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EDIBLE BIODEGRADABLE AGAR-BASED FILMS AND COATINGS IN READY-TO-EAT STRAWBERRIES: NEW TRENDS FOR AN ENVIRONMENTALLY SUSTAINABLE FOOD INDUSTRY

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Despite the general awareness for the sustainability of our Planet, non-biodegradable petroleum-based synthetic polymers still the foremost food packaging materials, mainly due to their availability, low-cost and functionality. Conversely, there is an increasing consumer's demand for natural products, with minimal additives and free of synthetic elements in contact with foods. In this context, packaging biodegradable materials is very appealing. The overall goal of this study was to produce and characterize edible agar films and coatings as part of a global strategy for the environmental sustainability through replacing fossil by biodegradable materials.
Agar, a biopolymer extracted from red seaweeds, is extensively used in food and pharmaceutical industries as gelling and stabilizing agent. Depending on seaweed and extraction procedures, agar with different physicochemical properties is achieved. This research aimed at a better understanding the effect of agar physicochemical properties on the performance of agar coatings to improve shelf-life of fresh strawberries.

Accordingly, agar was extracted from Portuguese autochthonous red algae *Gracilaria vermiculophylla*, cultivated in a multitrophic aquaculture system. Extractions were carried out in presence or absence of a pre-treatment with aqueous sodium hydroxide prior to extraction and purification stages. Commercial agar (typically from Gelidium and with low-sulphate and high-anydrogalactose contents) was comparatively used. Characterization of agar extracts encompassed molecular-weight (M_w), sulphates, *3,6*-anidrogalactoses (LA), gelation and melting point, extraction yield, gel-strength, microstructure (crio-SEM) and water-content. Distinct formulations of agar-based coatings and films were prepared resorting to native and low-sulphate and high-anydrogalactose content-commercial agars. Glycerol and tween-80 were used as plasticizer and surfactant, respectively. Agar-based coatings were employed in fresh strawberries, which were further packed and stored under defined conditions (10ºC, 80% RH, van at 25%) during 7-d, and shelf-life evaluated by several physicochemical, mechanical and nutritional parameters in fruit. Physicochemical parameters involved visual appearance, weight-loss, colour, firmness, pH, total soluble-solids (TSS) and dry-weight, whereas nutritional parameters were antioxidant activity (FRAP, and DPPH-inhibition), phenolics, ascorbic acid, flavonoids. Additionally, agar-based films were prepared with the same agar extracts and several physicochemical and mechanical properties assessed, *viz*. visual appearance, film-thickness, water-vapour permeability (WVP), isothermal water-sorption, microstructure (SEM), barrier mechanical assays and colour.
Significant differences were detected in some properties, *e.g*. LA, sulphates, M_w, gel strength and microstructure – particularly in comparison with commercial agar. Distinct agar properties resulted in changes of coating and film performance. Results of coatings showed minor differences between different agar extracts and formulations but significant differences with commercial agar formulations. Nevertheless, an improvement of shelf-life was apparent in coated strawberries when analysing colour differences and phenolic composition. Commercial agar led to slightly stronger films but *Gracilaria* agar produced appropriated films.
Results recognised significant correlations between extraction procedure and some agar properties which, in turn, have some important key-effects when used as edible coatings and films. Use of edible coating significantly improved shelf-life of strawberries, underling *Gracilaria* agar potential as coatings and films forming agent. Exploitation of this low-value biomass/by-product is economically promising and meets the new challenges and trends of food industry and, particularly, the fourth-generation food.