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Laser Biotechnology for Sustainable Development, Focusing on Bio-economy and Creation of Green Jobs

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ABSTRACT

Laser biotechnology is a high energy density photostimulation of some enzymes, enhancement of bioenergetic proceses, and unspecified adaptability in biological materials with empirically selected algorithms of lase irradiation. This technology is applied to plants for their growth rate, seed germination, higher biomass production in deteriorated areas and decreased concentration of green house gasses.The paper is focusing on bio-economy and creation of green jobs due to laser biotechnology and its sustainable development.

INTRODUCTION

Innovative application of laser biotechnology for better adaptation of cultivated plants to water deficiency and increase of soil contamination due to climate change as well as for more efficient bioremediation and reduction of contamination of the air, water, soil and food chains (Dobrowolski, 1976, 2000, 2006, 2011 & 2012). This phenomenon based on increase of adaptability of different species of plants and microorganisms to suboptimal environmental conditions (different pollutants of the air, soil and water, acidification, low and high temperature, etc.) in result of high energy density photo-stimulation of some enzymes, enhancement of bio-energetical processes and unspecific adaptability in result of stimulation biological materials with empirically selected algorithms of laser irradiation (Dobrowolski *et al*., 2002, 2015 & 2017) . One of applications fields of this new biotechnology is more efficient bioremediation of waste water, as well as contaminated land, acceleration formation protective green screens alongside main roads as well as effective reclamation followed by higher biomass production in deteriorated areas . Such kind of eco-innovation is contribution to recommended by the United Nations Sustainable Development of different regions of the world. Wide scale application of this new biotechnology (reasonable in terms of cost-benefit analysis) could contribute to decrease concentration of green-house gases (*e.g.* by enhancement of CO_2 fixation by stimulated plants) and primary prevention of climate change . This could be also useful tool for better adaptation to climate change by progress in prevention of desertification by reclamation deteriorated areas, reforestration, energy plantations renaturisation including contribution to sustainable development of the rivers regions, increase of water retention and prevention against flood incidences, as well as overexploitation of forests etc. (Dobrowolski, 2000 and Dobrowolski *et al*., 2017). Application of empirical selected - for different species of plants and environmental conditions - algorithm of laser irradiation of seeds, seedlings, cuttings of various species of plants could significantly increase accumulation of different trace elements (Dobrowolski 1986, 1996, Dobrowolski *et al*., 1987, 1990, 1996, 1997, 1998, 2002,2004,2011,2012b,2015 and 2017). This way laser biotechnology may be valuable tools for enhancement amount of

some deficient elements *e.g.* Fe, Zn, Se etc. in cultivated plants. Biogeochemical predisposition for deficiency of some biological active elements is associated with high risk for health including iron deficiency anemia, as well as of common in some regions of the world congenital malformations, cancer and leukemia (Dobrowolski and Vohora, 1989). Therefore laser biotechnology may be useful for nutritional prevention of these diseases and for stimulation immunological system. There are real perspective of integration application this biotechnology with optimization methods of cultivation vegetables, medical plants and production of the top quality phyto-honey (herb-honey) by feeding of bees in special beehives with extract of plants reach in deficient elements. Depending on used algorithm of laser photo-stimulation of tested plants species; it would be possible to decrease of accumulation of very toxic trace elements *e.g.* Cd, Pb, Ni or increase they accumulation for more efficient bioremediation from wastewater and contaminated soil. Integration laser biotechnology with ecotoxicology and human ecology opened also new perspectives of improvement of environmental health (Dobrowolski, 2001), including primary prevention of cancer by significant enhancement efficiency of biodegradation of carcinogenic pollutants of soil and water (Dobrowolski *et al*., 1989, 1997 and 2012 a) as well as better reclamation of contaminated areas and protection of biodiversity especially in regions of national parks (Dobrowolski *et al*., 2004, 2006, 2012 b, 2015 and 2017). Selected algorithm of laser irradiation of seeds could stimulate also germination different species of plants also under suboptimal environmental conditions (Dobrowolski *et al*. unpublished).

MATERIALS AND METHODS

AIM OF THE CASE STUDY

The aim of study of the team of Prof. Dobrowolski and his diploma and doctoral students were test of application of cheap low power coherent light for stimulation of growth rate of selected species of plants in contaminated environment and increase bioremediation of toxic metals, as well as biomass production as well as acceleration of formation of live fence (mean 3 times higher versus control bushes on contaminated urban soil) and increase resistance of irradiated plants to the traffic output alongside main streets . It was a subject of long-term case study in historical city on example of the region of the World Culture Heritage in Krakow, Poland (as contribution to better protection of the human health , cultural and nature heritage) . Another field of experimental study was more efficient reclamation of industrial areas polluted by metals and mining areas of salted soil (*e.g.* in the region of the Wieliczka Salt Mine). Practical output of our team experimental study could be also contribution to prevention against acidification and eutrophication and protection of biodiversity. For evaluation of efficiency of use of laser biotechnology for wastewater treatment our team used sensitive biological materials (including juvenile stages of development of tested fresh water Invertebrates) and computer-based image and kinetic analyses of tested tubifex, hydra, daphnia, snails in biological monitoring. For evaluation efficiency results of application laser photo-stimulation of selected species of plants for acceleration formation “green screens” alongside main roads we applied both cheap Amaya-Krochmal samplers for screening monitoring of men concentration of NO_2 as indicator of spatial and temporal differences of the air pollution and evaluation of surface of laser stimulated plants versus control material).

RESULTS AND DISCUSSION

The results of Dobrowolski *et al.* (2004, 2012 b & 2017) long-term study related to application of laser stimulation of grasses, vegetables, corns, bushes, trees as well as some water plants including microalgae supported innovative bio-management of contaminated regions. Another promising for the future object is laser stimulation of soil bacteria and fungi for reclamation of deteriorated areas (Dobrowolski and Smyk *et al*., 1997) and photo-stimulation of inoculum of mycorthitic moulds for more efficient reclamation of land contaminated with metals (Dobrowolski *et al*., unpublished). Diploma and doctoral students from several countries under scientific tutorship of Prof. J.W. Dobrowolski prepared innovative concept of introduction of laser biotechnology sustainable development for different regions of Asia, America, Africa and Europe. My formal Doctoral student from Uzbekistan Ph. D. O. Tusunov finished already his doctoral thesis on long term (after 5 years of laser photostimulation of the plants seedlings) enhancement of biomass production on low quality soil and increase efficiency of bioenergy production. This field and laboratory studies are complementary to his M. Sc. work on significant enhancement of biogas production from the municipal wastes by fortification with powder dolomite. Other former participant of this training on bio-economy-driven sustainable development Mr. Rimal from Nepal following concept of Prof. Dobrowolski good results of joint experiments and intend to make 1st in USA doctoral thesis using laser biotechnology for enhancement of biomass production of selected species of oil producing plants, sun flower, rape *etc.*

PERSPECTIVES FOR THE FUTURE

Application of laser biotechnology (and complementary eco-innovation) for innovative more efficient solving problems important for selected regions or enterprises, consortiums, foundations etc. in connection with better management of the natural environment (bio-treatment wastewater, wastes management to bioenergy and reclamation areas out of use (*e.g.* deteriorated, semiarid *etc*.,(greening cities or habitats) and System Approach to Sustainable Development and creation of many new Green Jobs (in linkage with Bioeconomy) in selected regions in different countries, *etc*. Good practice of long-term research and education focused on Sustainable Development, based on Eco-Innovation could support joint expertise opinions and distance postgraduate courses (including e-Handbook) on new applications of Laser Biotechnology, in linkage to Bio-economy and development of labor market by creation Green Jobs connected with introduction of innovative services and products e.g. good for health of consumers food, adaptation of water management (including better waste water treatment by selected local plants or biological reactors) and food production to climate change, better reclamation and energy plantations, etc . Experimental selected algorithms of laser photo-stimulation of seedlings of local plants (*e.g.* willow, alnus, reed, grasses including elephant grass) *etc*, significantly increase biomass /bioenergy production especially cultivated in low quality, deteriorated soil (*e.g.* in postindustrial or urban areas).This is very good starting point for System Approach to Sustainable Development focused on Local Renewable Sources of Energy with the priority of modern high efficient energy production according to concept of President of the International Consortium of Clean Energy Prof. Grob as well as ‘Methasyn Concept’ for high efficient organic wastes management as ‘Renewable Sources of Energy’ supported by cost-benefit analysis and adopted to local predispositions and possibilities. Such model of bioenergy based bioeconomy is especially promising for promotion sustainable development in rural

regions (including agro- and eco-tourism and production of functional food beneficial for health of consumers) and for developing countries. Interned based promotion of know how by distance education has crucial importance both for problem-solving training of staff as well as for open for all education for common action of experts and local knowledge-based society for improvement quality of life for all and creation many green jobs for support of local community with good quality drinking water (for primary prevention of water-born diseases), healthy food and renewable sources of energy (including management of organic wastes). Concept and experiences in laser biotechnology were adapted to needs of different regions of several developing countries during my training activity of graduate students from Asia, Africa, America.

CONCLUSION

Laser light of adequate wavelength, energy density and time of exposition could increase resistance of various species of plants to different pollutants of the air, water and soil (including traffic output, industrial contaminants and salted soil as well as ;and and ponds contaminated with petroleum). Laser biotechnology is useful for more efficient treatment of waste water in hydrobotanic plants, phytoremediation of toxic metals from soil and reclamation of regions of mining areas as well as metallurgical, chemical, cement plants, and enhancement of biomass production in areas out of use for food production and for contribution to development of biofuel and bioenergy production.

Results of experimental studies support also recommendation of laser biotechnology for management of the areas alongside main roads for reduction of negative impact of motorization of the air pollution and contamination of animal and human food chains, habitats, culture (old buildings) and nature (biodiversity) heritage. Wide-scale use of laser photo-stimulation of native plants (seeds, cuttings, seedlings) could increase their rate growth contribute to higher retention of water and prevention against both desertification and flood incidence as well as increase carbon dioxide fixation as prevention against global warming effect. Referring to these conclusions experts interested in interdisciplinary cooperation for new applications of laser biotechnology for sustainable development of modern agriculture and forestry and greening cities, including 'Urban Agriculture and Sustainable Design of Green Habitants and Eco-Hotels', as well as introduction of laser biotechnology for better adaptation of wastewater bio-treatment and food production to climate change. Laser Biotechnology, basic and research developing studies on applications for sustainable development and bio-economy in agro-environment focused on more efficient protection the natural environment (waste water treatment, reclamation areas out of use, improvement energy plantations for enhancement biomass/bioenergy production under suboptimal conditions, reforestration management areas alongside main roads, deteriorated areas both under risks of flood or water deficiency), better adaptation of food production to climate change including linkage with nutritional and environmental health) .

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