ISSN: 2583-3499 (online)
Volume 1, Issue1, June 2021

Role of Biotechnology in improving nutritive value of foodstuffs

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Abstract
The role of Biotechnology in improving nutrient content of crops & foodstuffs has undergone a lot of research work and is still being done. As world's population is ever increasing and resources are limited, therefore scientists are continuously trying to study best possible use of Biotechnology in developing more nutritious crops/ foodstuffs in least possible resources for good health of population. Human nutrition enhancement is being done via Crop biotechnology. Biotechnology is being used to improve food security. It is being done via making food more available and by enhancing nutritional composition of foodstuffs. Ortiz (1998) highlighted that high quality crops with improved nutritional and health characteristics may be attained via varied mechanism of scientists in the field of Biotechnology. Food and Agriculture Organization (FAO) has also highlighted the importance of Biotechnology in enhancing the crop yield via using all the steps of value chain. A similar study on Biotechnology has also highlighted that Biotechnology has a huge role in improving the crop & livestock yield (Frank, 2018).

Across the strata the farmers face some common issues of sub-optimum water utilization, soil issues and the pathogens therein. This in turn is responsible for lowering crop quality and exacerbating harvest uncertainty. This is causing increasing use of chemical fertilizers.

The agriculture industry has changed a lot after invention of DDT and other chemical pesticides. Blind usage of chemical fertilizers has led to degraded soil quality. A wide range of studies have been undertaken to analyze the role of chemicals on quality of water and fertility of the soil underneath (http://www.bioflora.com/increase-crop-yield/). Nollet & Rathore (2012) reported that over usage of chemical fertilizers is not enough beneficial to hold on nutrients to maintain soil quality. In fact chemical fertilizers are main reason to deteriorate soil quality. Various Biotechnological methods can help increase the soil quality also.

In this context the review is about the Biotechnological methods which improve nutrient value. The paper can be divided into following sub headings -

1. Role of Biotechnology in improving soil conditions and crop yield
2. Use of Bioflora/ Bioengineered microorganisms to combat plant disease
3. Genetic Engineering methods/ GM Crops
4. Herbicide Resistance
5. Nitrogen Fixation
6. Biotechnology and nutrient enhancement

1. Role of Biotechnology in improving soil conditions & crop yield
Soil health can be defined as the efficiency by which soil microorganisms support plant's and animal's growth simultaneously maintaining positive physical as well as chemical properties of soil (Abbott & Murphy, 2007). Biotechnologists have been focusing on improvement of soil quality by improved microbial selection which enhances the

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functionality of microbes via plant specific interaction on soil micro biome (Mitter *et al*., 2013).

Soil pathogens like fungi cause main soil borne vegetable diseases as it can survive for long with its ability to produce resistant chemical structures. Besides this, scarcity of irrigation water, poor quality & high cost are also leading factors for poor soil quality and less crop yielding.

Plants may be picked with better quality roots to improve nutrient availability, stress protection and better microbial proliferation. This also includes that the microbial induced antibiotic activities naturally suppresses the fungal pathogens of the soil. Kremer (2017) also presented that bio fertilizers or organic fertilizers are better than chemical fertilizers as these provide nourishment for soil microorganisms.

Soil improvement can be done in many ways. First of all soil testing is performed to find out any disease or non-availability of nutrients or lack of productivity in the soil. The soil can then be treated with the right organic product on the basis of specific requirement.

2. Use of BioFlora / Bioengineered microorganisms to combat plant disease & improving crop yield

Soil has several micro-organisms which are an important contributor to the quality enhancement of the soil by generating and supplying nutrients to the soil. Nutrients availability and transfer in soil is dependent on a variety of soil microorganisms (Richardson, 2001). There is an ever increasing usage of plant-beneficial micro-organisms in place of chemical fertilizers as chemical fertilizers are harmful to the nature (Lin *et al*., 2020). Bio flora happens to be a Biotechnological approach that has been used for the past several years to increase crop yield. It is an alternative to chemical pesticides that maintains integrity of the soil and control the spread of soil borne diseases. In this Biotechnological method, through patented mineral extraction process natural products like organic and sustainable fertilizers are produced. These products help in certain natural processes by which crops grow & develop.

In the same process, the Integrated Life Sciences Research Center (ILSRC) has developed a product named GOgreen through Biotechnology which is a mix of several micro-algae. It is a method of using the multi-coloured algae to improve the crop production. It's an innovative method by using micro-organisms to sustain plant growth and avoid using environment degrading pesticides and fertilizers.

Another Biotechnological method has been developed by Greenbelt Resources Corp. They have developed corn-to-ethanol method. They are using biomass or agriculture waste to produce ethanol by fermentation process.

Lin *et al*., (2020) also found that *Trichoderma* based bio fertilizer may be used in the betterment of the crop yield and soil quality in their study on tomato.

Kishore and Shewmaker (1999) tried to explore possibilities through Biotechnology to improve agronomic features, use of various bio-enriched crops to generate higher output. Using micro-greens to fortify crops with natural nutrients is becoming a popular biotechnology.

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3. Genetic engineering methods/ GM crops:

Genetically engineering may improve crops by:

1. Resisting local pests that make it possible of getting higher crops that are sustainable to the environment.
2. Post-harvest improvement in storage and quality of Agricultural produce

Genetic engineering methods are being put in extensive researches to increase crop yield that guaranteed food supply to increasing world's population (Estrada *et al*., 2017). It is evident from the research of Research Briefings (1984). Research work was done on the development of crop that is of better nutritional value, simultaneously it can survive the hardships of environment. In this series of research work, an extensive work has been done on the development of bio fortified or nutrient fortified crops. Provitamin A carotenoid fortified maize and sweet potato were developed by Nkhata *et al*. (2020).

Parsley et al. (1999) stated pros and cons of genetically modified crops. These may be beneficial when deficient person have some fortified food; on the other hand transfers of genes from one species to another may transfer allergic contents also. A number of researches have been done on genetically modified crops (Cherubin *et al*., 2017; Cappellari *et al*., 2015; Singh *et al*., 2013).

4. Herbicide resistance

Hance (2008) studied a lot on herbicide resistant plants to improve weed management in plants. Herbicide resistant weeds have been a valuable tool in understanding herbicides biochemical, genetic, anatomy and physiological behaviour. It was noted by them that resistance mechanism of weeds was different from that crop herbicides. Schutte *et al*. (2017) described that the crop rotation can be reduced by adopting herbicide resistant crops.

5. Nitrogen Fixation

Lindstrom & Mousavi, 2019 studied about efficacy of nitrogen fixation in Rhizobia. Nitrogen fixation is helpful in non-leguminous plants for better crop yield, therefore a lot of researchers have tried different modes (natural / manmade) for nitrogen-fixation in plants specially in cereals. There are many projects which are being worked on genetic modification of several cereals like maize to increase the colonization of diazotroph. Mehmud *et al*. (2020) also worked in the same direction. They stated that biological nitrogen fixation is an environment friendly mechanism of sustainable agricultural production. They also elaborated transferring nitrogen-fixing in non-leguminous plant from leguminous plants.

6. Biotechnology and nutrient enhancement

Biotechnology has played major role in eliminating infectious diseases, malnutrition etc. by producing nutrient enriched crops like soyabean, maize, golden rice, potato etc. (Afzal, 2016). Bouis (2000) stated that plant breeding is an efficient alternative intervention to combat micronutrient malnutrition. Bertioli (2016) also studied role of food biotechnology in improving nutritional quality of food for Asian countries.

Uncu *et al*. (2013) presented role of Biotechnology in enhancement of nutrients in crops that were usually deficient in those nutrients. It speed up process of bio fortification. Use of Biotechnology also supported in development of plants that had improved photosynthesis & nutrient uptake. Similarly, Biotechnology was used by Garg *et al*. (2021) in development of vitamin fortified cereal flour to balance the nutrient losses in cooking.

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Conclusion

Biotechnology is being used to benefit the environment by decreasing the usage of pesticide and herbicides. It is helping consumers by development of food crops with increased nutrition and medicinal value. Innovative uses of biotechnology in enhancing soil quality, crop yield, BioFlora enrichments, genetic engineering methods, herbicide resistance methods, nitrogen fixation techniques and fortification of food products have definitely showered human beings with blessings of good health, agricultural sustainability and food availability but at the same time there is a concern of careful and strict monitoring of impact of newly developed techniques on the health and ecosystem.

References

1. Abbott, L.K. & Murphy, D.V. (2007). Soil biological fertility: A key to sustainable land use in agriculture. ISBN: 978-1-4020-6618-4, DOI: 10.1007/978-1-4020-6619-1

2. Afzal, H., Zahid, K., Ali, Q., Sarwar, K., Shakoor, S., Nasir, U. & Nasir, I.A. (2016). Role of biotechnology in improving human health. *J of Mole. Biomarkers and Diagnosis,* **8:1**, 1- 7. doi: 10.4172/2155-9929.1000309

3. Bertioli, D.J., Cannon, S.B., Ozias- Akins, P. *et al*. (2016). The zenome sequences of *Arachis duranensis* and *Arachis ipaensis*, the diploid ancestors of cultivated peanut. *Nature Genetics,* **48**, 438 – 446.

4. Bouis, H.E. (2000). The role of biotechnology for food consumers in developing countries. Agricultural Biotechnology in Developing Countries. 189 – 213. https://link.springer.com/chapter/10.1007/978-1-4757-3178-1_11

5. Cappellari, L.R., Santoro, M.V., Reinoso, H., Travaglia, C., Giordano, W. & Banchio, E. (2015). Anatomical, Morphological and phytochemical effects on inoculation with plant growth promoting Rhizobacteria on peppermint (Mentha Piperita). *J Chem. Ecol*., **41**, 149- 158.

6. Cherubin, M.R., Tormena, C.A. & Karnel, D.L. (2017). Soil quality evaluation using the soil management assessment framework (SMAF) IN Brazilian oxisols with contrasting texture. *Rev. Bras. Cienc. Solo*, **4**, e0160148.

7. Estrada, E. (2017). The role of biotechnology in agricultural production and food supply. *Int J Agri & Natural Resources*, **44(1)**, doil: http://dx.doi.org/10.7764/rcia.v%25vi%25i.1567.

8. Frank, J. (2018). The impact of biotechnology on food and nutrition today. Sigerson: https://hackernoon.com/the-impact-of-biotechnology-on-food-and-nutrition-today-7fe89eab8d9b.

9. Garg, M., Sharma, A., Vats, S., Tiwari, V., Kumari, A., Mishra, V. & Krishania, M. (2021). Vitamins in Cereals: A Critical Review of Content, Health Effects, Processing Losses, Bioaccessibility, Fortification, and Biofortification Strategies for Their Improvement. *Front. Nutr*., 8:586815, doi: 10.3389/fnut.2021.586815

10. Hance, R.J. (2008). Herbicide resistance in plants. Edited by H.M. Le Baron and J. Gressel. Chichester, England: Wiley - Interscience (1982), pp 401

11. http://www.bioflora.com/increase-crop-yield/

12. Kishore, G.M. & Shewmaker, C. (1999). Biotechnology: Enhancing human nutrition in developing and developed worlds. *Proc. Natl, Acad Sci*. USA **96**, 5968 – 5972.

13. Kremer, R. J. (2017). Biotechnology Impacts on Soil and Environmental Services. Soil Health and Intensification of Agroecosystems Chapter 16, Editors: M. Al-Kaisi and Bl Lowery, Elsevier Academic Press, doi: 10.1016/B978-0-12-805317-1.00016-6

14. Lin, Ye., Xia, Zhao., Encai, Bao., Jianshe, Li., Zhirong, Zou. & Kai, Cao (2020). Bio-organic fertilizer with reduced rates of chemical fertilization improves soil fertility and enhances tomato yield and quality. *Scientific*

Reports vol: 10, 177.

15. Lindstrom, K. & Mousavi, S.A. (2019). Effectiveness of nitrogen fixation in rhizobia. Microbial Biotechnology published by John Wiley & Sons Ltd and Society for Applied Microbiology. *Microbial Biotechnology*, **13**, 1314–1335.

16. Mehmud, K., Makaju, S., Ibrahim, R. & Missaoui, A. (2020). Current progess in nitrogen fixing plants and microbiome research. *Plants (Basel*) **9(1)**, 97. doi: 10.3390/plants9010097

17. Mitter, B., Brader, G., Afzal, M., Compant, S., Naveed, M. & Trognitz, F. (2013). Advances in elucidating beneficial interactions between plant soil and bacteria. *Adv. Agron*., **121**, 381- 445.

18. Nkhata, S.G., Chilungo, S., Memba, A. & Mponela, P. (2020). Bio fortification of maize and sweet potatoes with provitamin A carotenoids and implication in eradicating vitamin A deficiency in developing countries. *Journal of agriculture and food research*. **2**, 100068, https://doi.org/10.1016/j.jafr.2020.100068

19. Pesticides: Evaluation of Environmental Pollution (2012). Edited by Hamir, S. Rathore & Leo, M.L. Nollet

20. Ortiz, R. (1998). Critical role of plant biotechnology for the genetic improvement of food crops: Perspectives for the next millennium. *Electronic journal of Biotechnology*, **1(3)**

21. Parsley, G.S., Siedow, J.N. & Gasson M. (1999). Applications of biotechnology to crops: Benefits and risks. CAST Issue Paper 12

22. Research Briefings (1984). The National Academies of Sciences Engineering Medicine. The National Academies Press

23. Richardson, A.E. (2001). Prospects for using soil microorganisms to improve the acquisition of phosphorus by plants. *Australian J of Plant Physiology,* **28(9**), 897 – 906.

24. Schutte, G., Eckerstorfer, M., Rastelli, V., Reichenbecher, W., Vassalli, S.R., Lehto, M.R., Saucy, A.W. & Mertens, M. (2017). Herbicide resistance and biodiversity: agronomic and environmental aspects of genetically modified herbicide-resistant plants. *Environment Sci. Europe*. **29(5**), https://enveurope.springeropen.com/articles/10.1186/s12302-016-0100-y

25. Singh, S.K., Tang, W.Z. & Tachiev, G. (2013). Fenton treatment of landfill leachate under different COD loading factors. *Waste Management,* **33 (10**), 2116- 2122.

26. Uncu, A.O., Doganlar, S. & Frary, A. (2013). Biotechnology for enhanced nutritional quality in plants. *Critical reviews in plant sciences*. **32(5**), 321- 343.