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DEVELOPMENT OF NEW BIOPLASTIC PACKAGING FROM SEAWEED WASTE: IMPROVED MICROBIOLOGICAL QUALITY OF PORK

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I. INTRODUCTION

Ensuring a safe, sustainable and accessible food supply is a strategic objective for the agri-food industry and society, which implies changes in production and consumption systems. Currently, plastics dominate food packaging because of their cost and practicality, but they generate serious environmental problems at the end of their useful life. In response, bioplastic packaging, such as edible film, is a sustainable alternative, produced from renewable and biodegradable polysaccharides, proteins and lipids [1]. These films, in addition to protecting food, may contain antimicrobial compounds and antioxidants, which could extend the shelf life, especially of refrigerated pork which is only about four days, and thus reduce its ecological impact [2].

Among the materials used, hydrocolloids extracted from brown and red algae, such as alginate, agar and carrageenan, stand out for their industrial properties. However, green macroalgae have been little explored in this field, despite their potential as a sustainable resource, due to their more complex chemical composition and structure [1]. In the Region of Murcia (Spain), particularly in the Mar Menor, the accumulation of green algal biomass, due to advanced eutrophication, especially from *Caulerpa prolifera*, poses environmental and public health challenges [3]. Using this biomass as a source of hydrocolloids to develop sustainable packaging materials represents a significant innovation, highlighting its viability as an alternative resource for the food industry and contributing to mitigating local environmental problems. Therefore, the objective is to evaluate the effect of edible *Caulerpa Prolifera* algae film on the microbiological quality of pork meat during refrigerated storage.

II. MATERIALS AND METHODS

Green macroalgae of the species *Caulerpa prolifera*, which was collected from the Mar Menor lagoon (Murcia, Spain), was used. Previously, it was pre-treated to eliminate impurities and reduce its particle size. Once pretreated, the hydrocolloid was extracted from this seaweed using the acid extraction method with citric acid at 1% (w/v), according to the procedure of Manikandan et al. [4] maceration 4h at 90ºC. For the preparation of the edible films, 3% dried hydrocolloid obtained and 30% sorbitol (E-420, Sigma-Aldrich) as a plasticiser, macerated in distilled water (w/v) at 80ºC, were used as a gelling agent. Once the film was ready, it was applied to pork *longissimus thoracis et lumborum* muscle (LTL) fillets stored under refrigeration at 4°C in polystyrene trays without a protective atmosphere for 11 days. Three production batches were carried out.

Microbiological quality was analysed in two treatments, the control treatment, pork without edible film and pork with edible film from green macroalgae applied, at different storage times, 0, 4, 7 and 11 days. A total of 10 g of packaged meat sample was taken aseptically, mixed with 90 mL of buffered peptone water (0,1 % w/w) and homogenised. Subsequently, serial decimal dilutions were prepared and seeded on PCA, VRBG and MRS agar plates for *Mesophilic aerobic* [5], total *Enterobacteriaceae* [6] and lactic acid bacteria counts [7], respectively. The plates used for *Mesophilic aerobic* and lactic acid bacteria counts were incubated at 30 °C for 72 h, while those used for total *Enterobacteriaceae* counts were incubated at 37 °C for 24 h. After incubation, all colonies were counted and the microbial counts were expressed as log CFU/g. Data processing was performed with SPSS 28 statistical software, using a two-way analysis of variance (significance level $P \leq 0.05$).

III. RESULTS AND DISCUSSION

Figure 1 shows that, with the extension of storage time, the microbial counts in pork fillets gradually increased for all treatments, except on day 4 of storage in the fillets with film where lactic acid bacteria decreased from the initial day ($P < 0.05$). The microbial load in the control group increased significantly and exceeded the national standard after the four days of refrigeration. Bacteria in the edible film samples increased slowly and had a lower count than the control from day 4 of refrigeration ($P < 0.05$), indicating that the hydrocolloid-based coatings of *Caulerpa prolifera*

seaweed could effectively inhibit the growth and reproduction of bacteria. This finding was due to the antibacterial activity of the sulphated polysaccharides of *Caulerpa* species [8].

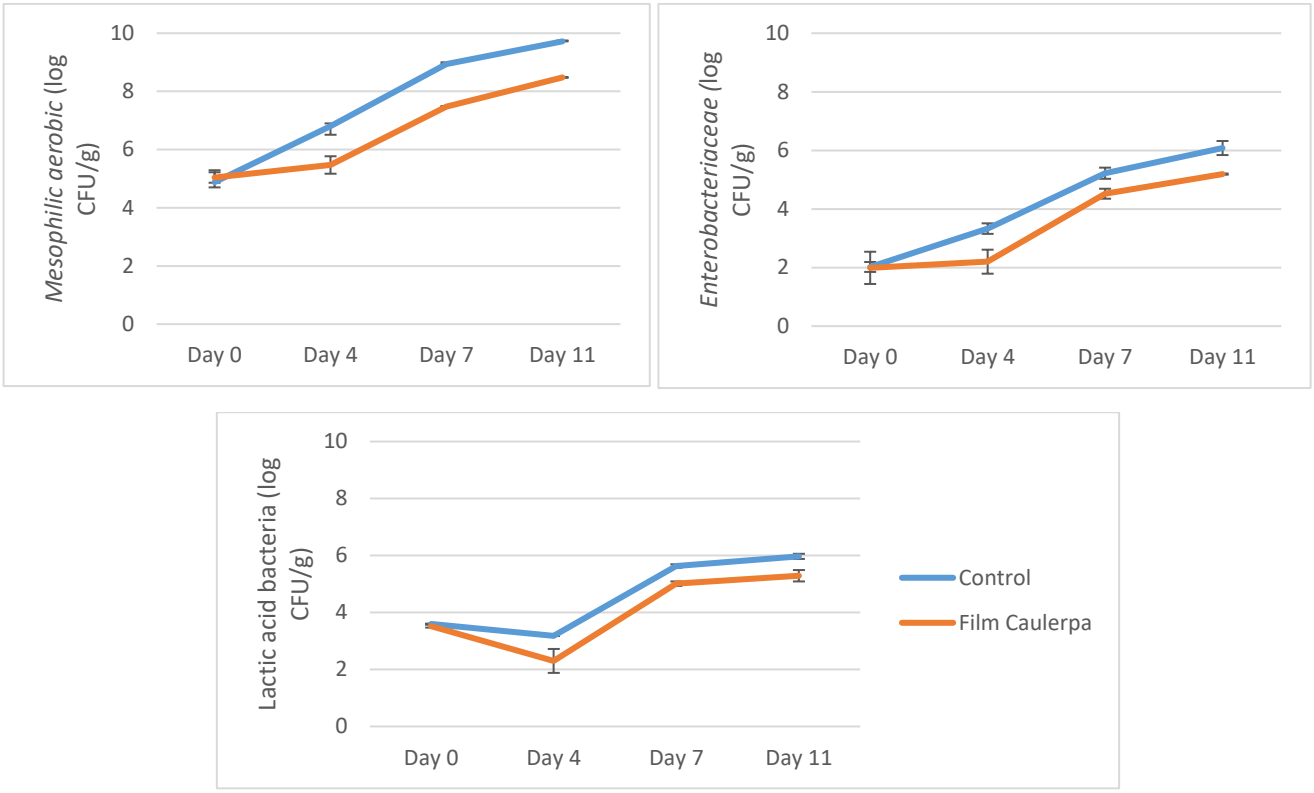


Figure 1. Evolution of microbiological counts in pork fillet.
The bars represent the standard deviation (n = 3).

IV. CONCLUSION

The edible film based on the hydrocolloid algae *Caulerpa prolifera* effectively suppresses the growth of spoilage-causing microorganisms. Indicating that this film could be a promising way to preserve fresh pork with a longer shelf life.

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