

## Development of Poly(Lactic Acid)/Poly(Butylene Adipate-Co-Terephthalate) Blend Films Incorporated with Seed Coat Extract from *Borassus Flabellifer* Linn. for Antimicrobial Food Packaging

### Abstract

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Antimicrobial biodegradable films were prepared by blending poly(lactic acid) (PLA) with poly(butylene adipate-co-terephthalate) (PBAT) and seed coat extract from *Borassus flabellifer* Linn (BFE). Melt blending technique was carried out to prepare the blend using an internal mixer and the film was further prepared by compression molding. The effect of PLA/PBAT ratios (100:0, 80:20, 70:30) was studied by comparing the film properties. The results indicated that the drawability and toughness properties of PLA were improved by blending PLA with 20%wt PBAT. The scanning electron microscopy (SEM) observation showed that the blend film was immiscibility between PLA and PBAT. The water vapor permeability of the films did not significantly increase for PLA/PBAT (80:20) film, while the oxygen permeability slightly increased for all blend films compared to neat PLA. The blend film with the highest improvement in mechanical properties has been selected to prepared the antimicrobial films. The blend film incorporated with different BFE (25 and 30wt%) was effective against *Staphylococcus aureus*, while it only showed bacteriostatic activity against *Escherichia coli*. The SEM observation showed disruption of the bacterial cell membrane after exposed to PLA/PBAT film with 30wt% BFE. The incorporation of antimicrobial compounds did not affect the water vapor barrier properties, while the oxygen permeability increased when the concentration of BFE reached of 30wt%. However, the mechanical properties of the antimicrobial films became dramatically poor for all parameters compared to the blend film without the extract. Therefore, the compatibility of the blend will be suggested to be improved for further study.

**Keywords:** *Antimicrobial packaging, Poly(lactide), Poly(butylene adipate-co-terephthalate), Borassus flabellifer*

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### Abstrak

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Antimikroba *biodegradable* film dibuat dengan mencampur poly(lactic acid) (PLA) dengan poly(butylene adipate co-terephthalate) (PBAT) dan ekstrak kulit biji dari *Borassus flabellifer* Linn. (BFE). Teknik *melt blending* dipilih untuk mempersiapkan campuran polymer dengan menggunakan *internal mixer* dan selanjutnya film dibuat menggunakan *compression molding*. Efek rasio PLA dan PBAT (100:0, 80:20, 70:30) dipelajari dengan membandingkan karakter film. Hasilnya menunjukkan bahwa kemampuan untuk ditarik PLA meningkat dan sifat kerasnya menurun dengan rasio 20 - 30wt% PBAT. Dari hasil *scanning electron microscopy* (SEM) menunjukkan bahwa walaupun PBAT mampu meningkatkan sifat elastis PLA, partikel PLA dan PBAT saling memisah di dalam film. Nilai *water vapor permeability* (WVP) tidak meningkat secara signifikan untuk PLA/PBAT (80:20) film, sedangkan nilai *oxygen permeability* (OP) sedikit meningkat untuk semua film dibandingkan PLA murni. Komposisi film dengan peningkatan karakter mekanis paling besar dipilih untuk membuat antimikroba film. Film dengan penambahan 25 dan 30% BFE efektif untuk menurunkan jumlah *S. aureus*, sedangkan terhadap *E. coli* hanya memperlambat pertumbuhannya. Pengamatan SEM menunjukkan bahwa ada perubahan pada struktur membran sel bakteri setelah terpapar PLA/PBAT film dengan penambahan 30% BFE. Penambahan BFE tidak mempengaruhi nilai WVP, dimana nilai OP meningkat ketika konsentrasi BFE mencapai 30%. Walaupun demikian, karakter mekanis dari antimikroba film mengalami penurunan untuk semua parameter dibandingkan film tanpa penambahan BFE. Oleh karena itu, kekompakan antara polymer dan komponen antimikroba sebaiknya ditingkatkan untuk dipelajari lebih lanjut.

**Kata kunci:** Kemasan antimikroba, *Poly(lactide)*, *Poly(butylene adipate-co-terephthalate)*, *Borassus flabellifer*