Active packaging based on PLA multilayer film with chitosan-cellulose nanocrystals for the shelf-life extension of cheese

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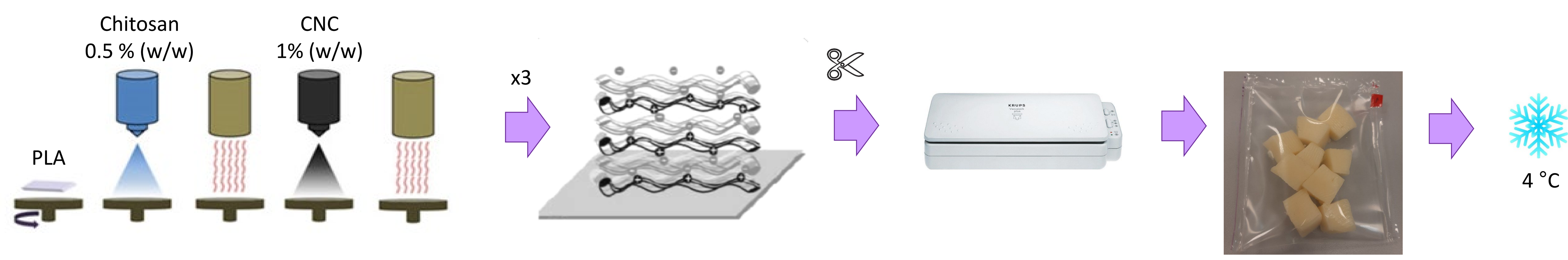
INTRODUCTION

Food packaging has become an essential tool in food manufacturing since it protects them against contamination (physical, chemical and biological), preserving their nutritional and sensory properties, and extending the product's shelf life. Polylactic acid (PLA) is one of the most attractive bio-based and biodegradable polymers used for food packaging due to its high transparency, good processability, and mechanical properties. However, its use has been limited because of the poor barrier properties, high brittleness, low toughness, slow crystallization rate and low thermal stability. Various strategies have been adopted to improve the properties of biopolymers, such as the creation of multilayer systems via a dip-coating or by spray coater, among others.

In the present study, nano layers of cellulose nanocrystals (CNC) and chitosan were applied on PLA film using the spray coating technique to enhance the barrier properties and antimicrobial activity. The films were then cut into 15 x 7.5 cm sizes and the bags were made by heat sealing the edges to package a cured semi-skimmed cheese at refrigerated conditions. The shelf-life parameters (e.g. moisture, pH, colour, texture and microorganisms growth) were monitorized at refrigerated temperature, through the performance of several physicochemical and microbiological analyses. The tests were carried out in parallel with unpackaged cheese samples (control) and cheese samples packaged in low-density polyethylene (LDPE) film.

EXPERIMENTAL

Film preparation by spray-coating:



Physicochemical analyses:

- ✓ Moisture content
- ✓ Colour determination
- ✓ Texture profile analysis (TPA)
- ✓ pH value
- ✓ Titratable acidity

Microbiological analyses:

- ✓ Total mesophilic count
- ✓ Total mould/yeast growth

RESULTS AND DISCUSSION

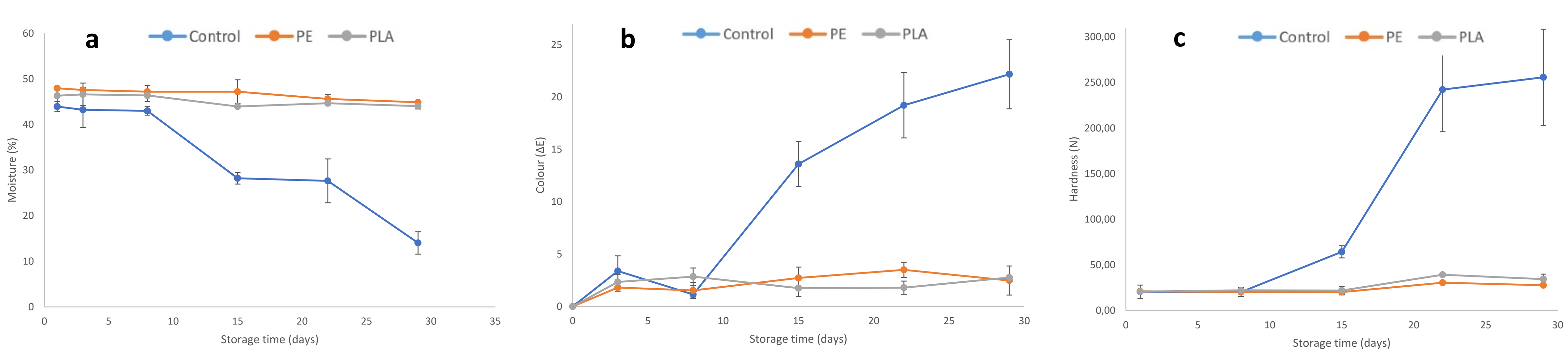


Figure 1. Average and standard deviation throughout storage time for cheese without packaging (blue), with a polyethylene (PE) film (orange) and with the PLA multilayer film (grey) in terms of moisture (a), colour difference (b) and hardness (c).

Coating	Day				
	0	7	14	21	28
Control		13,72	12,99	10,43	9,59
PE	12,61	9,09	9,44	10,43	12,81
PLA		8,89	9,88	9,11	9,00

Table 1. Total yeast count log (CFU/mL) of cheese samples as a function of the day of storage for cheese without packaging (control), with a polyethylene (PE) film and with the PLA multilayer film.

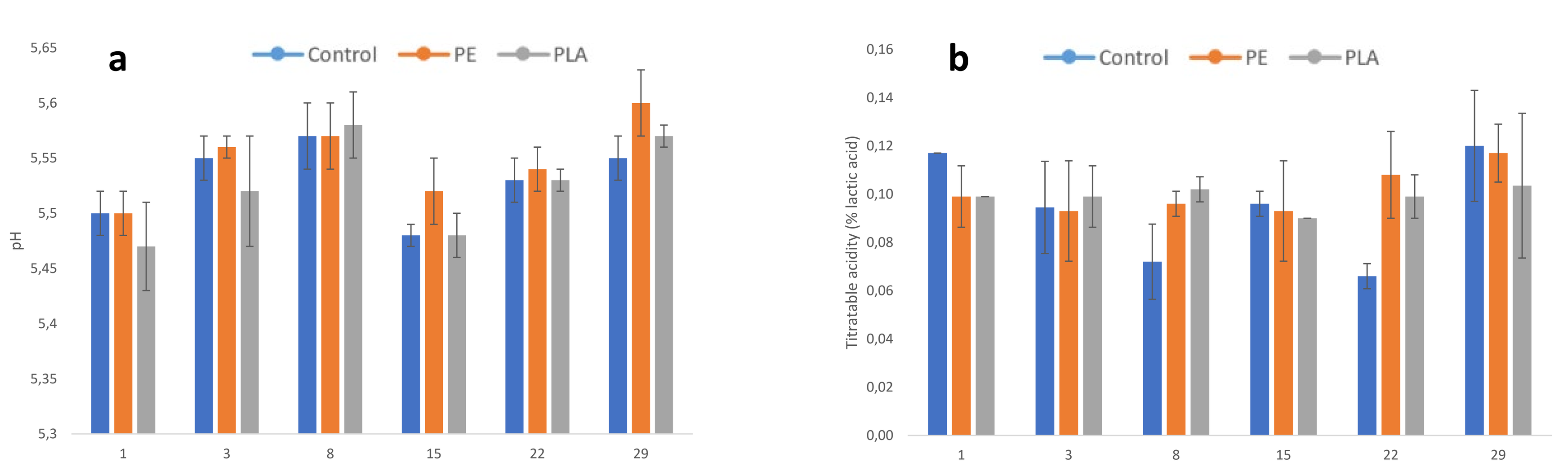


Figure 2. Changes in pH (a) and titratable acidity (b) of cheese without packaging (blue), with a polyethylene (PE) film (orange) and with the PLA multilayer film (grey).

Cheese samples without coating presented the worst values in terms of moisture, colour and hardness from the first week, while the PLA multilayer film with chitosan-cellulose nanocrystals developed in the present study presented physicochemical properties similar to commercial PE and better results in microbiological tests. Therefore, this active packaging can be used to improve the shelf-life of the cheese.

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