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ScienceDirect

Procedia Manufacturing 12 (2017) 59 – 65

Procedia MANUFACTURING

International Conference on Sustainable and Intelligent Manufacturing, RESIM 2016, 14-17 December 2016, Leiria, Portugal

Functionalized Coatings by Electrospinning for Anti-oxidant Food Packaging

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Abstract

The development of advanced formulations used for food packaging applications, which behave as protection or preservation materials and improve consumers' health offers a route to reduced food wastage. The present study deals with investigations on the possibility of obtaining functionalized coatings by electrospinning of poly(ε-caprolactone), a synthetic biodegradable polymer together with vitamin E (α-tocopherol), selected as plant-based phenolic antioxidant. In this approach electrospinning allows the production of high surface area materials and thus offering an increased antioxidant activity. The electrospun fibres of poly(ε-caprolactone)/vitamin E were obtained, studied and their antioxidant properties were evaluated by measuring the fibre reactivity with 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical. The potential for extending the shelf-life of food products by using this approach is discussed.

Peer-review under responsibility of the scientific committee of the International Conference on Sustainable and Intelligent Manufacturing

Keywords: food packaging; electrospinning; anti-oxidant.

1. Introduction

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Peer-review under responsibility of the scientific committee of the International Conference on Sustainable and Intelligent Manufacturing
doi:10.1016/j.promfg.2017.08.008

Food packaging is one of the major users of plastic materials and enables the self-service in the supermarket system. The packaging provides protection from the environment and the customer, it offers tampering resistance, but at the same time it allows the customer to view the product within. It protects the food from the shopper. It is especially important to prevent the ingress of bacteria which will lead to food spoilage and the necessity for it to be disposed. Packaging for meat products is especially important both to provide clear packaging for visual inspection and a barrier between the meat and the external environment. The qualities of packaging need to prevent oxidative degradation reactions of fats, proteins and pigments which will lead to degradation of the meat and affect its appearance, leading to customer rejection and greater waste. Lately, the use of active atmospheres and adding function to the packaging materials are discussed extensively.

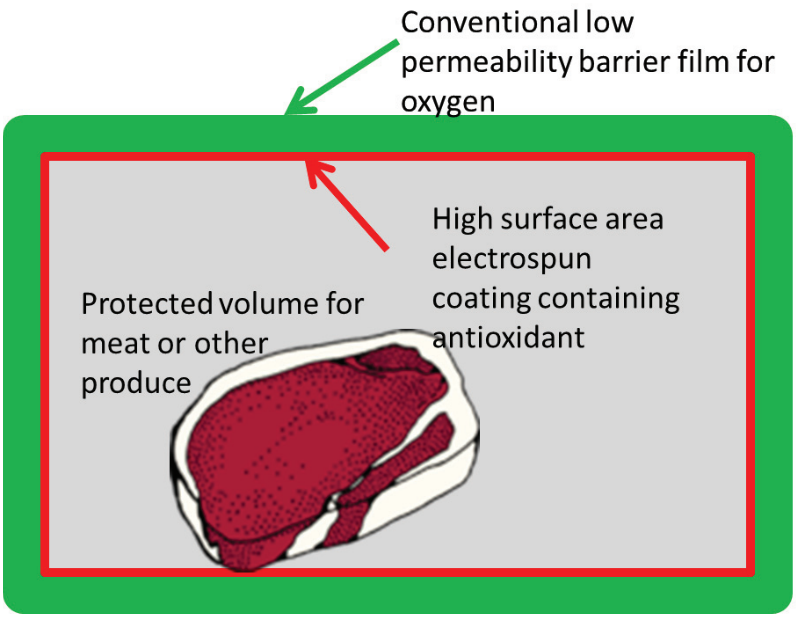

Fig. 1: Schematic representation of the design features of the anti-oxidant packaging considered in this work.

Packaging may offer additional routes for protecting food, as for example in the work of Lagaron et al on in-built temperature control [1] and the recent work of Krepker et al on packaging with antimicrobial functionality [2]. Of course the packaging already has the function of conveying nutrition facts and other information about food being offered for sale. In this work, the aim was to add antioxidant function. Thus, any oxygen which diffuses through the packaging material will be scavenged resulting in extending the shelf-life. The current status with respect to packaging for meat is detailed in the work of Fang et al [3]. Selection of materials for food packaging which comes in to contact with food is strongly regulated. Within the European Union the framework Regulation (EC) No. 1935:2004 covers this area. In the USA, this area is covered by the Food and Drug Administration and in particular by Code of Federal Legislation (CFR): 21 CFR 174 - 21 CFR 190.

In setting out to design an anti-oxidant food packaging coating material we have not necessarily plan to develop new materials but rather to exploit materials already approved for food contact (Figure 1). We have decided to develop a coating system for existing high performance barrier films, some of which are based on nanocomposites [4] and all the features of the existing packaging such as good mechanical strength, low permeability for oxygen and optical clarity to be kept. Because it is desirable that the anti-oxidant properties to be effective over a period of time, we need to adapt the approaches taken for a slow release. As a consequence the anti-oxidant is incorporated in to a polymer matrix. Thus a high surface area coating is generated using electrospun fibres. The electrospinning technique [5] readily produces microscale to nanoscale sized polymer fibres, through the application of a high voltage to a polymer solution or melt contained within a spinneret. The high voltage induces a deformation of the