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Nano-Technology:aninnovative leading edge infarming

1*V.Archana,2*BabyAbrarunnisaBegum

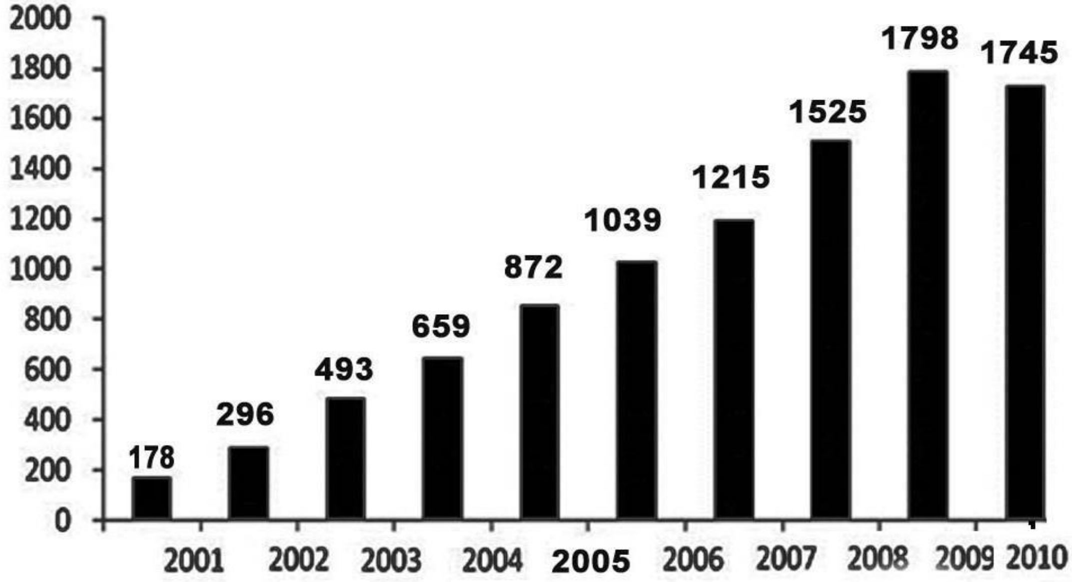
1*Assistantprofessor,AndhraMahilaSabhaartsandsciencecollege,OsmaniaUniversity(campus),Hyderabad, Telangana.
2*Associateprofessor,ShadanWomenCollege forEngineering&Technology,Khairtabad,Hyderabad
vallamarchana@gmail.com,abrarunnisa@gmail.com

Abstract
Ingredients that are smaller than a nanometer are used in nanotechnology. Nanotechnology is one of the most important recent developments in science. It can be used in every step of the production, processing, storage, packaging, and transportation of agricultural products. Pesticides, herbicides, and nutrients will be used less, and nutrients will be used more efficiently, with a more regulated release, and with a more selective transfer. Automation and central control of agriculture are now possible. Conventional farming cannot keep up with an ever-increasing population, unpredictable weather, diminishing resources, and a shrinking area. The use of nanomaterials in the agricultural food sector must also be evaluated for public approval in order to avoid a situation similar to that of genetically modified organisms. It provides an overview of nanotechnology's current and future applications in agriculture and food production.

Key words: "Nanotechnology," "Nano Pest Control," "Smart Dust," and "Nano Lamination" are all examples of nanoparticle engineering.

Introduction

With the help of nanotechnology, customers can choose their preferred flavor, texture, nutrient content, and shelf life for the food that will be produced in the future. It has the potential to be a game-changer in agriculture, and it has been dubbed "the future big thing." A "smart" safety packaging will be used to protect the food, and it will be able to detect contaminants and decay agents. On nanotechnology, a unique and pioneering inter-disciplinary scientific process, molecular components and devices are crafted, progressed, and applied at the molecular level in nanoscale scales [1], which is approximately one billionth of a meter in length. Applied and vital sciences can benefit greatly from its wide range of applications. Science and technology will leave no field untouched by their enthralling applications. farming sector is no omission. The 21stcentury observed a huge growth in Nano-food arcade. ScienceQuotationIndexExtendedthrough2001-2010demonstratesthatthereisaconstantgrowthinthisfield.Graph1showsanaggressivegrowthinresearchandpublicationinfield ofnanotechnology[2].



Graph1:numberofscientificpublicationsinthefiel dofnanotechnologyduringthelastdecade (2001-2010)[2]

Due to the potential for increased food value and reduced agricultural inputs, nanotechnology is becoming increasingly important in agriculture. Improved nutrient content and extended shelf life are some prospective advantages. In many developing countries, the agriculture sector provides the primary source of income for more than 60% of the people, either directly or indirectly. In the 21st century, it still faces challenges like decreasing nutrients in the soil and environmental issues such as runoff and accumulation of pesticides and fertilizers. As a result, the most important step is to embrace a technology that can improve modern agriculture's productivity while also reducing costs, allowing for the efficient delivery of precise amounts of input at precisely the correct time [6]. When it comes to the most recent advances in agriculture technology, nanotechnology has a prominent role to play in making agriculture and food production more efficient and cost-effective. Here are a few examples of how nanotechnology might be used in agricultural and food production in the future. In this particular subject, there are a number of applications of nanotechnology, however they are largely in the early stages of experimentation. In the near future, it is anticipated that these will be part of precision farming.

Methods

ExploreStrategyandSelection Principle

Google Scholar, Google Web Browser, Pub Med Central, and Pub Med were used to conduct a systematic investigation of the key word 'bio-nanotechnology, nano-herbicides, nano-pesticides, nano-encapsulation, and nanotechnology in food packaging' with no filter applied. This search has further screening for inclusion based on the journal's content and the year it was published. Academic articles published between 2000 and 2010 were analyzed in this study.

Only a small number of documents are found to contain errors because of their importance and relevance to the topic matter. A total of 55 articles from peer-reviewed journals were used for this investigation.

Discussion

NanoscaleCarriers

Tools that can be installed to distribute herbicides, manure, pesticides, and plant growth regulators in a well-organized manner are called "smart nanoscale tools." It is hoped that the nano scale carriers will be able to affix the roots of plants to neighboring soil and organic matter. First and foremost, the goal is to improve environmental stability and reduce the amount of material needed [8, 9].

Nano-pesticide

Preventive agricultural yields are hampered by pests. Over-the-counter pesticides are a common part of traditional pest control strategies, and their widespread use raises the cost of crop production. Pesticide overuse also pollutes the environment and waterways. In order to save the environment and lower the cost of crop production, pesticides must be used in plenty and at a reduced value [10]. It can be achieved by increasing the pesticide's preservation duration. An effective pesticide regulator can be maintained for a long amount of time if the pesticides used in the early stages of crop growth are determined to have the appropriate competence. It is possible to increase the insecticidal value by using a nanotechnology process known as 'nano-encapsulation'. The active pesticide component is encased in a thin fenced shell in the nano-encapsulation process (shielding layer). Pesticides that are 'managed free of the active ingredient' would be the most effective method for increasing efficiency and reducing pesticide use, as well as reducing environmental hazards. Pesticides, for example, can be transported by clay nanotubes known as 'Halloysite' (Clay nanotubes). Pesticides' charge will be reduced to a low level with less impact on the environment because of the longer release duration and improved interaction with plants that these pesticides have [11]. Nano-structured catalysts, which can increase pesticide and insecticide productivity while also reducing the dosage required by plants, could be an additional benefit in this context [12]. Validamycin-loaded Porous resonant silica nanoparticles (PHSNs) were found to be effective in reducing pesticide runoff by Liu et al. [13]. The use of nano-silica to reduce crop bug infestations has previously been studied. Nano-silica works by physiosorption. Afterwards, the insect was killed by physical causes as a result of the absorption of its circular phospholipids. When it comes to controlling bugs that attack cotton, soybeans, peanuts and rice, Syngenta's Karate® ZEON insecticide has a broad spectrum of activity. Lambda-cyhalothrin, a synthetic pesticide, is the product's active ingredient and is released into the environment when it comes into contact with leaves. When exposed to an alkaline environment like an insect's stomach, a functioning nano-insecticide known as "gut buster" discharges its contents.

Nano-herbicidesforeffectiveweedresistor

The greatest hazard to farming is weeds, which reduce yields by as much as half. As a result, the only option left is to eradicate them. Using Nano-herbicides in an eco-friendly method, weeds can be eliminated without leaving any toxic residues in the soil or environment [16]. If the active component is paired with a'smart' delivery system, the herbicide will have a lower value. Weeds that have become resistant to traditional herbicides will be unable to grow in the presence of these tiny particles. Herbicides now on the market are thought to control or kill the weeds that grow above the earth. The herbicides do not interfere with the activity of feasible. Ground plant parts such as rhizomes or tubers, which serve as a foundation for future weeds. Nanoparticle-encapsulated herbicide molecules are designed for specific receptors in the roots of target weeds to enter the root system and translocate to areas that limit glycolysis of food stores in the root system, ultimately causing the specific weed plant to starve for food and die. Too much herbicide use over a long period of time leaves residues in the soil that harm subsequent crops [17]. Detoxification of weed remnants is therefore crucial. In addition, repeated use of the same herbicide over a long period of time leads to the development of weed resistance to that herbicide. Atrazine herbicide can be decontaminated by (CMC) Carboxyl Methyl Cellulose nanoparticles up to 80% [18]. [20, 21].

“Smartdust”(Smarttinyresearchlaboratory)

Nano-sensors will soon be distributed like dust across plantations and fields, acting as the ears, nose, and eyes of the agriculture industry.... The information sensed by these tiny wireless sensors can be linked together. These are pre-programmed to respond to a variety of variables, including humidity, nutrients, and temperature shifts [19]. Networked smart particles' circulated intelligence can respond immediately to a few changes in atmosphere, providing an early warning to improve techniques and means of dealing with environmental variances. An environmental assessment can be made using gas sensors and smart dust [21]. Effectiveness is maximized by using GPS sensors to show parameters in real time [15]. This is the most efficient method in this regard.

Sanitizers(Disinfectants)

A new generation of sensors will soon be dispersed like dust across plantations and fields and will serve as the agriculture industry's ear, nose, and eye. It is possible to connect the data gathered by these wireless sensors. A multitude of variables, including humidity, nutrition, and temperature fluctuations, are pre-programmed into these [19]. Using the circulating intelligence of networked smart particles, early warnings of environmental changes can be provided to help enhance strategies and methods of dealing with environmental variations.. Using gas sensors and smart dust, an environmental assessment may be conducted. [21]. Using GPS sensors to display parameters in real time maximizes effectiveness [15]. This is by far the most effective approach.

[22] Escherichia coli and Bacillus subtilis were inhibited by ENPs of C60 aggregates, according to research [23]. Staphylococcus aureus and Bascillus subtilis continue to be poisoned by Ag ENPs. When biosynthesized by fungi, comparable Ag nanoparticles showed lethal consequences against fungi like Aspergillus Niger [25]. In addition to using quantum dots, germs can be detected in food items (QDs). Conservatory dyes with excellent luminosity and light stability have been found to be more successful with these [26]. Since QDS is a fluorescent indicator for E. coli O157:H7 detection, this issue has been taken into consideration. Also, a rectilinear polymer called chitosan encased in ZnS and Mn2+ nano-particles offers a ginger flavor to Bascillus species tags. colourluminescencebeneath fluorescencemicroscope[9].

Nanoparticlesincropenhancement

The use of nanoparticles for crop development is well documented. Generally, nanoparticles containing metal oxides and carbon have been the subject of education [27]. Tomato seeds with nanotubes of perforated carbon (CNTs) sprouted more frequently in 2009, according to Khodakovskaya. CNTs' ability to absorb water greatly increased seed sprouting [28]. By enhancing Rubisco activation mobility and refining light absorbance, Ti02 nanoparticles have been proven to speed up spinach growth. By enhancing nitrogen uptake, nano-particles of TiO2 improve spinach growth. ZnO nanoparticles inhibited rye grass and corn seed sprouting, according to DeRosa et al. A putative nutrition delivery pathway may have been uncovered since these left open spaces in plant roots. [33] Plants are able to absorb silicon NPs, which causes an increase in disease and strain resistance. Primo MAXX®, a plant growth controller made by Syngenta under the brand name, is intended to protect turf grass from heat and disease stress, as well as drought.

Nanolamination

Gases, lipids, and moisture accumulation are other key issues that affect the food that is to be perished. Additional options for protecting food from harmful toxins include nano-lamination. By coating food with nano-laminations or simply spraying it on the food's surface, nano-lamination can be beneficial. Along with food preservation, they can enhance the nutrition's texture, flavor, and color. Protective films made from edible polysaccharides, fats, and proteins known as nano-laminates are thin and non-harmful food grade shields. Carbon dioxide and oxygen should be able to pass through these with ease. Moisture-based nano-laminates provide real protection against lipids. According to Predicala, (2009), nano-coatings have been utilized to prevent fruits from shrinking and losing weight as an alternate advancement in this field. [36].

Foodpackaging

Whenever possible, customers prefer fresh, easy-to-handle packaging materials over less healthy alternatives with shorter shelf lives [17]. As solid waste material, conventional food packaging materials are extremely difficult to breakdown. There are still questions about the performance and economic effectiveness of biomass-based materials in food packaging [37, 38]. Blends in biopolymers such cellulose and polyesters made from it [39], oil from plants, and gelatin from animals in food packaging [40, 41].

offer the mechanical strength and reinforcing needed, as well as superior barrier characteristics [42]. Polymer nano-composites, according to Choudalakis et al. (2008-2009), offer great potential as a barrier against gases (e.g., O2 and CO2) and water vapours. Since Yano et al. and Rhim et al. created several types of clay combinations with condensed (WVTR) water vapour transmission rate and comparative absorptivity, the ground breaking in this field has already been completed [42-45]. It has also been demonstrated that TPS clay nano-composite films may be produced in incredibly small sizes and with impressive outcomes [46]. Many nanocomposites have also been created to obtain plastics with increased heat resistance and fencing properties [47], including nylon 6, which is a good example. In food packaging, nano-clays and silicates, such as montmorillonite, hydrated alumina-silicate coated clay, have proven to be successful. It has also been found that nano-clays have better thermal degradation and glass transition temperatures [49-51]. As well as being used in food storage containers, carbon nanotubes (CNTs) like polyamide [52] and polyvinyl alcohol [53] are also being used in food packaging. Kraft food's development of a "electric tongue" is an unresolved feat. To put it another way, it's a collection of Nano sensors whose discharge changes the color of gases as the nutrients spoils As a result, it's easy to tell if the food is still fresh. There are nano-sensors in the foodstuff when it is packaged; they can also be used for intensive care and food traceability [56]. Many farm infections can now be detected with the use of fluorescent nanobarcodes developed by Cornell University researchers. Even a non-trained individual can utilize a site indicator to detect pathogens [57]. Electronic nose (E-nose) is a concept similar to the human nose in terms of identifying scent and odorant concentration in food. It encases ZnO nanoparticles, which are commonly used in gas sensors. Since different gases provide different signals for detection, the process relies on a robust pattern to work

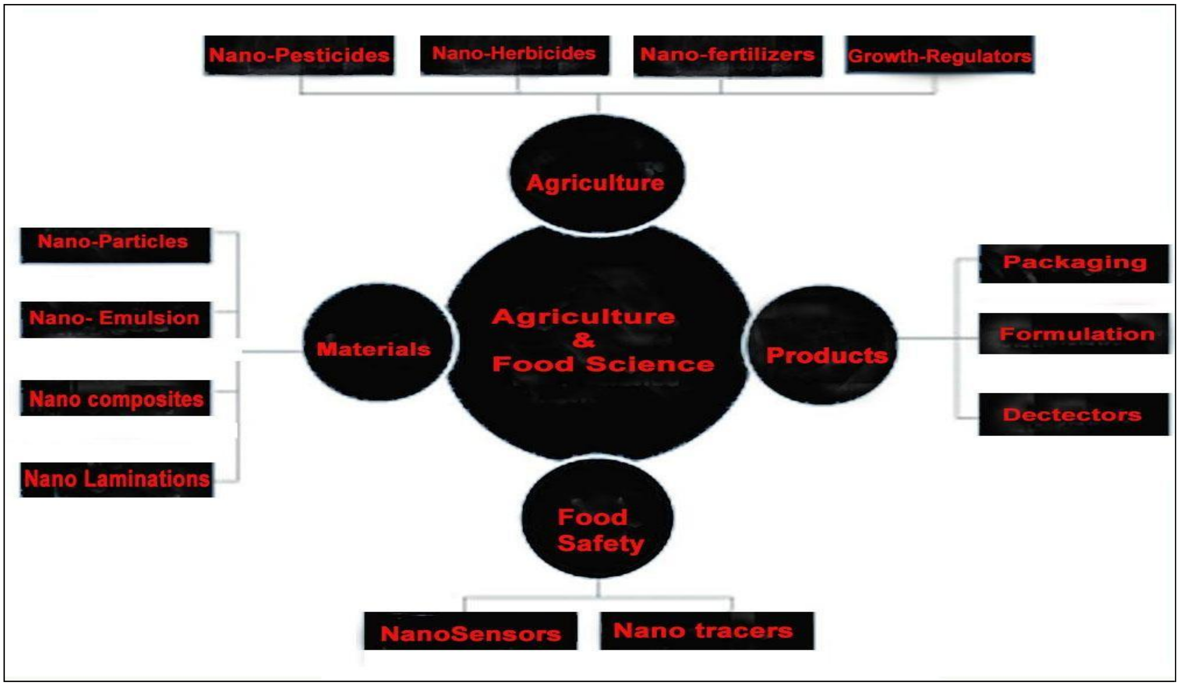


Figure1:Apictorialdemonstration ofapplicationsofnanotechnologyinagro-food

Sector

Conclusion

Agricultural production in the twenty-first century will be more diverse to meet the needs of a growing population, which will require more food and fiber to be harvested while using fewer rural workers and dealing with unpredictable weather and population increase. By 2050, we'll have to deal with a population of over 10 billion people, which will only exacerbate these problems. There will be an increase in demand for agricultural products in the future. Raw materials will soon be seen as the foundation of trade and industrialization, particularly in developing countries with larger populations [59]. Agriculture-dependent countries must adapt to this circumstance by adopting better-organized procedures, labor-saving and maintainable manufacturing methods. Precision farming's next step will be enabled and framed by Nanotechnology, which has astounding potential in the agricultural sector. Even in difficult environments, it will increase agrarian capacity to produce improved harvests in an environmentally responsible manner [60]. Several governments throughout the world have realized the potential of nanotechnology in the agro-foodstuff industry and are investing a significant amount of money in it. Nanotechnology's role in feeding the world's ever-expanding population and diminishing natural resources is critical. However, public acceptance of this novel technology must be monitored at the same time. The agro-food industry's perspective on nanotechnology is rather hazy, given the public's lack of enthusiasm for genetically modified organisms (GMOs). The safety of food will always be a top priority, regardless of how nanotechnology affects the food industry and the items that enter the market. In order to gain public attention and acceptance, it is imperative to inform the public at large of its potential benefits at every phase. It is also risky to train future nanotechnology workers. The mechanisms by which nanomaterials are detrimental and their effects on the natural environment must be elucidated through general investigations. If we were able to overcome these attitudes, emerging countries may look forward to a bright and prosperous future.

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