Prospect of nanotechnology in food and edible packaging: A review

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Abstract
Nanotechnology represents an efficient and important tool for increasing the shelf life of food. Reducing the size of Nanometric scale gives material distinct and improves the properties when compared to a larger system. Edible coatings are usually prepared with the help of natural polymers that are non-toxic, economical and readily available. The new tendencies are to use edible coating as carriers of functional ingredient by incorporating antimicrobial, ant browning, and nutraceutical agent to improve the quality of fruits and vegetables. In recent research, it has been found that nanotechnology can bring revolutionary changes in various departments of food, post harvesting management, food storage and packaging, bio sensor, medicine, nutrient and nutraceutical delivery, ingredients and additives, and also bioprocessing of food.

Keywords: Nanomaterial, nanoparticle, packaging, edible coating

Introduction
Norio Taniguchi, for the first time in the year 1974, used the term “Nanotechnology” and the information was deeply given by Richard Feynman and gave acknowledge about carbon based structure like buckyball. Normally 1-100 nm is size considered as nanomaterial. Nanomaterial size less than 100 nm is very useful in latest technology development (Paul et al., 2019) [33]. It is also used in harvesting, food processing and modifications of food processing and all those technology attached with biological makeup. (Thiruvengadam et al., 2018) [39] In the coming years, we can see many changes in food industry throw the nanotechnology. It is built in two forms: food additive (nanotechnology is inside of packaging) and food packaging (nanotechnology is outside of packaging). A food additive are used for increasing the shelf life of product, nutrient factors, flavor, and texture and also helps to detect the food pathogens. Nanoparticles has limited diameter and high surface area for reactions and its beneficial for metallic nanoparticles that attracts more consideration (Hamelian et al., 2018) [21]. Recently, many nonmetallic particles are give good chemical, magnetic, optical electronic properties that’s why they use in nanosensors and nanoparticles based edible coating. Every year near about 25% to 80% of harvested fruits and vegetables lost because of spoilage. (Hamelian et al., 2018) [21] Edible coating concept helps to increase consumption of raw and perishable vegetable and fruits and control the horticulture crop losses (Nisha et al., 2016; Hazirah and Armylisas, 2016) [30]. Edible coating base material has developed by polysaccharides, proteins and lipids. Chitosan will be used in organic based coating for preventing food spoilages and contaminations. According to Zambrano-Zaragoza et al., (2020) [44] edible coating controls the respiration rate, control microbial growth during preservation of fruits and vegetables. In food packaging nanotechnology give positive response and also inorganic and organic nanoparticles are use in edible coating. (Saravanakumar et al., 2020) [36] Inorganic nanoparticle like silver np, titanium oxide np, zinc oxide np, silver oxide np are mostly use in food packaging as a detector, control the food borne diesis and increasing the shelf life of the poultry meat, citrus juice, melon slides, beef meat exudates. Bio material based packaging materials are on demand because of they are non-toxic, biocompatible & environmentally friendly and used to control the humidity, toxic gases and lipids between food and outside of packaging material. Smart packaging gives the information regarding the internal environments and also gives data about how much food spoil and how much food is sheaf. During transportation smart packaging is very helpful because they have a time indicators.(Nile et al., 2020) [29] In Nanotechnology various types of nanobiosensors are available and those are used in detecting size, color, shape of fruits and vegetables.
In the field of nanotechnology, the use of nanoparticles as a delivery system for biomedical applications is a rapidly growing area of research. These nanoscale particles have unique properties due to their small size, which allows them to interact with both biological systems and materials in new ways.

**Nanoparticles in food formulations**

Nanotechnologies are applied in food production machinery. Some attentions may be required for different types of nanomaterials for filters or coatings, but each particle is not good for nanotechnology and nano materials. Now a day’s nanotechnology is mainly focus on agro chain business and scientists are doing research on nano size additives, nano-biosensors, attractive packaging those gives all information about inside the packaging.

**Nanocapsule**

Functional ingredients like drugs, vitamins, colorants, antimicrobials etc all those are classify in molecular weight, physical and chemical properties (GuhanNath et al., 2014)[20]. All those ingredients are hardly used in nanocapsule as original form and they are gives very frequently result in the fraction of the seconds. (Nile et al., 2020) [20] Food additives are used as a delivery vehicle because they can help to delivery of functional food at targeted place. Secondly, functional ingredient may have to be protected from chemical or biological degradation. Third, they have control regarding the release quantity and it also detects the environment conditions then after release the drug or food ingredient. Fourth, the delivery system with the other components in the system has to be compatible, as well as with the physiochemical and qualitative attributes of end product. Some types of delivery techniques are use in under nanotechnology.

- Association colloids
- Bio polymeric nanoparticles
- Nano emulsion and so on.

**The above mentioned points are discussed below:**

**Association colloids**

A colloid system is a mostly useful system to sparing tiny particles in around the surface and it’s under controlled (GuhanNath et al., 2014) [20]. Tiny particles are combined and make small atom or molecule under association colloid system. (Bahrami et al., 2019) [6] some of the examples of colloid such as surfactant micelles, vesicles, bilayers are used to summarize and carry all type of food additives. Association colloid is one type of hydrophobic and naturally favorable process. Colloids are decrease boundary between nonpolar materials. Surfactant molecules, co surfactant molecules, different concentration and other parameter (PH, Temperature) are affected on association colloid structure. Association colloid size is between diameters 15-100nm ranges because of that it is including in nanocapsles. Association colloid process is suitable in any environmental condition and transparent material that is main benefit of this system.

**Bio polymeric nanoparticles**

In nanometer rang biopolymers are developed by using food grade biopolymers via accumulation of polysaccharides or proteins or phase separation method (GuhanNath et al., 2014) [20]. Polyactic acid (PLA) is mostly use in drug supplier; also provide food additives and some vitamins. (Ahmed et al., 2019) [1] BSA and Sodium alginate are also nano particles based bio polymer it’s develop by using emulsion solidification method. Polyalkylcyanoacrylate and polyanhydride are synthetic bio polymers those are created by nanomaterial. Gelatin and albumin proteins based bio polymeric nanoparticles are non-toxic and easily biodegradable. Albumin protein is a low immunogenic but they play role as extracellular antioxidant. Additionally they do attach to any other free radical and stop the harmful effect. Protein bio polymeric nanoparticles have a number of advantages that’s why they got premier place.

**Nano-emulsions**

An emulsion can be defined as the mixture of two or more liquids that are not combine easily (“Enhancement the antibacterial agent of edible coating and films by incorporating it with green metallic nanoparticles using Luria mobile leaves,” 2020) [14]. Normally nanoemulsion have 500 nm diameter but when solution pass under high pressure gauge homogenizer particle size is change under 50-500nm range because of the food additives and food drugs in combined with the nano droplet at any phase. (Godbole, 2018) [19] Nano emulsions have various physical and chemical properties. They are using these properties to make number of multiples or multilayer nano emulsions those are helpful in targeted delivery system as per particular environmental conditions. Some company such as Vadilal, Nestle are make nanoemulsion based frozen yogurt.

**Nanofibres**

Nanofibres have a high surface area to volume ration, range between 10-500nm rang (Guhan et al., 2014) [20]. It has physicochemical properties those are helpful in artificial food development, make more attractive. (Paul et al., 2019) [33] All well as use in bioactive compound for targeted delivery and bio sensors. Nano fiber is give stage to develop bacterial culture. Eco friendly food packaging are made and created varies type of food matrix due to the nanofibres. Now century, Researcher is mainly focus on development of nanofibres based biopolymer.

**Nanocapsules**

A nanocapsule is latest drug carrier system. Now days, nanocapsule is a famous as a nanovesicular process that is denoted inner core structure in which drug holder place. (Ravichandran, 2010) [35] Nanocapsules given protection against moisture content, temperature, PH value and oxidation- reduction. Nutraceutical material is transfer by using casein micelle based capsules or nanocarrier. Casein micelle carrier is very use full because of its stability and good sensing nature. Improving bioavailability in gastrointestinal food supplements are need those are providing throw the Nanocapsule.

**Nanostructures and Nanoparticles in food**

Nanotechnology is already present in nature like starch, it is a crystalline structure and process starch is converting in to gelatinization form. (Xing et al., 2019) [42] During digestion starch is convert in gel formation at that time we can see 2D (two dimensional) nanostructure and it is nutritional benefit for human body. Nanostructure has good self control
properties of food and milk based product because of oil in water phase and air in water phase. Example of oil in water is milk, mayonnaise and air in water is tiny bubble in surface of cold drinks glass. Molecules stability is decides by using interface and provide example of 2D nanostructure. Surfactants are available in many foods structure that why unpredictability produces. Guhan et al., (2014) [20] have also reported different type of raw material and latest technology based food processing, adjustment and build up of self developed nanostructure. (Nile et al., 2020) [29] Additionally with the help of atomic force microscope we can easily understand of interaction between proteins and other molecules. Build the certainty of the protein that can be help in making khoya, paneer, etc.

**Nanoparticles in food quality easement (Biosensors)**

In resent year various technologies have developed in nanotechnology based on application in food safety like biosensors, detection system etc. (Paul et al., 2019) [33] has focuses on research works and production. These technologies are giving potential benefits to both the public and private sector. Main applications of biosensor in food sector are upgrade in product quality control, traceability and food safety. The advantage of nanobiosensors in various production specters: raw material preparation, processing of food department, main monitoring of storage conditions. These are use as a cost effective tools for controlling quality & process controls as well as ensure the food safety.

Wegari Dera and Bogale Teseme (2020) [41] have developed novel nanomaterial with modifying electrode surface so that it can give faster electron transfer of binomolecular and also give better accuracy. This advantage has inspired research in coupling nanomaterial base biosensors. These types of sensor are applied in food safety, clinical analysis and environmental control. US University is developing “electronic tongue” for a food packaging material. The tongue is detecting the highly sensitive gases released by food. When gases are released, at that time sensor strip changes color and give clear visible signal about whether it is good for eat or not. Agro Micron has researched regarding the Nanobioluminescence detection spray where a detector such as luminescent protein. EU scientists developed the portable nanosensors to detect some chemical pathogens and toxin in food. In this project, they also developed DNA biochips based on another device that can detect pathogens (Thiruvengadam et al., 2018) [39]. The technique is used to detection of harmful bacteria in fish and meat based product. In fruit, plant and water large amount of organophosphate is available with the help of pesticide detection based nanosensors so to clearly identify. Pesticides are easily soluble in water which is why they are speeded in all over the farm and reaches to the table. Semiconductor and metal based nanoparticles nanotubes have great optical and mechanical properties, and helps to increase the sensitive transducer signal improvement. Fluorescent semiconductor nanoparticles are used for detection of high sensitive pesticide.

Biosensor rapidly detects the pathogen of the food borne diess in food and beverages, on the farm or during processing, in the laboratory or even better in storage. Salmonella and E.coli are mostly available in common food contamination. Streptavidin-coated ferrofluid (Fe₃O₄ nanoparticles) based biosensor used to detect the Salmonella bacteria. Here (Fe₃O₄) was used to improve the signal. Cheng et al. (2008) [9] developed Perfluorosulfonated cation-exchanger polymer with multiwalled carbon nanotubes base amperometric sensor to detect colli forms. E.coli, construct single bacterium detector in this sensor hetero-structured silicon/gold nanorode array functionalized with Salmonella antibodies.

**Health consequence of nanoparticles**

Nanotechnology has gave different types of material and unique products in various different areas (Thiruvengadam et al., 2018) [39]. There have a better application in manufacture sector and domestic sector. When normal material convert in nanometre size then after improve safety issue regarding workers, customers as well as the human environment. Nanoparticles also hazards for human body and wildlife due to their small size.

Thiruvengadam et al., (2018) [39] studied about toxicity of CuO nanoparticles on human blood lymphocytes. In human body Cu play very important roll. Particularly is used in the field of pharmaceutical, engineering and technical. CuO nanoparticles have been utilized as a semiconductor, catalyst, gases and solid ceramic pigment and sensors. In pharmaceutical field CuO-NPs is also useful in preventing and protecting human body and every disease that are occurred through Escherichia coli and staphylococcus aurous. Also some toxicity has been noted in many studies: see cell death in human lymphocytes because of CuO-NPs. In CuO-NPs have changes of glutathione levels, which trigger lipid per oxidation in the cell that oxidation stress induced. Mostly CuO-NPs was affected on two cells which include the liposome and mitochondria. The concentration of CuO-NPs related to human exposure levels can suppress the human immunity system by induction of cell death in lymphocytes. For the first time Scientists have found out a mechanism by which nanoparticles causes damage to lung and have shown that it can fight back by blocking the process involved, taking a step towards directing the growing concerns over the safety of nanotechnology.

Nanotechnology is an industry with a projected annual market of around one trillion US dollars in the year 2015. It involves in controlling the atoms and molecules in order to create a new materials with a variety of useful functions, including many that could be really beneficial in medicine. Although it is not clear that how the nanoparticles causes damage to lungs.

**Nanopackaging**

The main goal of packaging is to physical protection in order to protect the food from external shocks and vibrations, microbial infestation and also to give protection against the temperature providing barrier protection by scavenging oxygen and other hazards gases. (Al-Naamani et al., 2016) [6] Now a day’s packaging material are made by biodegradable material and green synthesis based nanoparticles that helps to reduce the environment pollutions. Nanoparticles could impart as their active and intelligent properties to food packaging as they can protect the food against the external facture (Al-Naamani et al., 2016) [3]. Nanoparticles based material improves various properties like barrier properties to moisture, UV- protection, gasses and some volatiles components, thermal resistant, mechanical strength and seal ability. Nanotechnology also has shown its potential future in smart packaging. (Bahrami et al., 2019) [6] Nanoclay provide gas barrier, for antimicrobial protection nano – Zinc oxide and nano – Silver oxide, for UV protection use nano – Titanium dioxide, nano – Titanium nitride for mechanical strength and
nano silica use for surface coatings etc. Across the world nanotechnology has already immersed with packaging industries with extraordinary systems. Paul et al. (2019) [33] have reported applicability of silver nano particle with some types of polymeric material such as PVC, PE, and PET etc. Silver nano particles helps to kill bacteria, fungus, viruses and pathogens and are used as a better and safe packaging material. For storage of milk, juice and other perishable food nanoparticle based packaging material is 100 times better than the regular packaging. In food packaging material one film namely “hybrid system” has a number of silicate nano particles. They mostly stop the entrance of oxygen and other food spoilage gases and also remove moisture and volatiles thus protect the food from drying. They also helps in modifying the permeating behavior of foils improve mechanical and heat resistance and increasing the barrier properties of packaging material. (Zambrano-Zaragosa et al., 2018) [44] Many types of nano particles shows good results for packaging materials like TiO$_2$, SiO$_2$, silver nano particles, nano clay etc. TiO$_2$ is UV resistant, transparent and is also sold by many companies as a filler particle in foils or plastic containers. Approved by food department so many safety data refers to the larger form of TiO$_2$ and still have no record of any type of investigations to prove whether packaging material containing Nano TiO$_2$ is only inert (not generally reactive) as those containing the high “bulk” form. It cannot be ruled out that nano TiO$_2$ particles migrates from packaging to the food and all the particles provide protection for the food for example controlling the permeability of foils, blocking UV light and act against the bacteria and fungi. Paul et al. (2019) [33] produced nanocomposite films with the help of polybutylene adipate-co-terephthalate (PBAT) and silver nanoparticles. At 435 nm range, it has showed maximum plasmonic absorbs the silver nanoparticles. Moreover, it improves water permeability and tensile strength of film. Enormous potential and nanocomposite are the least material that are used in production of active packages. In Europe, polymer nano composite industries are use in this type of material but are going slow. The main reasons are acceptance by customers in market, the cost price of material and processing, restriction due to the legislation, lack of knowledge and influence of nanoparticles on the ecological and on human health. In this type of film, it has high surface to volume ration of nanofillers which is why they are protected for microbial spoilage. Chitosan, gelatin, poly lactic acid, alginate and polyglycolic acid, blends of starch and sodium caseinate are some of the material used in the production of bio plastic with application in edible thin film. The edible film can be developed from edible nano laminates that mostly protect the food from lipids, gases, off-flavor and orders. This type of material can be prepared with polysaccharides, lipids or proteins. Lipid based film provides barrier against oxygen and carbon dioxide but this film is not protected against moisture. Lipid film is good but they offer limited resistance.

**Inorganic nano-particles**

Inorganic nano-particles are becoming popular due to their widespread applicability. Different applications of inorganic nano-particles in edible coating have been shown in Table 1.

**Metal oxide nanoparticles based coating**

Edible coating developed by incorporating metal oxide nano-particles viz., Titanium dioxide (TiO$_2$) and Zinc oxide (ZnO) nanoparticles are reported to have better moisture barrier properties (Nasim et al. 2019; Seyed Amir et al. 2016; Xin Zhang et al. 2019) [42]. (Nasim et al. 2019) [20] Has developed sesame protein isolate based bionanocomposite film using casting method and reported better mechanical and water barrier properties due to addition of 3% w/w of TiO$_2$ nanoparticle in SPI film at that time. Additionally TiO$_2$ nanoparticle based film exhibited better oxygen scavenging ability and the pigment of photo degradation potential is noted at accepted level. (Mahmood et al. 2017) improved efficiency of cellulose nanofibres (CNF) due to incorporation of TiO$_2$ nanoparticle. Xin Zhang et al. (2019) [42] also reported better water resistant properties, mechanical strength and improved ethylene scavenging properties for the edible film based on black plum peel extract (BPPE), Chitosan (cs) and TiO$_2$ based nanoparticle. Bahram fathi-Achachlouei et al. (2018) [6] reported UV- shielding and also provides mechanical properties for nanocomposite films based on novel carboxymethylcellulose (CMC), sodium montmorillonite (Na-MMT) and titanium dioxide (TiO$_2$) nanoparticles, respectively. Similarly (Aswathy Jayakumar, 2019) [24] reported enhanced water registrant properties, UV resistance, mechanical and chemical properties for PVA-starch based film in combination with nutmeg oil, ZnO nanoparticles and jamun extract. ZnO nanoparticle based composite film has been found to their antimicrobial properties (Emamifar and Mohamadizadeh et al. 2020) [14]. Also reported antimicrobial properties of chitosan zinc oxide nanocomposite coating on PE films. Recently Joshy et al. (2020) [23] have reported applicability of ZnO encapsulation xanthan-based edible coating in controlling weight loss of fresh produces. (Emamifar and Mohamadizadeh et al. 2020) [14] have reported antimicrobial strawberry juice packaging put in ultrasonication and a significant changes been noticed under 4 and 12 min time as compared to other sample and both the time have given the same treatment, which is why +US 4 treated showed the highest ranked sensory attribute was found compare to other and + US 12 treated packaging controlled the microbial growth.

**Silver nanoparticle based films**

Silver nano-articles Kandasamy et al. (2019) [26] have reported extended shelf life of cut fruits coated with silver nanoparticles; which was found to be effective in controlling the toxicity of pathogens. (Nicoli et al. 2016) [30] reported about control lactic acid bacteria on chicken sausages for 30 days with the help of silver nanoparticle, D-glucose and green route based film. Has reported improve efficiency of kinnow fruit for 4 months at 4 ºc and 2 months at 10 ºc due to incorporation of silver nanoparticles, carboxy methyl cellulose, guar gum powder.

**Organic nanoparticles (organic synthesis)**

Now a day’s edible coatings are being developed by using organic nano-materials, which are effective in maintaining post-harvest quality and control loss of horticulture crop loses (Table 2). Chitosan

Earlier studied have reported that chitosan based edible coating delays the decay of the horticultural produces (Eshghi et al., 2014; Esyanti et al., 2019) [15, 16]. (Eshghi et al., 2014) [15] has reported effect of nanochitosan (50-100nm) based edible coating on strawberry. Without Copper and with copper loaded nanochitosan based fruit store under 4 ºc and
70% RH for 20 working days. Both the coatings gave good result but without copper loaded nanochitosan based coating is better than copper loaded strawberry. Anthocyanin level is increases in those fruits are coated without copper concentration and anthocyanin is decrease in with copper coated fruits during 12 days. Copper loaded nanochitosan based strawberry fruit gives very fast reduction of ascorbic acid content and shows unacceptable response on nutritional value. It also shows visual damage in nanochitosan based coating but delays in color changes, off flavor development and dehydration.

(Esyanti et al., 2019) [16] Have reported the utilization of chitosan based nanoparticles as good coat and noted its effect on (Musa acuminate AAA group) Cavendish banana ripping process. In this paper, synthesized and characterized chitosan nanoparticle is studied and it shows that the chitosan nanoparticles rapping effects on the fruit ripening process. Ionic gelation method could be used for synthesis of chitosan nanoparticles with average size ranging 102.4 – 370 nm and the polydispersity index of 0.251 – 0.303. In Fourier Transform Infrared Spectroscopy (FTIR) shows that the one new peak indicates the amine group in chitosan and triplyphosphate group in NaTTP. Surface of banana analyzed by the Scanning Electron Microscope (SEM) shows a smoother skin contour on coated banana compared to without coated banana. Fruit coated with chitosan nanoparticles 0.2% has a slower skin discoloration by 2-3 days compared to control treatment.

(Nisha et al., 2016) [30] Reported effectiveness of chitosan based film for controlling microbial activity. Chitosan based coating affects positively on the apple and tomato. Chitosan silver nanocomposite based coated samples have showed delay in time of ripening of the fruits in compared to other two groups. Chitosan and silver nanocomposite based coating controls the moisture content between the fruits and the external environment. Eman et al. (2020) [13] developed edible film of gelatin powder incorporated with AgNO₃ nanoparticles. Luria leaves and glacial acetic acid are used for development of silver nanoparticles. They have reported prolong shelf life of strawberry during storage at 0.5°C and 90-95% relative humidity for 12 days due to antimicrobial action of silver nitrate AgNO₃.

### Bio-based coating

Vegetable based oil is mostly used in fruit and vegetable coating because the application of nanotechnology based strategies for bio-based edible coating improved moisture barrier properties and extended shelf life of fruits and vegetables. (Hazirah and Armylisas, 2016) [12] Has reported promising results for bio-based edible coating of palm oil. Palm oil has a two fractions palm stern and palm olein and is mostly helpful in development of edible based nano coating materials. Apart from being safe, non toxic and biodegradable that has high productivity of oil palm ensures continuous supply of the raw materials. Palm oil based nanocoating is effective in inhibit enzymatic browning and provides prolong the shelf life to raw produces. (Zambrano-Zaragoza et al., 2020) [44] studied about beeswax based edible coating on fruits for increasing storage life of strawberry fruit. These edible coating is made by using xanthan gum and propylene glycol and different concentration of beeswax solid lipid nanoparticles (BSLN). All concentration is applied on strawberry without any outer treatment. They have found L best result for 10 g/ BSLN and noted low weight loss compared to higher concentrations of BSLN.

### Table 1: Inorganic nanomaterial and its application

| No. | Nanomaterials | Application | Example | Reference |
|-----|---------------|-------------|---------|-----------|
| 1   | Nano silver  | Strong disinfection & Storage Rich in 22 essential vitamins and minerals Sterilization & quality control Antibacterial Antibacterial agent | Nano-silver salad bowl, storage box, Daily vitamin boost Nano colloidal silver Nano silver sol. Food packaging | (Nile et al., 2020) [29] |
| 2   | Silicon dioxide | Biosensor Prevent UV light Pesticides & herbicides Edible coating | Detect food colorant hygroscopic, drying agent Food packaging Fruits and vegetable based coating | (Jones et al., 2008) [25] |
| 3   | Titanium dioxide | Biosensor | Used as whitener in dairy (milk, cheese) | (Zhao et al., 2008) [44] |
| 4   | Nano clusters Iron np 30nm | Development of functional food | Nano cuticles slim shake vanilla, fortified fruit Juice | (Nile et al., 2020) [29] |
| 5   | Zinc oxide | Food preservations Edible coating | Antimicrobial agent Improve strawberry, banana etc. fruits properties | (Zhao et al., 2008) [45] |
| 6   | Nano Gold | Detector | Pathogen, glucose detector | (Zhao et al., 2008) [45] |
| 7   | Carbon Nano Tube | Food packaging | Wine, honey | (Nile et al., 2020) [29] |

### Table 2: Organic nanomaterial and its application

| No. | Nanomaterials | Applications | Examples | References |
|-----|---------------|--------------|----------|------------|
| 1   | Nano liposome | Food processing | Specific delivery of nutraceutical Active and passive delivery of gene, protein & peptide Delivery of pesticides fertilizers | (Nile et al., 2020) [29] (Pradhan et al., 2015) [34] |
| 2   | Colloidosomes | Food processing | Increasing the nutrient content of food | (Nile et al., 2020) [29] |
| 3   | Chitosan np | Food processing (functional food) | Encapsulation antimicrobial agent plant growth promoting agent | (Jones et al., 2008) [25] |
| 4   | Casein micelles | Nutritional supply | Delivery sensitive product | (Nile et al., 2020) [29] |
| 5   | Alginate & chitosan | Target delivery supply | Supply B-carotene, lycopene, vitamins A, D, E, Omega -3-fatty acids | (Nile et al., 2020) [29] |
| 6   | Nanocochleates | Nutritional supply | Nutrients are efficient deliver without affecting color and test | (Gommans et al., 2006) [19] |
Conclusion
There is no doubt that Nanotechnology in the food industry has become gradually important. Food innovation has been observed as a sector where in the coming years the nanotechnology is expected to play a major role. Resources of Nano food packaging will improve the safety of food, nourishment of life and most importantly repairs any holes and tears present in packaging. Additionally Nano food packaging also helps in adding substances for increasing the life of food in terms of packaging. New and innovative nanotechnology has an exceptionally extraordinary property in food source chain such as precision farming technique, smart feed, improvement of food texture and quality, packaging, labelling, as well as the use of agrochemicals such as nano-fertilizers, nano-herbicides, and nano-pesticides etc, around the whole agricultural sector. Finally, nanotechnology enables to change in the existing food systems and processing to make sure that the products are safe, by creating a healthy food culture, and enhancing the nutritional quality of food.

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