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# Application of Nanotechnology as a Tool in Animal Products Processing and Marketing: An Overview

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## ABSTRACT

In the faster pace of life and more consciousness of consumers about food safety and security, nanotechnology may be the important tool to augment the livestock products to fulfil the future demand. By the exploitation of the use of nanoparticles we can produce meat, milk and poultry products in much faster pace with high safety. Nanotechnology may serve the purpose of vegetarians who are willing to eat high proteinous food without killing the animals in form of *in-vitro* meat, cultured meat or laboratory grown meat. The nutritional quality along with quantity to fulfil the stomach of hungry peoples in the coming year's nanotechnology may be the modern weapon. The transportability of livestock products with freshness is a great concern which may be meet out by the use of nanoparticles in form of flexible pouches, laminates and eatable coatings. Besides, this technology is having enormous scope in the livestock based industry.

**Key words:** Nanotechnology, nano meat, nano milk, nano eggs, packaging

## INTRODUCTION

Nano is a Latin word which means 'Dwarf' and the thought of nano-technology was first time given by Noble Laureate Physicist Richard P. Fennan in South California in 1952 (Kakade, 2003). In real sense term 'nanotechnology' was popularized by Eric Drexler in 1980's. Nanotechnology is a technology of experimenting and manipulating with particles, called nano-particles that are demonstrated in the scale of nanometres (a billionth of a metre). By the exploitation of the concept of Nano-technology one can manufacture the structures, materials, decades and machines by using nano-particles with programmed precision (Chaudhary *et al*., 2006; Chaudhary *et al*., 2005). Nanotechnology is considered as a potential technology to revolutionize veterinary medicine, animal health and other areas of animal production (Sekhon, 2012). By the use of emerging technology one can alter the form of production, processing, packaging and even mode of products ultimate use. Nanotechnology may also be useful to develop nanoscale materials, controlled delivery systems, contaminant detection and to form nanodevices for molecular and cellular biology. Use of nano size materials with powerful design may decrease the power by 38% in these multipliers and latency by almost 36% (Assadi, 2008a). By the use of novel multiplication algorithm in nanotechnology we can reduce transistor count by 12% (Assadi, 2008b). It is shown that the proposed reversible full circuit adder for nanotechnolog is better and optimizes the number of reversible gates, number of garbage outputs and number of constant inputs as compared to the existing counterparts

(Haghparast and Navi, 2007). Savithramma *et al.* (2011) suggested that the nanoparticles based on synthesis of metal nanoparticles using biological systems is an expanding research area due to the potential applications various field of life sciences because nanoparticles synthesized by chemical method are not eco-friendly. Mallikarjuna *et al.* (2012) suggested that the plants are the easily available sources for nano materials and are safe to handle and possess a broad variability of metabolites that may aid in reduction for the synthesis of nanoparticles. Besides plant sources some other natural sources are whey proteins and it is proved a-LA nanoparticles which are derived from whey is a good for food delivery system in nanomedicine (Velusamy and Palaniappan, 2011). Singh *et al.* (2011) advocated that nano-biotechnology can be exploited revolutionary in new modalities of bio-molecular manufacturing, early diagnostics, medical treatment and disease prevention beyond the cellular level to that of individual proteins, the building blocks of the life process. This fact can further be utilized for food and nutritional need of the human body. The nano-biotechnology is actually the technology of integration between biotechnology and nanotechnology for developing bioactive, biosynthetic and ecofriendly technology for synthesis of nano-materials like silver etc. These materials may be used for assurance of food safety in different food products (Kannan and Subbalaxmi, 2011). There are various types of nanoparticles such as silver nanoparticles, salicylic acid, glutamine and essential oils can be used as novel antimicrobial agents in extending the shelf life of different food products (Kazemi and Ameri, 2012). Saifuddin *et al.* (2011) suggested that silver nanoparticles embedded in chitosan are a non-toxic and biodegradable natural polymer which can be used in the reduction of pesticides from water and other food materials. The intellectual property right issues relating to nanotechnology is utmost important economically for both an offensive and defensive standpoint (Bastani and Fernandez, 2005). This study has discussed in detail various aspects of nanotechnology for the benefits of livestock products.

**Nanotechnology and livestock products:** Nanotechnology is quite competent in new products and new processes development with the objective of enhancing the performance of the products, extending the product shelf life and freshness as well as in getting better the safety and quality of food. Nanotechnology is an enabling technology that has the potential to modernize the food industry. The major challenges in improving nano based technologies are integration of the hardware (nanomachines), software and management tools for generation of new information's on this aspect (Opara, 2004).

Nanotechnology can also reduce the time of production of eggs and meat. Thus, consumers can get faster eggs and faster meat. The supply chain for these products may also be managed as an engineering industry. The time reduction in production of livestock and poultry are due to radical intervention of oviduct physiology at nano level and the cutting edge genetic reengineering. The new nanoimaging techniques, new quantitative analytical tools, quantitative integration of information by using the microchips and the nanoprobes will alter the frontiers of the livestock and poultry physiological research (Kannaki and Verma, 2006). The qualities of fermented livestock products are now well proven for health benefits which can easily be obtained by this vital technology (Singh *et al.*, 2012).

The development of meat industry may also depend on an ability to track every stage in the life of the product, including the birth of the animal, its medical history and its movements between the farms, the slaughterhouse and the meat-packing plant, right through to the consumer's table (Prasanna, 2007).

**Nano meat production:** Nanotechnology is a promising technology that has applications in almost all fields. The technology has opened the path to an unexplored science for studying individual nanoparticles and their unique application for poultry and meat industry ranging from meat design, achieving food security, meat safety, overcoming food allergies, eliminating pesticide use, meat packaging, restoring meat damage and sensory evaluation to processes such as filtration, separation, encapsulation etc. Nano-technology can make poultry and meat products cost-effective with the natural properties (Singh *et al.*, 2011). Production may be carried out by self replicating nano-devices using small assent of material, energy, low capacity, less labour and land. Thus, production is more efficient (Rajkumar *et al.*, 2006). For quality meat products development nanotechnology based diagnostic techniques may replace the ultrasound like existing techniques (Pathak *et al.*, 2011). Nanotechnology already exists naturally in foods and meat is naturally composed of nanofibres. These nanofibres undergo changes during cooking or processing, which in turn influence the texture and eating quality. For manufacturers to deliver a successful vegetarian alternative that gives the taste and texture of meat, they need to understand and control the assembly of structures at the nano level. The differentiation in qualities of the products can easily be made by nanotechnology based techniques (Singh and Neelam, 2011). Designer poultry meat has to be designed in a cost effective way that strikes a rebut balance between sensory characteristics. One of the more futuristic applications of nanotechnology lies in the production of "interactive" poultry meat that change colour, flavour or nutrients depending on diner's taste or health (Marquez, 2004). Many of the molecular structures that determine these characteristics are in the nanometer range and information on the source can play an important role in the poultry meat design. The purpose is to master over the characteristic of meat components in an intelligent manner by manipulating atoms individually and place them exactly where they are needed to produce the desired flavour, texture, etc. (Chaudhary *et al.*, 2005). The potential of nano-technology in poultry meat industry cannot be fully appreciated yet because of lack of sufficient knowledge. If Nanotechnology continues to advance at its current pace, we could expect that soon we will be able to create unlimited amount of meat by synthesis at the atomic level, which would eradicate hunger (Moraru *et al.*, 2003). Nanotechnology has the potential to revolutionize the global food system. Novel agricultural and food security systems, disease treatment delivery methods, tools for molecular and cellular biology sensors for pathogen detection, environmental protection and education of the public and future workforce are the examples of the important impact that nano-technology could have on the science and engineering of agriculture and food systems (Moraru *et al.*, 2003). There were many methods to improve livestock meat products by nanotechnology.

Recently, nanotechnology and vegetarian meat, the optical tweezer ability to move individual particles around has intrigued nanotechnologists, who have wildly imaginative plans for what to do with the molecular scale sized robots they would like to create but so far, having few tools with which to make them. Nanotechnology holds out enormous possibilities and although, so, far relatively little has been accomplished, tons of money is being poured into the research, suggesting as nothing else that it is taken seriously. The holy grail of nanotechnology is some version of an 'assembler', a robot the size of a molecule that would allow moving matter at the atomic and molecular level. The obvious power of such a technology given that everything is made of the same basic atoms but simply arranged in different ways is that we would be able to construct virtually any substance we wanted from scratch by putting together exactly the molecules we wanted. Interestingly, one of the first examples given of the speculative technology of nanotechnology was

that of synthesized meat. In short then, technologies ranging from the actual to the speculative promise a variety of ways to create real meat without killing animals. Although, still commercially infeasible at the moment or in some cases technically infeasible for several years to come, the point here is not to be unfocused by the fact that we cannot yet make exploit of these technologies but rather to choose whether we should support the development of these technologies. Some of the researchers in this field, for instance, are so committed to the development of cultured meat; largely out organizations to pursue the technology. For example, New Harvest is a 'non-profit research organization working to develop new meat substitutes, including cultured meat-meat produced *in vitro*, in a cell culture, rather than from an animal'.

Cultured meat has the possibility to make eating animals unnecessary, even while fulfilling all the nutritional and hedonic requirements of meat eaters. It also has the potential to greatly diminish animal suffering. As such, the development of cultured meat would seem to have a moral claim on us; whether moral vegetarians for whom a greater opportunity exists to reduce animal suffering or conflicted meat eaters for whom practice could now cohere with beliefs or even for recreational hunters for whom ancillary arguments about providing food would fall by the wayside and require defences of getting pleasure from animal death *per se*. The development of cultured meat, then, is not merely an interesting technological phenomenon, but something that we may be morally required to support. In doing so, we recognize that morality is not something that must simply respond to new technologies as they arrive, throwing us into confusion, but rather that morality may champion and assist in the development of new technologies, as a step toward the production of a world that in fact and not merely in ideal, mirrors the moral vision we possess for it (Hopkins and Dacey, 2008).

**Nano milk production:** Nanotechnology is a new technological tool in modern raw milk production and pasteurization. Recent and ongoing advances in biomedical technology may assist in advancing our understanding of disease prevention and health promotion, as well as medical diagnostics and therapeutics (Ross *et al*., 2004). Likewise, these advances will also soon open the barn door and accelerate our understanding of identical aspects in relation to the milking cow considering the ongoing progress within livestock genomics (Womack, 2005). These new, emerging technologies such as microarray technology and nanotechnology have the potential to advance nutrition and health science in many aspects of relevance for modern milk production. This implies both a better understanding of the aspects of importance for ensuring the establishment of the conditions for the "whole cow" and hereby the necessary public acceptance of an effective and industrialised milk production and the support of milk and dairy products as a natural part of a healthy diet. The simultaneous development within information technology makes it already now possible to integrate all data obtained throughout the milk chain. Consequently, data obtained through existing devices in the milk chain in combination with new data coming from the future devices for data collection based on the above mentioned new emerging technologies would be a unique possibility to develop solid decision support systems at all levels in the future (Andersen, 2007). Moreover, nanotechnology is meant to be a major driver in the; (1) development of biosensors, (2) support of sustainable agriculture, (3) pathogen and contaminant detection, (4) improved animal health, through development of smart treatment delivery systems and (5) material science and engineering development of material with antibacterial activity and which is easy to clean (Kuzma and VerHage, 2006). These are all areas that can benefit from a modern raw milk production.

**Nano egg production:** Role of nanotechnology in designer eggs production is now a well known fact. In future the share of designer eggs in the total share of the egg market will rise to more than 30% in 2020. It is expected that by 2000, market has to supply the cholesterol free eggs, yolkless or reduced yolk eggs which can be the high value protein source, immune eggs which can supply the predetermined antibodies and therapeutic eggs with supply the predetermined physiological factors for treatment purposes. The tools and techniques currently with us will not give the solution for these challenges. They can only be meet out by the emerging nanotechnology, which deals not merely at the molecular level but at the atomic level (Kannaki and Verma, 2006).

Furthermore we can know in advance about the source of pathogens in eggs and poultry meat. Early detection of food borne pathogenic bacteria is critical to prevent disease outbreaks and safeguard public health. Numerous methods have been developed in order to detect this pathogen; however, the biggest challenges remain detection speed and sensitivity. Now, a novel nanotechnology-based biosensor is showing great potential for food borne pathogenic bacteria detection with high precision.

**Nanotechnology based meat packaging:** The flexible packaging industry is growing much quickly and having $38 billion market worldwide. The demand of flexible packaging is increasing at an average rate of 3.5% per year. Increasing competition between suppliers and government regulations, have resulted in innovations in films that enhance products and package performance, as well as address worldwide concerns with packaging waste. The consumer demands meat, to remain fresh for longer period, ease in handling, safe and healthy with environmental friendly packaging. Properties such as mechanical and heat resistance can be augmented by the use of nanotechnology. Packaging materials that have improved temperature performance can be used for hot fill operations. Very thin films that can offer the advantages of flexibility and functionalities like being anti-counterfeit, anti-tamper and anti-microbial should be made. Self-heating feature can also be incorporated in the packaging material. Environment friendly, lightweight-packaging materials can be made for use in army rations. In future, with the aid of nano-composites we may be able to modify plastic into a super barrier just as glass or metal (Brody, 2003; Singh and Neelam, 2010).

Nanotechnology provides food scientists with a quantity of ways to make novel laminate films suitable for use in the food industry. A nano-laminate consists of two or more layers of material with nanometer size that are physically or chemically bonded to each other. Nano-laminates can provide food scientists some advantages for the preparation of edible coatings and films over usual technologies and may thus, have a number of significant applications within the food industry. Edible coatings and films are presently used on an ample type of foods, including fruits, vegetables, meats, chocolate, candies, bakery products and French fries (Morillon *et al*., 2002; Cagri *et al*., 2004). These coatings or films could serve as moisture, lipid and gas barriers. Alternatively, they could improve the textural properties of foods or serve as carriers of functional agents such as colours, flavours, antioxidants, nutrients and antimicrobials. The basic functional properties of edible coatings and films depend on the characteristics of the film-forming materials used for their preparation. The composition, thickness, structure and properties of the multilayered laminate formed around the object could be controlled in a number of ways, including changing of the type of adsorbing substances in the dipping solutions, the total number of dipping steps used, the order that the object is introduced into the various dipping solutions, the solution and environmental conditions used (pH, ionic strength, dielectric constant, temperature, etc). The dynamic force for

adsorption of a substance to a surface would depend also on the nature of the surface and the nature of the adsorbing substance and it could be: Electrostatic, hydrogen bonding, hydrophobic interactive, thermodynamically incompatible, etc.

## CONCLUSION

Food industry especially livestock based food products are the foods of shorter shelf life and its nutritional status is highly precious. So, to enhance the shelf life and to facilitate the easy transportation of livestock products with natural properties and freshness these products requires suitable packaging materials. These packaging materials may be evolved with the help of nanoparticles by the experimentation and trails basis. For further demand satisfaction variety of livestock based foods can be produced in very shorter period of time. The productivity can also be increased directly by the genomic alteration or by the prevention of diseases.

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