemical components of plastic in their tissue. Scientists are attempting to develop plants with tissue that contains a much higher level of these components. Researchers have already engineered plants to increase these levels; the chemicals make up 4 percent of the modified plants. If this percentage can be increased, the world will have an expanded source of biodegradable plastics.

Plant Traits Desired by Producers

The ability to genetically engineer plants has caused plant breeders and researchers to stop asking what traits are available in a plant species and to start asking what traits are needed or desired by producers and which plant can best be modified to fulfill this need. As genes for more and more traits are discovered, the possible genetic combinations grow as well. Researchers are focusing on several major areas. One of these areas is that of environmentally tolerant plants, including the development of plants that are drought-tolerant, frost-tolerant, and salt-tolerant. The development of better forestry products is another area of plant research. Traits desired in this area include stronger wood, fire-resistant wood, and trees that grow more quickly. A third area of research involves the development of food products with an improved taste. Products being investigated include sweet corn and peas that stay sweet longer and naturally decaffeinated coffee. Research into fiber crops is being conducted as well. Scientists are trying to produce naturally colored and fade-resistant cotton. Naturally blue cotton that resists fading would create a revolution in the denim industry.

Summary

The rapidly expanding field of plant biotechnology is the focus of a great deal of interest. Biofuels and biopolymers are two examples of the emerging applications of plant biotechnology. Scientists are examining many plants, animals, and microorganisms as a part of their attempts to enhance the traits of crop plants and increase their usefulness.

Credits

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