5TH WORKSHOP ON SURFACE ENGINEERING

Nanomaterials in food packaging

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SUMMARY

Nanomaterials used in the food industry should be biocompatible, biodegradable, non-immunogenic and non-toxic. In addition, nanomaterials should be considered safe for direct use in food. The use of nanomaterials in the food industry is based primarily on food packaging, food supplement encapsulation, sensor development and crop growth. Sensors and detectors are developed to detect microbes, moisture, gases that can be found in the food industry.

INTRODUCTION

Intelligent packaging is a promising application of innovation using nanotechnology to develop antimicrobial packaging. Intelligent packaging can react to environmental conditions or to react to warnings alone and warn the consumer about the contamination and the presence of pathogens. Nanotechnology and nanoscience have great potential for use in food processing and food chemistry. It should raise awareness about the mechanisms of interaction of nanoparticles with food ingredients and packaging for food [1]. Fig. Presents areas of application of nanomaterials in the food sector [3].

EXPLICATION

In the past few years, the food packaging industry has experienced a progression in novel techniques. Evolution in nanoscience has a significant role on this inflated growth [2]. Today we can find a copious number of smart food packages that are competent in facilitating antibacterial effect, scavenging moisture, oxygen, and carbon dioxide inside the package, and even indicating whether the food is in a safely consumable condition [2]. Furthermore, antibacterial smart food packages have been introduced to improve the shelf-life of processed meat, fish, cheese, and dairy products [2]. The potential to act as a barrier to heat, UV light, oxygen, moisture, and facilitation of antimicrobial conditions are the pivotal improvements of these smart food packages [2]. The prominent strategies used to produce hybrid materials for food packaging include blending of polymers and polymer nanocomposites. Nanocomposites are composites or hybrid materials that comprise a dispersion of nanometer size particles in a polymer matrix [3]. The interest in novel food packaging is to develop intelligent, active and smart packaging systems by mimicking the biological processes, which would safeguard the integrity of packages and foods in food chain systems [3]. The classification and characteristics of an innovative food package are shown in fig.2. Smart packaging phenomena is based on the background features of the polymer, intelligent packaging systems provides information to use on the packed food integrity and active packaging systems surveillance the packed food integrity [3]. Luminescent films of ZnO nanoparticles embedded on polyvinylpyrrolidone (PVP) exhibited significant sensing capacity for the status of various food substrates by varying their intensity of luminescence [3]. Freshness indicator provides the information of the food product quality from characteristic changes from chemical effects or the growth of spoilage microorganisms in packed food products. The metabolites evolved from microbial spoiled food products can react with the indicators integrated onto packaging materials, hence provides visual indications about the quality of the food products [3]. Additionally, the real-time temperature indicator (TTI) were synthesized from chitosan and polyvinyl alcohol (PVA) polymers doped with thocyanins extracts from *Brassica oleracea* var. Capitata (Red Cabbage) [3]. There are various types of sensors such as nanosensors, gas sensors, printed electronics, carbon nanotubes based sensors, fluorescence and luminescence biosensors, quartz crystal microbalance biosensors, surface plasmon resonance biosensors, electrical biosensors, and field effect transistor biosensors, electronic nose and chemical sensors [3]. Antimicrobial nanofibrous films of PVA-b-cyclodextrin blended with cinnamon essential oils/exhibited excellent inhibition to *Staphylococcus aureus* and *Escherichia coli* growth in a Media [3]. Adhesion-resistant surfaces are a kind of antimicrobial surfaces that without requiring the presence of an antimicrobial by itself, indirectly promotes bacteria removal [4]. Basically, these surfaces repel the adhesion of microbes via different physical repulsion techniques thus avoiding biofouling formation on them. Very low surface energies give very weak adhesions that can be reverted by water frictional force [4]. Fig.3. shows antibiofouling surfaces for both low surface energy polymer and high surface energy polymer [4].

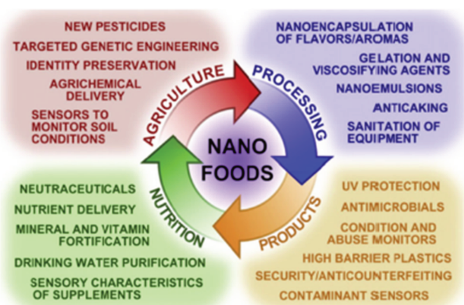

Fig. 1. Research areas of nanoparticles in food applications [3]

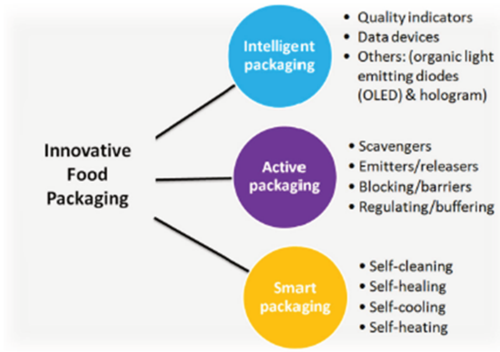

Fig. 2. Intelligent packaging systems [3]

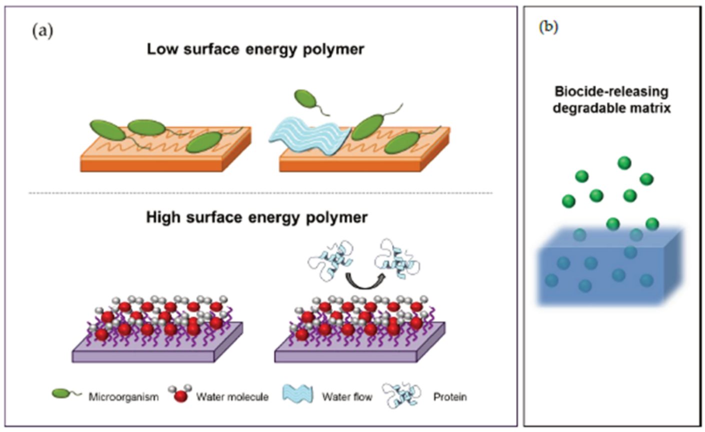

Fig. 3. Antibiofouling surfaces. (**a**) Adhesion-resistant surfaces; (**b**) Non-toxic biocide releasing matrices [4]

CONCLUSION

In general, nanoscience and nanotechnology have helped to create new systems and, indeed new antimicrobial systems with improved properties. It seems that new strategies can be developed to achieve enhanced performance but no doubt, that combinations of existing ones could be effective and promising approaches. The research on the development of more potent antimicrobial polymeric materials without compromising the human toxicity is increasing and will be enhanced in the upcoming years. Merging of nanotechnology with food industry has brought about ingenious ways to enhance the goodness of food. The applications and the research and development of nanoparticles in food industry have majorly focused on four disciplines, smart food packages as shelf-life improvers, encapsulation of nutrients as stability enhancers and also as potential slow release carriers, to boost the crop growth, and as development of sensors that indicate the condition of a food.

LITERATURE

1. WRÓBLEWSKA-KREPSZTUL J., RYDZKOWSKI T., MICHALSKA-POŻOGA I., MITURA S.: Carbon nanoparticles interactions with food products components and pathogens. Forum Catalogue of 10th International Forum on Innovative Technologies for Medicine ITMed 2016, Innovative Eastern Poland Association and The President Stanislaw Wojciechowski State University of Applied Sciences in Kalisz, ISBN-978-83-64090-95-0, s. 35 - 37
2. ARIYARATHNA I.et all, The rise of inorganic nanomaterial implementation in food applications, Food Control 2017, 77 s. 251-259
3. MLALILA. N et all, Transformation of food packaging from passive to innovative via nanotechnology: concepts and critiques, J Food Sci Technol 2016, 53(9), s. 3395–3407
4. ALVAREZ-PAINO M et all, Antimicrobial Polymers in the Nano-World, Nanomaterials 2017, 7