

Edible films-based on κ -carrageenan/Locust bean gum – effects of different polysaccharide ratios on film properties

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INTRODUCTION

Polysaccharides obtained from renewable sources are extensively applied in food industry due to their low cost and wide range of functional properties. In the last years, the development of edible films to extend shelf-life of food products was one of the most studied applications for polysaccharides [1]. However, when compared with commercial plastics, polysaccharide-based films present a great water sensitivity and poor mechanical properties, which have led to an extensive number of studies with the main objective of improving their physicochemical properties. Mixed systems formed by different hydrocolloids, such as Locust bean gum (LBG), and κ -carrageenan (κ -car) have already showed extensive applications as thickening and stabilizing agents [2,3]. However, their peculiar synergic behaviour can still offer new interesting applications such as the development of edible films with particular properties. In order to verify their synergic behaviour, edible films composed by mixtures of κ -car and LBG were developed and the effect of different ratios of these polysaccharides on films' properties were evaluated.

MATERIALS & METHODS

Films with different κ -car/LBG ratios - 100/0; 80/60; 60/40; 40/60; 20/80; 0/100 % (w/w) –and with 30 % (w/w) glycerol (as plasticizer) were prepared for this study. Moisture content, water vapor permeability (WVP), tensile strength (TS), elongation at break (EB) and optical properties were determined [4], being the chemical interaction between the two polysaccharides assessed by Fourier Transform Infrared (FTIR) spectroscopy. The relationship between moisture content, WVP, mechanical and optical properties was studied using principal component analysis (PCA) with the R software for Windows (version 2.11.1).

RESULTS & DISCUSSION

The film characterization results of the κ -car and LBG films at different ratios are reported in Table 1. Results showed that water content ranged between 26.77 % and 13.69% for 80/20 % (w/w) of κ -car/LBG and 100 % (w/w) of LBG, respectively. The WVP values changed from 8.01×10^{-11} to 5.15×10^{-11} g (m s Pa)⁻¹ for films composed by 100 % (w/w) of LBG and 40/60 % (w/w) of κ -car/LBG, respectively. Film opacity values did not show significant ($p < 0.05$) differences for the different formulations. Edible films composed of 100 % (w/w) of LBG present simultaneously the highest value of EB (28.21 %) and the lowest value of TS (8.61MPa), while for edible films composed of 20/80 (% w/w) of κ -car/LBG and 40/60%

(w/w) of κ -car/LBG films have exhibited the lowest value of EB (10.19 %) and the highest value of TS (27.57 MPa), respectively. The IR spectrum of κ -car/LBG films showed a shift of C-O-C band from 1162 cm^{-1} (100/0 % (w/w)) to 1151 cm^{-1} (20/80 % (w/w)), a shift of C-OH band from 1023 cm^{-1} (0/100 % (w/w)) to 1033 cm^{-1} (20/80 %) and a shift of C-H band from 919 cm^{-1} (100/0 % (w/w)) to 926 cm^{-1} (20/80 %), suggesting physical entanglements of these two polysaccharides. PCA showed that edible films composed of 40/60 % (w/w) of κ -car/LBG could be the best choice to be applied on food systems due to their good water vapour barrier and mechanical properties.

Table 1. Values of thickness, moisture content (MC), water vapor permeability (WVP), elongation at break (EB), tensile strength (TS) and opacity obtained for κ -car/LBG films

κ -car/LBG film % (w/w)	MC (%)	WVP $\times 10^{-11}$ (g (m s Pa) ⁻¹)	EB (%)	TS (MPa)	Opacity (%)
100/0	19.28 \pm 0.58 ^a	5.48 \pm 0.19 ^{abc}	16.18 \pm 1.57 ^a	19.95 \pm 1.06 ^a	8.90 \pm 0.09 ^{ab}
80/20	26.77 \pm 1.37 ^b	6.32 \pm 0.26 ^d	22.06 \pm 2.57 ^b	20.68 \pm 1.97 ^{ab}	9.61 \pm 0.32 ^a
60/40	24.81 \pm 0.42 ^b	6.00 \pm 0.30 ^{ad}	14.95 \pm 1.18 ^a	22.98 \pm 1.91 ^b	8.97 \pm 0.62 ^{ab}
40/60	21.08 \pm 1.13 ^{ab}	5.15 \pm 0.11 ^b	19.88 \pm 1.44 ^b	27.57 \pm 1.46 ^c	8.82 \pm 0.30 ^b
20/80	19.25 \pm 0.21 ^a	5.43 \pm 0.06 ^c	10.19 \pm 3.40 ^c	18.19 \pm 0.83 ^d	9.55 \pm 0.09 ^{ab}
0/100	13.69 \pm 0.63 ^c	8.01 \pm 0.40 ^e	28.21 \pm 2.89 ^d	8.61 \pm 3.27 ^c	8.90 \pm 0.69 ^{ab}

^{a-c}Different superscript letters in the same column indicate a statistically difference (Tukey test $p < 0.05$)

CONCLUSION

The results provided useful information on the structural properties of κ -car and LBG and the structural changes in the films network induced when mixing different ratios of the two polysaccharides. This work will contribute to the establishment of an approach to optimize films' composition based on the interactions between different polysaccharides sources, aiming at improving polysaccharide-based films' properties when compared with other sources, namely non-edible and non-biodegradable films.

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