Chapter 14
Bryo-Pharmaceuticals: An Emerging Era of Pharmaceutical Products

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ABSTRACT

Because bryophytes are a promising source of a large number of secondary metabolites, they are used efficiently in surgical dressing, herbal medicines, antibiotics, and other pharmaceutical products. The advent of several biotechnological tools and their utilization in the exploitation of pharmaceuticals properties of bryophytes leads to a new era of bryo-pharmaceuticals. Nowadays, the biopharmaceutical productions using moss system are gaining importance over other plant systems because of their unique properties such as predominant haploid gametophytic stage, stable gene integration, efficient secretary signals, and large-scale production in bioreactors. Several researchers have established moss system as safe and efficient for the production of several complex modified recombinant pharmaceuticals under standard conditions. The moss Physcomitrella patens are extensively exploited and commercialized as a production host for production of several recombinant proteins, human growth factors, antibiotics, and its derivatives.

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INTRODUCTION

Biopharmaceutical is defined as complex medicinal biomolecule which possesses pharmacological activity exploited for therapeutic or *in vivo* diagnostic purposes and are formed via genetic modification instead of extracting directly from indigenous biological sources (Ryu & Nam, 2000). They are large, complex macromolecules that are developed from living system. Biopharmaceuticals and synthetic drugs are different in all aspects such as source, composition, structure and properties of product, methods of development and handling; dosing and formulation; IPR (Intellectual Property Right), legal regulations and marketing strategy. Primarily, biopharmaceutical includes protein drugs such as monoclonal antibodies, attenuated vaccines and nucleic acid drugs that include DNA, RNA or antisense RNA oligonucleotides (Ryu *et al*., 2012). The production system widely used for development of these drugs includes plant cells, yeast, insect cells, bacteria and mammalian cells. The selection of production system for the development of drug usually depends on the specific properties of required protein. Biopharmaceuticals has significant position in the public health system of both developed and developing countries by combating several life-threatening diseases (Rencz *et al*., 2015).

With the advent of biotechnological tools such as RDT (recombinant DNA technology), the increased production of desired protein became possible by simply expressing the target cDNA in recombinant host organisms. In 1982, the Human insulin became first recombinant protein that was launched in the market and this further lead to the development of several other new biopharmaceuticals. Presently, over 300 proteins therapeutics have been permitted globally by the FDA (Food and Drug Administration, US) for humans use and several drugs are under clinical trials (Lawrence, 2007). In 2004, the market size estimation for recombinant therapeutics was nearly 44 billion and these values will be even higher in the future (Lawrence, 2005). Thus, the biopharmaceutical industries are most rapidly growing sector of industrial biotechnology.

Microbial or mammalian systems (Chinese Hamster Ovary cells) have been extensively exploited production organisms for the vast variety of therapeutic protein (Schmidt, 2004). The major advantage of using microbial system is easy handling, well understood growth characteristics high product yield and relatively low cost. Most exploited microbial system for production of biopharmaceuticals is *E.coli* which is extensively used production system for small recombinant proteins. The major limitation of microbial system is lack of posttranslational modification of target protein and presence of bacterial lippopolysaccharids. However the mammalian cell lines (e.g., Chinese haster ovary cells, rodent cell lines and human cell lines) can provide correct posttranslational modification of the target proteins and used for production of recombinant protein. The major drawback of this system