GRID 2022
11 . INTERNATIONAL SYMPOSIUM
GRAPHIC ENGINEERING AND DESIGN
03-05. NOVEMBER 2022

11th GRID SYMPOSIUM

Preparation and Characterisation of Carboxymethyl Cellulose/ Carrageenan/ Jackfruit Seed Starch Blend film for Packaging Applictions

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Introduction

Plastic has numerous functional applications, humans have developed a dependency on single-use or disposable plastic, which has severe environmental effects. People have been more concerned in recent years about the safety of plastic as a food packaging material, as well as its long-term environmental impact. As a result, scientists are concentrating their efforts on developing new biodegradable packaging materials from renewable sources.

- However, the use of bio-based materials for packaging is still limited because of their usually poor physical properties.
- Blending two or more polymers is one of the simplest methods to improve film properties by interacting with different polymers through physical entanglement to form the polymeric networks simultaneously or sequentially, to improve the cost–performance ratio on commercial products
- According to previous studies Carrageenan and carboxymethylcellulose blend films had better functional characteristics than control films
- When starch blend with natural polymer, the blend films were reported to have an inferior mechanical properties and water vapour barrier properties, as well as to maximize its inherent qualities.
- Therefore, the goal of this study is to see how different concentrations of JFS affect the polymer matrix of CMC and carrageenan, as well as to analyse the suitability of prepared film for packing applications.

Methods

The CMC/CAR (CC) control films were prepared by dispersing 1.5 g of CMC and 1.5 g CAR in 100 mL of deionized water with 70º C temperature, at 600 rpm revolution for 2 hours using a hot plate magnetic stirrer. The films CCS1, CCS2, CCS3 and CCS4 were prepared by adding JFS with weight of 0.5, 1.0, 1.5, and 2 g respectively to CC film forming solution and continued stirring for 30 minutes.

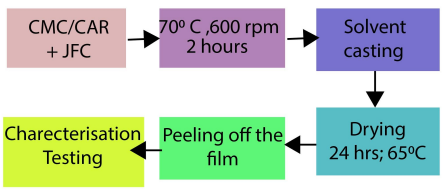

Figure 1

Preparation of film CC film samples with various concentration of JFS

Results

FTIR : The inclusion of JFS lowered the water affinity of the produced films by lowering certain characteristic peaks, particularly peaks associated with the O-H group. As a result of the effect, the water-related properties of the sample films may have a direct influence.

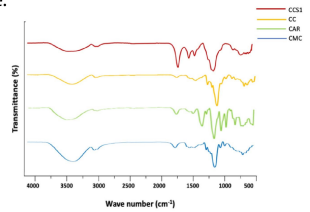

Figure 2 *FTIR spectra of CMC, CAR, CC, and CCS*

SEM : By the addition of JFS, the film surface shows an increasing heterogeneity nature. The film surface shows a good nonporous structure without much agglomerate for JFS concentration of 1.5 g and above. This suggests a good molecular bonding, which could contribute to improved mechanical and barrier properties.

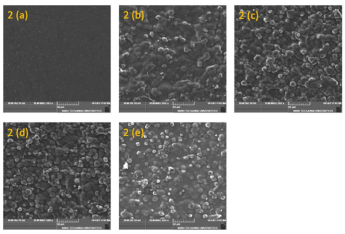

Figure 3 *SEM surface structure representing 2(a) (CC), 2(b) CCS1, 2(c) CCS2, 2(d) CCS3and 2(e) CCS4,*

Table 1
Test results of sample films

Film Sample	Film Thickness (µm)	Moisture Content (%)	Tensile Strength (MPa)	Elongation at Break (%)	Contact angle
CC	140.39 ± 1.12^{e}	22.08 ± 0.53^{a}	26.62 ± 1.17^{d}	38.33 ± 0.81^{a}	49.56 ± 1.26^{d}
CCS1	148.58 ± 1.23^{d}	20.42 ± 0.73^{b}	29.48 ± 1.04^{c}	23.45 ± 1.21^{b}	52.49 ± 1.18^{c}
CCS2	153.44 ± 0.92^{c}	17.55 ± 1.10^{c}	31.03 ± 0.75^{bc}	18.94 ± 0.95^{c}	53.72 ± 0.93^{c}
CCS3	155.36 ± 1.01^{b}	14.69 ± 0.77^{d}	33.26 ± 0.94^{a}	17.54 ± 1.25^{c}	56.54 ± 1.00^{b}
CCS4	158.62 ± 0.79^{a}	10.19 ± 0.36^{e}	32.58 ± 1.05^{ab}	17.37 ± 0.93^{c}	59.31 ± 0.99^{a}

Discussion / Conclusion

From the observed values from table 1, the thickness of the control film (CC) is 140.39 µm and the addition of JFS increased the film thickness significantly. it can be concluded that increasing concentrations of starch positively influences the thickness of the prepared films.

Moisture content data from table 1, gives the hydrophilic nature of the film and how it was affected by the addition of starch. The inclusion of JFS altered the moisture retention capacity of the film, according to the findings. The film's moisture content decreased from 22.08 % to 10.19 %, and the changes were found to be gradual and significant.

The surface wettability of the sample films was evaluated by the contact angle study, wettability of the sample film is decreasing with the increasing amount of JFS. The increased contact angle value was due to the functional groups of CAR, CMC, and JFS interact through hydrogen bonds, which provided more stiffness for the prepared films and lower hydroxyl groups on the surface.

Mechanical properties such as tensile strength (TS) and elongation at break (EAB) are very important parameters for a packaging film, as it determines the strength and stretchability of the material. . The increased strength might be due to the increase in the intermolecular interaction between the CAR and the JFS, as starch molecules have affinity to create molecular bonding with CAR. TS dropped for CCS4 with 2 g JFS, possibly due to increased solid content above the saturation point as seen in SEM examination.

This impact due to hydroxyl group deficiency can also be seen in the observed mechanical properties result, The moisture content in the film act as plasticizers, breaking secondary bonds, making polymer molecules easier to move (Jaleel Kareem et al., 394 2015). Lower moisture content characterised by reduced EAB values. The lower EAB values suggest that the film stiffened at the highest concentration of JFS and became more dimensionally stable when the JFS concentration was increased.

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