Biotechnology—The Interface between Agri-resources and the Consumer

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Introduction

Biotechnology appears to be one of the oldest technologies known to mankind. Microorganisms are micro-biotechnology laboratories that came on earth much before man (Glazer & Nikaido, 1995). Literally, biotechnology implies both micro-technologies at appropriate cellular level on one hand and macro-technologies such as down stream processing of enzymes, proteins or bioactive substances on the other (Reed & Nagodawithana, 1995).

The role played by the medieval science in conventional biotechnology especially has relevance to India which includes its inputs in the area of fermentation, sera vaccines and diagnostics, tissue culture methodologies, bio-fertilizers, bio-pesticides, plant breeding, enzyme technologies as well as interfacing the living organism in the form of its components with inanimate objects like DNA chips hitherto not known to bring in the word called “Biotechnology” (Tengerdy & Szakacs, 1998). One may also use the word bioengineering for engineering living organisms. But this is in a sense of integrating certain knowledgebase innovations across various subject areas (Szarka, 1999).

Food and Biotechnology

Looking at food, one seldom realizes the journey that the food has made from farm to consumer and how it gets handled and how it gets value added. With food as a total holistic organic matter, the following five important considerations emerge: (i) land, water and agricultural management; (ii) traditional and scientific management of the field; (iii) skilled labour force including women in the agricultural sector; (iv) pre- and post-harvest practices and technologies adopted subsequently for value addition; and (v) the “farm to consumer to farm” agenda as a chain of operation (Prakash, 1997, 1998, 2001).

For all the above activities to happen, the entire chain has to be sustainable. Sustainability stems from the sustainability of agriculture, the production verses productivity, preventing losses especially by post harvest diseases and encouraging micro entrepreneurs at rural level (Swaminathan, 2001). Such micro entrepreneurs also need mega push, underpinning value addition and processes that get adopted at micro level and impart value at the local levels to the grower, the farmer and the seller, many more times the value of the raw material that they trade today. In such a system, the role played the biotechnology can be highly impactful.

The success story always lies in the economic benefit through economic sustainability of the system. The roles played by the Central and the State Governments, the large number of micro and mega enterprises, the financiers and non-governmental agencies, all have to be networked. This would be very challenging as so many parameters are to be put into one system making it difficult and more demanding to deliver the final product. Obviously, there must be a clear support and strategy encompassing a clear societal mission and the end beneficiaries.

To mobilize large amount of food grown in India currently like 84 million tons of rice, nearly 72 million tons of wheat and 132 million tons of fruits and vegetables, there is need of a foolproof system of networking to minimize wastage and adding value (APEDA Report, 2001; FAIDA Report, 1998). This also should ensure that the farm to consumer to farm concept reaches a clear mandate and becomes a commitment and should be imbibed into the entire chain of movement of food. Biotechnology has a major role to play in this chain of operation.

To succeed globally, marketing ability has to be skilful in this competitive world especially in the post World Trade Organization (WTO) and the Intellectual Property Right (IPR) regime (Gandhi & Patel, 2001;...
When it comes to success stories of withdrawal of patents of turmeric, neem and basmati by the patentees, the world knowledge-base wins over (Mashelkar, 2001). Today, in the IPR regime, one has to move from fighting patents to fiercely fighting and filing patents parallelly. This paradigm shift is very crucial. This is also true of the geographical appellation and one cannot be quiet as the millennium round of WTO negotiations are coming close now. One needs to emphasize brand equity in India without any hesitation. One should also protect the traditional knowledge in the strategic plan of IPR especially in the area of herbal medicine and in the area of food processing. Homework is needed even to stay in the international arena of IPR requiring a very thorough exercise to preserve and encourage the local biodiversity.

**Networking Food Biotechnology**

If India has to really be a leader in biotechnology, it is required to integrate different teams working on the same subject into one funnel to extrude a product/process in the area of biotechnology. Infact, the Department of Biotechnology, New Delhi, has been playing a pivotal role in addressing this issue in a very strategic way to build up “Team Biotechnology India” concept and it has already started paying dividends. This network of operations of public/private sectors, R&D institutions, academia and industry must go together to share the intellect and the infrastructural facilities to address critical problems. Agricultural and food biotechnology probably is one of the most complicated area because of its large number of parameters involved in the network of the plant or animal or microorganism kingdom. Subsequently, it augments processing and, in many instances, it is the biotechnological approach that works in saving the time of operation as well as implementing its cost effectiveness. The vital areas such as enzymes, proteins, detoxification, rapid analysis as well as precise and accurate analytical instrumentation, are worth mentioning. It is here that bioinformatics counts and paves way for biotechnology pitted against disease and hunger. Innovation are needed to increase our strength in niche areas with ultimate goal of economic transition through borderless biotechnology which obviously would include bioinformatics also in its journey for outreaching to the society.

Whatever is done, the implementing industry has to fight in the market place. The challenges of biotechnology have also to address tomorrow’s operation skills so that its benefits reach the common man in terms of societal commitments and eco-friendliness. Value addition by way of byproduct utilization as well as technologies, which are adaptable under constraints of investment, skilled labour, storage and transportation, leads to the point of entrepreneurship or micro entrepreneurship. In the area of food, this micro entrepreneurship basically works to empower, train and retrain the farmer through adaptable, efficient micro processing systems which include the knowledge of preharvesting, grading, or even supervising bulk processing, preservation, etc. in the field of agri-business. Massive inputs can be linked to mega markets on a continuous basis so that the farmer goes through various steps where the chain is well interlinked for his profits and to be a partner in the link.

Agri-business has to be looked into from the economic and sustainability angle. It could be through co-operative systems rather than individuals especially at rural level who want to deliver with active involvement of knowledgeable people. Unless the entire movement is carefully planned and until it reaches the processing system, especially with perishable and horticultural products, it could never extend itself to the outside market.

In the chain of process of a food that is reaching to the consumer, biotechnological intervention is needed in nature for higher yields, method of harvesting and storage, transportation with adaptable and appropriate methodology and primary processing to make it edible from the plant to the processor/consumer (e.g. paddy to rice). Subsequently, value additions are needed by utilizing the scientific knowledge to enhance shelf life as well as the basic raw material and at the same time byproduct utilization and ultimately addressing that fundamental question of a safe food from it.

**Biotechnology in Paddy Processing**

With biotechnological intervention, genetically improved high yielding varieties of paddy have been produced with better cooking characteristics and better acceptability. But, it requires a very important step of sheller-huller to open the paddy to give unbroken rice in its fullest form, which the consumer demands. But, by doing so, one cannot keep the rice for more than a week as the bran layer on the rice contains lipase, which starts acting and makes the rice rancid as
soon as the paddy husk is removed (Raghavendra Rao et al., 1965; Hirayama et al., 1975). This may require basic work on lipase in vivo and in vitro. Hence, when rice is polished, to keep the rice grain longer, whether for public distribution or for extension of shelf life for further value addition, biotechnological approach is required to address such issues. Rice bran contains proteins, waxes, oil, crude fibre, tocopherol, tocotrienol, lecithin, gums, oryzanol (an antioxidant and anticarcinogen), etc. An integrated approach with biotechnological intervention can make rice bran into a powerful byproduct. Further polished rice can be converted into many products such as poha, puffed rice, byproducts of rice for traditional food processing, rice flour and through appropriate enzymatic treatments even value added products like rice vermicelli, all of which require interface of biotechnology (Prakash, 1999; Pszczola, 2001).

Biotechnology helps system to utilize the agri-materials for beneficiation and value addition (Tengerdy & Szakacs, 1998). Therefore, one should look biotechnology and food safety from a holistic approach and arrive at certain clear mandate for food safety through biotechnological approach and application (FAO/WHO, 1996).

Quality consciousness has become vital at various stages right from the farm to the consumer. In the area of food regulations, one has to harmonize from different angles including GM foods. Such harmonization that ultimately will blend the different organizations to one nodal point on a common platform of food regulations and ensures safety to the consumer. The role of natural additives, the awareness of pesticide and insecticide residues in the food, the hygienic aspects of primary processing and microbiological load of food as well as the importance of areas of nutraceuticals has become very vital to address from an overall development point of view towards reaching that human face and the societal aspect of food processing through biotechnological approach.

Therefore, on one hand there is genetic engineering with recombinant DNA technology as pure biotechnology and on the other hand there is a long list of biotechnological approaches that needs to be done, especially when a food material has to be evaluated for safety from those days of nitric acid tests of argemone in mustard oil to ELISA tests of today. It is always important to integrate the various approaches such that whatever is being thought of in the area of food safety and biotechnology, it should have a high content of basic research with a freedom of thinking, accepting failures of experiments which only paves way for better experiments and better results in the future.

Innovations are now being recognized by many organizations and institutions as a clear pathway of creating and sustaining a perfect and a competitive protocol for combating the market requirement in this new millennium decade (Watzke & Saguy, 2001). Many companies have focused on in-house R&D integrating itself into the down stream and up stream areas of business. With a clear balancing of the systems especially in biotechnology, one needs to address it from a holistic point of view; innovations in biological areas should encompass, utilizing the past knowledge and linking it with the future requirements through economical and alternative innovative methods.

As one enters in the cutting age of technology, innovative initiatives in agri-food and medical biotechnology (accepted more as life saving) embark into future research programmes in plant and animal biotechnologies and also on research management issues in biotechnology with a clear mandate of safety and security to the consumer and also to the manufacturer, keeping in view of the balance in nature.

**Conclusion**

Biotechnology, using the informatics as well as knowledge-base in terms of safe modification of cells (plant or animal or microbial), will ultimately give better products and processes in the area of pharmaceuticals, nutraceuticals, better high yielding crops, eco-friendly leather and textile technologies, DNA fingerprinting, agro-chemical industries, healthcare biotechnology, bio-pesticides, sericulture, enzyme industry, nutritional benefits and better environment which may include biodegradable plastics and all the way to safe and healthy foods with a very clear demarcation of bio-safety aspects. It is the fond hope of everybody that science will ultimately promote the development of a safer, cleaner and healthy world around with an emphasis on "more from less" and also with the emphasis on better economic empowerment with clear mandate for poverty alleviation, sustainable development and a firm food security for all to live in this marvelous world which is so rich in biodiversity through biotechnology.

**References**


