ACTIVE AND BIODEGRADABLE FOOD PACKAGING SYSTEMS

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Abstract: The packaging system has become a major element in the food chain, due to that most food products reach the consumer with some type of packaging technology. Among many of the packaging material functionalities, one of the most important is to maintain or increase food quality and safety. The active packaging technology is an innovative concept that can be defined as a mode of packaging in which the package, the product, and the environment interact to prolong shelf life or enhance safety or sensory properties, while maintaining the quality of the product. The paper materials are large used as packaging within this new concept, because are cheaper than other packaging materials, are high recyclable, biodegradable and compatible with active/bioactive molecules.

In this paper are presented the preliminary results regarding obtaining of active antibacterial package that consists in a paper substrate coated with functional elements complex formulas. The main feature of this concept is given by their interactive properties which manifests in contact with the hazardous microorganisms and bacteria, without migration of other components in the surrounding or in the packaged product.

Key words: cellulose packaging, active antibacterial package, biodegradable, active molecules

Introduction

The active packaging has been greatly developed in recent years based on recent outbreaks of contaminations associated with meat products, as well as growing concerns regarding the safety of intermediate moisture foods. As mentioned in Quintavalla and Vicini (2002) and Anonymous (2001), a packaging material is defined as *''a type of packaging that changes the condition of the packaging to extend shelf–life or improve safety or sensory properties while maintaining the quality of the food''.* These concepts, which are successfully utilized in the US and Japan, have seen only limited development in Europe. This could be due to legal restrictions, to a lack of knowledge about both the acceptability of these systems to consumers and their effectiveness in packaging, or to their economic and environmental impact. Although little developed in Europe, in the past decade active packaging has become one of the major areas of research in food packaging. Of these active packaging systems, the *antimicrobial version* is of a great importance.

A novel issue in the antibacterial and active packaging is the development of contact–active antibacterial surfaces. Although there were a few early examples *(Isquith et al. 1972),* this research area accelerated in the beginning of the twenty–first century *(Tiller et al. 2001)* and is now an expansive research field of study. Whereas conventional antibacterial surfaces, such as silver *(Silver et al. 2006)* continuously leach biocides into their surroundings, contact–active surfaces kill bacteria only upon physical interaction with the surface. This type of surface is constructed by having the antibacterial agent, usually a hydrophobically modified cationic polymer, irreversibly attached to the surface, which gives several benefits. First, the surface concentration remains intact during the material's life–span, thereby eliminating environmental pollution of toxic compounds. Second, the surfaces' general antibacterial mechanism, which targets the outer bacterial cell envelope, minimizes the risk of emerging resistance *(Lewis and Klibanov 2005; Milović et al. 2005).* The details of the antibacterial mechanism of these surfaces are not yet fully understood and are heavily debated. *(Bieser and Tiller 2011; Hsu et al. 2011a, b).*

These active antibacterial surfaces can use as substrate a paper material, taking all the advantages of its (low cost, renewable and biodegradable, high recyclable etc).

In this paper are presented the preliminary results regarding obtaining of active antibacterial package that consists in a paper substrate coated with functional elements complex formulas.

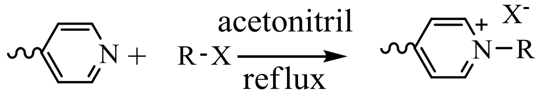
Objectives

The objective of this study (that is the first step of a long term research work aiming on development of the antimicrobial food packaging and environmental sensors) is to obtain and evaluate individually the bioactive quaternary ammonium salts (QAS) as materials for developing antimicrobial activity on paper surface.

Experimental

The experimental programme consists of: synthesis of active organic compounds based on heterocycles with quaternary ammonium salts (QAS); immobilisation of the QAS on ZnO particulates at different QAS:ZnO ratios; the preparation and application on paper surface of the QAS:ZnO composites as water suspensions of various concentrations (Fig.1).

The antimicrobial activity of coated paper samples was evaluated against the gram–positive bacteria (*Bacillus subtilis, Sarcina lutea)* and against fungi (*Aspergilius niger, Penicillium roqfortii, Geothricum candidum).* Antimicrobial activity was performed in Petri dishes on solid medium; the sterile discs with paper samples were immersed in a culture medium and stored about 120h and 168h at 25°C in case of fungi tests and 48h at 37°C in case of bacteria; the inhibition zones around discs were controlled (Fig. 2).



The QAS synthesis is based on the alkylation reaction of the pyridines derivatives with reactive halogenated derivatives. The cationic charge of quaternary nitrogen and alkyl chain confer antimicrobial activities to these compounds.

Coating formulas	Composition
R1	100p **ZnO** (micro particulate powder) + (0,05p; 0,06p; 0,07p; 0,08p: 0,09p; 0,1p) **QAS**
R2	100p **ZnO**

Fig.1 Synthesis of QAS and their immobilization on ZnO particulates

Fig.2 Antimicrobial activity tests

The paper samples treated with *composite formulas (QAS:ZnO)* show a good activity against gram–positive bacteria (*Bacillus subtilis* and *Sarcina lutea*) and *Geothricum candidum* fungi. Comparative with the paper samples treated with ZnO dispersion only, the paper treated with composite formulas presents a better antimicrobial and antifungal activity (Figures 3,4). In center of the disc, it can be observed a region without sporulation.

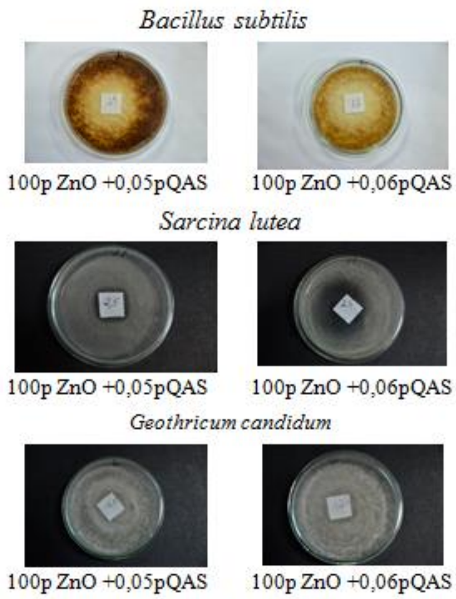


Fig.3 Antimicrobial activity of paper samples with QAS:ZnO formulas

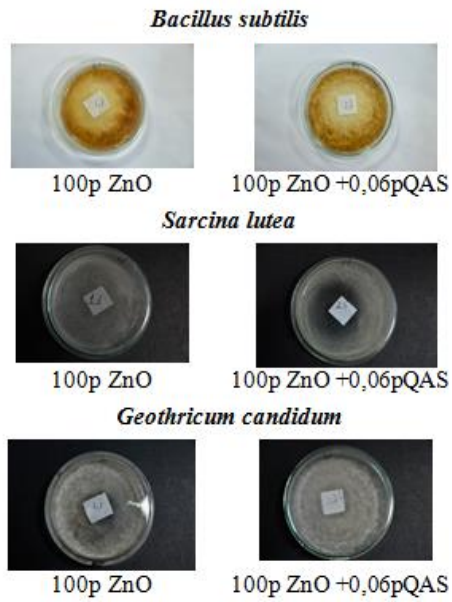


Fig.4 Antimicrobial activity of paper samples treated with 100p ZnO and QAS:ZnO formula

Conclusions

Studies on the synthesis and characterisation of the QASs emphasize that these compounds can be recommended to obtain the active surfaces that interacts with the contaminate environment to reduce, inhibit or retard the growth of microorganisms that may be present on food surfaces.

These active antibacterial surfaces can use as substrate a paper material for to active packaging systems, taking all the advantages of its (low cost, renewable and biodegradable, high recyclable etc).

References

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