



Influence of medicinal and aromatic plants into risk assessment of a new bioactive packaging based on polylactic acid (PLA)

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ABSTRACT

A new biodegradable antioxidant active packaging for food applications based on antioxidants from medicinal and aromatic plants incorporated into a polylactic acid matrix was designed and developed. Melt blending processing technique was applied to prepare polylactic acid films loaded by sage and lemon balm leaves. Antioxidant properties of developed active films were investigated using the following methods: 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid), 2,2-diphenyl-1-(2,4,6-trinitrophenyl)hydrazyl and a home-made generator of hydroxyl radicals. In addition, reducing power and total phenolic content of polylactic acid films were checked. The results of antioxidant capacity showed that percentage of hydroxylation for active film with lemon balm and sage was $55.5\% \pm 0.1\%$ and $67.4\% \pm 0.3\%$, respectively. The reducing power of active films increased 8 times in comparison to the blank samples.

Moreover, extensive investigation of influence of sage and lemon balm leaves on material safety and type of migrants was performed using migration assays. The composition of both non-volatile and volatile compounds of different active packaging films was compared with neat polylactic acid film. Three different food simulants such as 95% (v/v) ethanol, 10% (v/v) ethanol and 3% (w/v) acetic acid were checked. It was shown that the addition of sage and lemon balm leaves into a polylactic acid structure decreased the migration of both linear and cyclic polylactic acid oligomers, currently not legislated by European Union. Besides, total absence or decrease of migration of volatile compounds were observed when using the active films. Both thermal and mechanical properties of films were also evaluated.

1. Introduction

Plastics have become the world's most chosen materials in food packaging applications due to its performance, cost effectiveness and durability (Majid et al., 2018). Unfortunately, they have resulted in a global transboundary pollution problem (The Lancet Planetary Health, 2018). Therefore, researches of the last decade have focused on finding solutions for replacing traditional plastic with bio-plastics that could be applied for bio-packaging applications.

The bio-packaging and the active packaging with antioxidant properties are new areas of technology. Antioxidants are a group of food preservatives that delay or prevent food deterioration through

oxidative mechanisms. They can work as scavengers, either by preventing the formation of reactive species, or by removing them before they start damaging processes of food (Lin et al., 2018). There is currently a general tendency in the food industry to replace the use of synthetic antioxidants with natural ones, such as flavonoids present in medicinal plants (Lin et al., 2018). Natural compounds have been recently studied and proven to be effective antioxidants and once they are incorporated into packaging materials these could be utilised as antioxidant stuffs in different fields like food, pharmaceuticals or cosmetics (Masek et al., 2018; Wrona et al., 2015, 2017a, 2017b).

Extensive studies on medicinal plants have been performed and published. Either fresh or dried leaves of *Melissa officinalis* L. (lemon

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