ACTIVE PACKAGING BASED ON PP OR PLA AND ESSENTIAL OILS:
Antimicrobial and antioxidant properties

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INTRODUCTION

Active packaging incorporates "active" components intended to be released into the food or to absorb substances [1]. Renewable and biodegradable polymers as well as natural additives are currently considered sustainable alternatives for food packaging applications, reducing environmental negative issues associated with packaging wastes after their useful life. Poly (lactic acid) (PLA) is one of the most commercially available biopolymers for use in food packaging [2]. Essential oil (EO) has shown the most promising action for its antimicrobial and antioxidant properties [3]. The objective of the present work was to develop active PP and PLA based film by incorporation different EOs (thyme, oregano, lemon, grapefruit). Antimicrobial and antioxidant capacity of the developed film were investigated to select the best formulation for food packaging application.

1 MATERIALS AND METHODS

1.1 Film preparation

To produce the monolayer active films, PP Isplen PR230C1E (Repsol) and PLA Luminy® LX175 (TOTAL Corbion) were employed as polymeric base materials. Additionally, two different microporous additives were used (Accurel XP 100 and Accurel XP 951B, Evonik, Germany) for PP and PLA active films, respectively, to facilitate the incorporation and the retention of the active compounds into the polymeric matrix. The film processing was carried out by using a co-rotating twin screw extruder, to obtain films where the final theoretical concentration of actives (thyme, oregano, lemon, grapefruit) was 2.5 - 3 % (w/w). It was observed an incompatibility between the polymer PLA and the oregano EO, so that, it was not possible to obtain viable PLA-oregano active films.

PP-control PP-Lemon PLA-control PLA-Lemon

Fig. 1. Pictures of films based on PP and PLA

1.2 Antimicrobial activity

The antimicrobial activity of the processed films against different types of microorganisms (*Listeria monocytogenes, Escherichia coli, Saccharomyces cerevisiae* and *Aspergillus niger*) was analyzed by *in vitro* tests in vapor phase. *E coli* and *L. innocua* were inoculated in plate count agar at 36ºC for 24h whereas *S. cerevisiae* and *A. niger* were inoculated in Potato Dextrose Agar at 25ºC for 3 and 5 days, respectively.

1.3 Antioxidant capacity

The free radical scavenging capacity of PP and PLA active films was evaluated using DPPH method [4]. 30 cm^2 of each film was immersed in 50 ml of two different food simulants: A (10% ethanol) and B (3% acetic acid). Samples were stored for 10 days at 25°C. Results were expressed as percentace of inhibition.

1.4 Data analysis

The results were reported as the mean ± standard deviation. Anova was used to evaluate the effect of the film composition on the antioxidant capacity of the films by using spss software (spss inc. 17.0, Chicago, 2002). Differences were considered significant at $p < 0.05$.

2 RESULTS

2.1 Antimicrobial activity

The results obtained, indicates that oregano and thyme EOs when incorporated to PP matrix, exhibit very strong inhibition activity against the four target microorganisms evaluated. Whereas when thyme EO was incorporated into PLA matrix, no antimicrobial activity was observed. Films incorporating lemon and grapefruit EOs for both PP and PLA showed no inhibition. The reason for this may because the concentration of actives may be too low to present antimicrobial activity or because of losses of the EOs during the processing stage. A summary of the results is shown in *Table 1*.

2.2 Antioxidant capacity

All the samples exhibited inhibition towards the DPPH free radical. Among PP active films, PP+EOthyme and PP+EOoregano showed the highest antioxidant capacity in both simulants, with values always greater than 50% of inhibition. For PLA active films, PLA+EOgrapefruit showed the higher antioxidant activity for simulant A, equal to 48%; no differences were found among all the samples in simulant B.

Table 1. Results of antioxidant and antimicrobial activity.

	PP						**PLA**					
	Antioxidant capacity (%)		**Antimicrobial activity**				**Antioxidant capacity (%)**		**Antimicrobial activity**			
EOs	A	B	*E. coli*	*L. innocua*	*S. cerevisiae*	*A. niger*	A	B	*E. coli*	*L. innocua*	*S. cerevisiae*	*A. niger*
Thyme	59a	52a	*	*	*	*	41b	39a	***	***	***	***
Oregano	61a	52a	*	*	*	*	n.a.	n.a.	***	***	***	***
Lemon	39b	44b	***	***	***	***	31b	39a	***	***	***	***
Grapefruit	42b	42b	***	***	***	***	48a	37a	***	***	***	***

*Very strong inhibition activity, ** Moderate inhibition activity, *** No inhibition.

3 ACKNOWLEDGMENT

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