NANOTECHNOLOGY IN FOOD SECTOR- A REVIEW

Beenish[1*] , Bazila Naseer[2],Farheena Iftikhar[3]

[1,2,3]Division of Food Science and Technology Sher-i-Kashmir University of Agricultural Sciences and Technology (SKUAST-K),Shalimar,Kashmir,(India)

ABSTRACT

Nanotechnology is the production of such substances and systems with properties designed at atomic levels to exhibit significantly improved properties.Nanotechnology has a prospective to revolutionize various fields of science and technology.It can catalyze new and improved products to evoke new benefits.It controls structure and shape at nano scale.Such products will give novel implication.Nanotechnology is being tremendously applied in various food applications like food processing,food packaging,flavor and nutrition,on-demand preservatives,encapsulation of odours,nanosensors to detect food spoilage etc.However,public appreciation should be taken into account.Tangible food products that are better for the environment will be easier to market and will have more positive effects on consumer benefits.This technology is expected to grow more in future with immense potential.

Keywords:nano composites, nano laminates, nano sensors, nano packaging, public perception

I.INTRODUCTION

Nanotechnology is the technological application for manipulating macroscale products by reducing the size upto the nanoscale. Nanotechnology is generally defined as the design, production, and application of structures, devices, and systems through control of the size and shape of the material at the10−9 of a meter scale [1].Nanotechnology has stimulated wide applications in various fields of science and technology.New ideas and innovations have been generated in medical sciences, biological analysis,microfabrication, chemical industry,computer electronics, microfabrication,semiconductor physics, food industry etc. There is an increased progress in using nanomaterials in these sectors. Nanotechnology has become evident in Food processing sector in last years. In food industry, nanotechnology is announcing new plans to improve existing food products, adding nutritional elements, detecting food spoilage, customization of foods, food packaging,functional foods, nutraceuticalsetc.Scientists are using various promising techniques for characterization of various engineered nanoparticles and improve food processes that uses highly active enzymes to offer various health benefits.Nanofoods are superior due to their large surface to volume ratio to their large surface to volume ratios compared to macroscale food products. The physical, chemical, and biological properties of structures and systems at nanoscale are substantially different than the macro-scale counterparts due to the interactions of individual atoms and molecules thereby offering unique and novel functional applications [1]. The development of new functional materials, microscale

and nanoscale processing, product development, and design of methods and instrumentation in food production maybenefit from nanotechnology [2]. Nanotechnology has great potential to generate new productsin the food domain with numerous benefits. New food packagingcan be developed by adding nanoparticles or by using nanotechnology.Such new products may have desired properties, such aspreventing the invasion of micro-organisms [3]. Although manyfood scientists would claim that the industry have alreadyembraced nanotechnology, only limited researches in nanotechnologyhave been performed in foods and food-relatedproducts, and the global development of nanofoods is indeedon its initial stage [4].

II.NANOTECHNOLOGY, ENVIRONMENT AND PUBLIC RESPONSE

A number of studies have examined public perception of nanotechnology in the US and in Europe. Results of these studies show that public knowledge about nanotechnology is very limited [12].The application of new technologies in food production and processing can have the merits of being environmentally friendly and increasing the sustainability of the industry[5]. Environmentalattitudes may be able to moderate the acceptance of novel technologies [6]. Increased environmental knowledge held by peoplechanges the trade-offs between untraded environmental services and market products [7]. Historically, research into the determinants of public acceptance of emerging technologies (including those applied in the agri-food sector) has occurred subsequent to public rejection of a particular application.For example, the European public's rejection of genetic modification of food and crops is frequently interpreted as representing the normative societal response to new technology [9]. Consumer acceptance of cloned animals may be low if the derived animal products are allowed to enter the food supply chain under current regulatory/market conditions.Acceptance will be dependent ondevelopment of a robust,clear and reliable regulatory system for managing the technology,taking on board the ethical concerns that have beenraised [9] According to the affect heuristic, affect evoked by nanotechnology products influences risks and benefits associated with this technology [12]. Nanotechnology foods may be more acceptable to consumers who perceive tangible benefits. Results of a Swiss study suggested that acceptance of GM products was largely determined by perceived benefits [11]

III.NANOMATERIAL PRODUCTION

Production of new nanomaterials is achieved through either a ‘‘top-down’’ or ‘‘bottom-up’’ approach. The ‘‘topdown’’approach involves physically machining materials to nanometre size range by employing processes such as grinding, milling, etching and lithography. The commercial scale production of nanomaterials today primarily involves the ‘‘top-down’’ approach. As nanoscience matures, the use of the ‘‘bottom-up’’ approach in industry is expected to increase. The ‘‘top-down’’ approach involves size reduction by the application of a force. The degree of control and refinement in size reduction processes influences the properties of the materials produced. The balance between size reductions to a functional level and solely making things smaller must be clearly understood when determining what processes may be used for a particular size reduction process. Size usually relates to functionality of food materials. A smaller size means a bigger surface area and is desirable for purposes such as improved water absorption, flavor release, bioavailability and faster rates of catalysis. Uniformity or a narrow size distribution is also required for better control of functionality and product quality. The three types of force used in the size reduction of foods are compression, impact and shear [10].

IV.BARRIER APPLICATIONS OF POLYMER NANOCOMPOSITES

When food will not be consumed immediately after production, it must be contained in a package that serves numerous functions. In addition to protecting the food from dirt or dust, oxygen, light, pathogenic microorganisms, moisture, and a variety of otherdestructive or harmful substances, the packaging must also be safeunder its intended conditions of use, inert, cheap to produce, lightweight,easy to dispose of or reuse, able to withstand extreme conditionsduring processing or filling, impervious to a host ofenvironmental storage and transport conditions, and resistant tophysical abuse. This is a tall order for any material to fill [8]. A critical issue in food packaging is that of migration and permeability [13-16]. In general, permeability of a polymer to oxygen or moisture is dependent on a large number of interrelated factors, including:polarity and structural features of polymeric side chains, hydrogen bonding characteristics, molecular weight and polydispersity, degree of branching or cross-linking, processing methodology, method of synthesis, and degree of crystallinity. Permeability to one migrant can also be complicated by the presence of other migrants. For instance, ethylene–vinyl alcohol (EVOH) exhibits quite excellent oxygen transmission rate (OTR) values under dry conditions, but under very humid conditions (relative humidity >75%) it can possess OTR values more than an order of magnitude higher due to swelling of the polymer and plasticization in the presence of diffused water molecules [17,18]. Because no known pure polymer exhibits all the desiredmechanical and barrier properties required for every conceivablefood packaging application, complex multilayer films or polymer blends are often utilized. For example, in an application whereultrahigh oxygen barriers are required over a large humidity range,a high oxygen barrier, water sensitive material like EVOH can besandwiched between two layers composed of a relatively hydrophobicpolymer such as polyethylene [19-21].

V.FOOD PACKAGING

Polymer nanotechnology is a broad interdisciplinary area of research, development and industrial activity that involves the design, manufacture, processing and application of polymer materials filled with particles and/or devices that have one or more dimensions of the order of 100 nanometers (nm) or less [22-24]. Over the last decades, the use of polymers as food packaging materials has increased enormously due to their advantages over other traditional materials [25,26]. In the polymer global market that has increased from some 5million tonnes in the 1950s to nearly 100 million tonnes today,the 42% is covered by packaging (Fig. 1), with the packaging industry itself worth about 2% of Gross National Product in developed countries (Applied Market Information

Ltd., 2007). Polymer packaging provides many properties including strength and stiffness, barrier to oxygen and moisture, resistance to food component attack and flexibility [27].

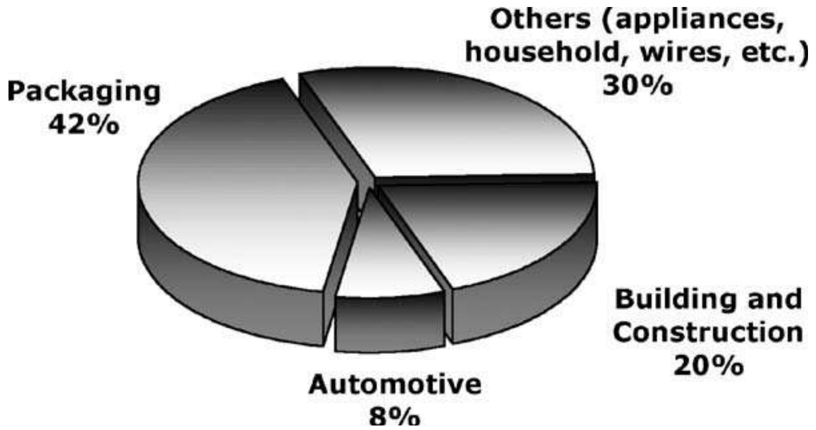

Fig.1 Polymer global market

One problem in the food is its physical–chemical stability and its microbial contamination during storage. Proteins, lipids, carbohydrates and water in food change with time due to environmental and processing conditions (light, moisture, temperature, etc.). However, the use of edible thin film or packages can delay food deterioration by increasing shelf life and enhancing quality. Carrageenan, chitosan, gelatin, polylactic acid, polyglycolic acid, alginate, blends of starch and sodium caseinate are some material used in the production of bioplastic withapplication in edible thin film packaging [28].

VI.NANOSENSORS

Nanosensors are an important area in agriculture because these devices may be able to detect and quantify very small concentrations of pathogens, organic compounds and other chemicals and can be nondestructive. Furthermore, these devices exhibit high sensitivity, fast response and recovery, potential for the integration of addressable arrays on a massive scale, among others [29]. There are different analytical methods to detect and quantify pesticides that include liquid/gas chromatography and mass spectroscopy.These devices have advantages that include high surface-to-volume ratios, leading to the loading of more enzyme/antibody and consequently high interface sensitivity; low detection limits; excellent selectivities; fast responses and small sizes [30].

VII.FUNCTIONAL FOODS

Functional foods can be encapsulated in these nanoparticles (form food grade proteins or polysaccharides) and released in response to specific environmental triggers[31]. In fact the change of solution conditions induces particle dissolution or porosity [32].The efficiency of delivery systems can be increased by dendrimer (unique class of polymer) coated particles. Dendrimers which have regular, highly branched 3-dimensional structure can be applied as sensors, catalysts, delivery of drugs, and in gene therapy [33]. The main criteria for using dendrimers as delivery system is their nontoxicity, nonimmunogenecity,and biodegradability [34,35]. Aqueous solution of starch-based nanoparticles which behave like colloids can be applied in mixing, emulsifying, producing of paints, inks, and coatings [36]. Colloids also have been used for encapsulation and delivery of polar, nonpolar, or amiphilic functional ingredients [37-39].

VIII.CONCLUSION

Significant amounts of the science and fundamental research under the banner of 'nanotechnology' is too speculative to fit into a box that has its potential use written on the lid. However, there is a great deal that has some intention of a particular end-use behind it [40]. In fact, nanotechnology has the potential to revolutionize agriculture and food systems. The nanoscale level of foods can affect the safety, efficiency, bioavailability, and nutritional value properties as well as the molecular synthesis of new products and ingredients [42]. Nanotechnology could change the society by creating new innovations in various fields.However,there can be some adverse effects of the technology too.Public acceptance is also a concern in this field as in the case GM foods. A preliminary framework has been developed to inform therisk analysis and risk management of nanomaterials [41].Trust and certain regulations need to be adopted to improve the consumer acceptance.

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