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Role of NISIN in Nanotechnology

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Abstract:

There has been a significant increase in global interest in Nisin and other similar food preservatives of natural origin in recent years. The use of nanotechnology to control and modify nisin for improved capabilities in the food and nutrition field is growing significantly. There are important food science applications for nanotechnology in nanoparticle delivery systems, packaging, food safety and security. However, there are significant problems related to the use of nisin in the food sector, including uncontrolled interactions with various food components, its degradation and electrostatic repulsion. These issues limit its use. Alternative strategies such as nanoprocessor systems such as nanoemulsions, including blending nisin with polymeric nanoparticles, nanofibers and other technologies, are used to increase the use of nisin in the food industry. This review highlights recent developments and new approaches to nisin use in the food industry.

Keywords: nisin, nanotechnology, food preservatives, nanoparticles

INTRODUCTION:

This review sheds light on the current state of nanotechnology in the food industry. Issues related to the use of Nisin by the food industry are noted. Nisin demonstrates increased efficacy in combination with other existing technologies for improved food safety.

Nisin is the most popular AMP which has been used in the food sector for improving food safety and is the focus of this work. Now, nisin is produced in an industrial level. Nisin is composed of 34 amino acids residues if histidine places to position 27 it is called “nisin A”, and if asparagine places to this position, it is called “nisin Z”. Nisin has been used commonly in the food sector as an antibacterial agent against several Gram-positive bacteria (e.g. *Staphylococcus aureus* and *Listeria monocytogenes*). The inhibition of foodborne pathogens and preventing spore germination are two major roles of nisin in the food industry. FAO/WHO Codex Committee on milk and milk products accepted the use of nisin in food products; however, the amount of nisin must not be greater than 12.5 mg of pure nisin per kg). Also, the safety of nisin has been approved by the US Food and Drug Administration (FDA) (Ross, Morgan *et al*. 2002, Gharsallaoui, Oulahal *et al*. 2016). However, nisin doesn't have antimicrobial activity against Gram-negative bacteria, filamentous fungi, yeast cells, and viruses. *Micrococcus, Lactococcus, Leuconostoc, Lactobacillus, Pediococcus, Listeria*, and *Staphylococcus* are some main bacterial species which can be inhibited by nisin (Gharsallaoui, Oulahal *et al.* 2016.)

Nisin application:

Nisin is used as a natural preservative / additive in some food and food products such as processed cheese, butter, canned, alcoholic beverages. It can be used in combination with one or one or two or more other defense methods. Other applications of maintenance techniques include the development of antimicrobial active packing. (Lucera A, et al., 2012) Nisin A can prolong the shelf life of food by suppressing Gram-positive and other wasted pathogenic bacteria during production time. In food, it is used in the range of 1-25 ppm depending on the type of food and administrative approval. As a food additive, Nissin has the E number of E234. (Colas et al., 2007) Nisin predicts bacterial protection in dairy products. Moreover, as innovations in the medical, nanotechnological and medical fields, research is needed to identify gaps that may affect their future application.

Nanotechnology and food integration:

When nisin is used in food it is influenced by many factors. Binding / contact of nisin with matrix nutrients may reduce the function of nisin and thus reduce food stability (Bernela *et al*., 2014; Bi, Yang, Narsimhan, Bhunia, & Yao, 2011). Nisin can be adversely affected by a number of dietary factors, such as glutathione, protease, sodium metabisulfite, and titanium dioxide (Quintavalla & Vicini, 2002). In addition, the use of nisin in its free form loses its effectiveness due to its depletion of enzymes. Jung, Bodyfelt, and Daeschel (1992) observed a significant loss of the efficiency of nisin in milk due to its interaction with dairy components (Imran *et al.*, 2015).The positive charge on the bacterial cell wall reduces the effect of nisin by inhibiting the interaction of nisin and bacterial surface molecules due to electrostatic repulsion (Taylor, Wise, 2007). The use of nanoparticle systems can greatly improve the controlled release and distribution of nisin (Quintavalla and Wiki, 2002). Finally, nanotechnology was introduced for the synthesis of nisin-loaded / coated nanoparticles (Dr. Silva Malhiros, Droit, & Brandelli, 2010) to overcome the barriers associated with nisin as a food preservative. Nanoscience and nanotechnology show great potential in a variety of disciplines, including chemistry, physics, life sciences, medicine, engineering, cognitive science and information and communication sciences, thus representing a real fusion between different disciplines (Rosian *et al*., 2014) Khan, Khan, Omar, & Oh, 2015). The opportunities and benefits of nanotechnology are growing rapidly in all fields (Javed *et al*., 2015).The impact and applications of nanotechnology in food science have attracted much attention from the medical field. The use of nanotechnology to control structures has already introduced modern methods and equipment and value-added properties are expected in new foods. Manipulation of nanoscale materials offers worldwide possibilities as this technology is applied throughout the food chain from production to processing, packaging, safety, distribution, transport and storage (cushion, carry, morris, cruz-romero and cummins) (Simmino *et,al.*,2011). Nanotechnology applications in the food industry are represented in nanoparticular delivery systems, packaging, food safety and security. In the near future, it is clear that nanotechnology will play an important role in the two major areas of food processing, food packaging and food / additives (Shukla, 2014). Antioxidants, antimicrobials, flavors, colorings and food preservatives are functional elements of food with certain molecular and physical structures. However, they are rarely used in pure form; Instead, they are usually applied as coatings or incorporated into some type of delivery system. For this purpose, several nanotech-based delivery systems have been developed, including nanoliposomes, nanemulsion, nanoparticles and nanofibers (Weiss, Takhtistov, & McCall, 2006).

Application of nanotechnology:

Reconstructed food ingredients are claimed to provide improved flavor, texture, and consistency (Cientifica Report, 2006). Nanotechnology enhances the shelf-diversity of food items and helps reduce the rate of food wastage due to microbial infections (Pradhan *et al.*, 2015). Nowadays nanocarriers are used as delivery systems to manage food additives in food products without compromising their basic morphology. Particle size can directly affect the delivery of any bioactive compound to various sites in the body as it was observed that in some cell lines, only submicron nanoparticles can fit properly but not the size of large particles (Ezhilarasi *et al.*, 2013). A good delivery plan should have the following structures: (i) capable of delivering the active site directly to the target area (ii) ensuring the availability of the target at a specific time and level, and (iii) efficiency to keep active chemicals at the appropriate levels for a long time. Nano polymers try to incorporate ordinary substances into food packaging. Nanosensors can be used to prove the presence of pollutants, mycotoxins, and microorganms in food (Bratovčić, 2015).

Nanoemulsion:

Nano Emulsions nanoscale (200–600 nm diameter) oil-in-water or water-in-oil dispersion, water, surfactants, oil (soybean oil) and co-solvent (ethanol) (Imran 2015). Due to their distinctive shape, nanoemulsions appear transparent or translucent to the naked eye (Asivedo-Fani, Salvia-Trujillo, Rojas-Gray, & Martin-Belloso, 2015). Nanoemulsions are not only physically stable but also physically stable over a long period of time, sometimes characterized by thermodynamic stability (Jaiswal, Dude, & Sharma, 2015). Nanoemulsions are stable against flocculation, creaming, sedimentation and cleansing. In general, nanoemulsions are nontoxic, formulated with oil and approved by the FDA as GRAS for human consumption (Azevedo-Fani *et al.*, 2015).Some of the benefits that nanoemulsions share in various fields are that they increase the bioavailability of drug drugs, provide a larger surface area for drug drug absorption, enhance taste, improve lipophilic solution drug solutions, and provide less potency. Required (Jaiswal *et al.*, 2015) Recent nanoemulsions. Gaining more attention in the food industry, especially in the beverage industry, due to the potential applications in clear beverages and fortified beverages (Zhang, Peppard, & Raincoas, 2015). However, there are some successful nano-based drinks on the market, mainly due to the lack of a functional diet and allowable basil. Nanoemulsions provide a platform for grafting many beverage products and water-based foods that can be incorporated into food systems (Walker, Decker and McCall, 2015).In addition, Nanoemulsion with antimicrobial properties have been tested in the food industry to reduce food and food spoilage microorganisms, including *monocytogens.Typhimurium, E. Coli* O157: H7 (Bhargava, Konti, Da Rocha, & Zhang, 2015).), *Salmonella enterica enteridis* (Laundry, Michelle, McCall, 2015).The coated antimicrobial agent nano emulsions provide an effective mechanism to improve the physical stability of nisin and to increase nisin distribution in the target area in the food matrix. A limited number of available reports highlight the effectiveness of nisin and nanoemulsion encapsulation. Recently, Matte, Periago, & Palop (2015) have been linked to the growth medium of tryptic soy broth, vegetable cream and chicken broth. The number of monocytogenes in all culture media was reduced by three lag cycles and the foods were tested within the first 90 minutes after the natural antimicrobial was added as a nanoemulsion. The development of monocytogenes was interrupted for four weeks with a combination of antimicrobials. When a nanoemulsion of nisin (0.04 mm) and di-limonene (0.5 mm) was added to the growth medium, none of the 10 antibodies detected growth.Similarly, Liang (2014) theyfound the synergistic inhibitory effect of de-limonene and nisin nanoemulsion against all target organisms. Such nanoemulsion delivery systems of more than one antimicrobial agent with synergistic inhibitory effects not only broaden the spectrum but also reduce the preservatives required for effective antimicrobial resistance. In another study, the synergistic approach of nisin with essential oil was reported (Gowaris, Solomakos, Pexara, & Chatzopoulo, 2010). Related. Studied the effect of encapsulated nisin emulsion and reported that nanemulsion of nisin significantly reduced foodborne pathogenic population or significantly weakened microorganisms on the sensory properties of food. In addition, nanoemulsion technology significantly solves the solubility problem associated with lipophilic antimicrobial agents, which can be further assessed and optimized for commercial purposes in the food industry. Many patents on nanoemulsion with antimicrobial properties have already been claimed in various fields (Simonet, Sonville, & Legret, 2004); However, very little work has been done in the food industry. The lack of functional, edible and permissible emulsifiers limits the use of nanoemulsions in the food industry. Much work is required to identify emulsifiers of natural origin with low toxicity and high stability**.**

Conclusion:

In-depth studies over the past 5 years have increased our knowledge of nisin and its potential applications in many fields, including food and medical science. Further studies are needed to better understand the action, molecular mechanisms, and structural performance relationships of nisin against different food spoilage pathogens. Nissin has the closest business opportunities in the global market for antimicrobial food additives. The importance of nisin over other bacteriosine and multi-technology is its "natural" content and wide range of antimicrobial activity. The integration of nanotechnology with food science has helped to improve existing preservatives in food science. Nanoparticle systems of various forms such as nanoliposomes, nanoparticles, nanofibers and nanoemulsions interact with target cells in the most powerful way, thereby increasing efficiency and reducing the cost and quantity of sanitizers used. The potential use of nanotechnology in relation to consumer health and its importance in the food industry should be promoted. Consumer concerns about the negative effects of nano-based delivery systems need to be addressed.

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