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EFFECT OF ESSENTIAL OIL OF ATTARASA LEAVES (*Litsea cubeba* Lour. Pers) ON PHYSICO-MECHANICAL AND MICROSTRUCTURAL PROPERTIES OF BREADFRUIT STARCH-ALGINATE EDIBLE FILM

(Kesan Pati Minyak Daun Attarasa (*Litsea Cubeba Lour. Pers*) ke atas Sifat Fiziko-Mekanikal dan Mikrosturktur Pati Sukun-Alginat Filem yang boleh dimakan)

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Abstract

Research on preparation of edible film from breadfruit starch and alginate incorporated with essential oil of attarasa leaves (*Litsea cubeba* Lour Pers.) has been done. The film was evaluated of their thickness, tensile strength, elongation at break, water vapor transmission rate (WVTR) and microstructural properties by Scanning Electron Microscopy (SEM). Incorporation of the oil increased thickness of film from 0,033 mm to 0,036 mm, tensile strenght from 32,8 to 37,0 MPa, elongation at break from 48,92% to 50,43% but water vapor transmission rate (WVTR) decreased from 142,9 g/m^2.hour to 120,3 g/m^2.hour. However SEM analysis showed that the surface microstructural of the film was more rough and solid compare with film without incorporation of essential oil.

Keywords : attarasa leaves, essential oil, breadfruit starch, alginate, edible film

Abstrak

Penyelidikan ke atas penyediaan filem yang boleh dimakan dari pati buah Sukun dan alginat digabungkan dengan pati minyak daun attarasa (*Litsea cubeba* Lour Pers.) telah dijalankan. Filem ini dinilai ketebalan, kekuatan tegangan, pemanjangan, kadar pemindahan wap air (WVTR) dan sifat-sifat mikrostruktur oleh Mikroskopi Imbasan Elektron (SEM). Pengabungan minyak telah meningkatkan ketebalan filem dari 0.033 mm hingga 0.036 mm, kekuatan tegangan daripada 32.8 kepada 37.0 MPa, pemanjangan dari 48.92 % kepada 50.4 3% tetapi kadar pemindahan wap air (WVTR) menurun daripada 142.9 g/m2.jam kepada 120.3 g/m2.jam. Walau bagaimanapun analisis SEM menunjukkan bahawa permukaan mikrostruktur filem itu adalah lebih kasar dan kukuh bandingkan dengan filem tanpa pengabungan pati minyak.

Kata kunci: daun attarasa, pati minyak, pati sukun, alginat, filem yang boleh dimakan

Introduction

Polysaccharide, such as starch, alginate, cellulose derivatives and plant gums, has been reported as edible film and coating in food packaging and preservation. They are known to be effective barrier of gas transport (O_2, CO_2), although they posses high water vapor permeability. Generally the main functional properties of these hydrophilic materials strongly depend on their water content and therefore on the surrounding humidity. Particularly, the use of starch could be an interesting reason since this polymer is abundant, cheap, biodegradable and edible [1].

Breadfruit (*Artocarpus artilis*) which belongs to the family Moraceae has been processed into many forms for utilization in the food industry and it has also been processed into starches and flour [2,3]. The breadfruit contains starch up to 18.5 g/100 g with purity of 98.86 % and content of amylose 27.68 % and amylopectin 72.32 %, scanning electron microscopy shows the starch granule is irregular-rounded [4].

Alginic acid and alginate are natural biodegradable, biocompatible, non-toxic and low cost polymer, which have been utilized in various biomedical applications, such as surface modification of biomedical implants and encapsulation of drugs, cells and enzymes [5]. Preparation of edible films from hydrocolloids like alginate forms strong films and exhibits poor water resistance because of their hydrophillics nature. Alginate has a potential to form biopolymer film or coating component because of its unique colloidal properties, which include thickening, stabilizing, suspending, film forming, gel producing and emulsion stabilizing [6].

The ability of edible film or edible coating to carry some food additives such as antioxidants, antimicrobials, colorants, flavors, fortified nutrients and spices has been reported [7,8]. The method is different from direct application, such as the incorporation of antimicrobial agents into edible film or edible coating localizes the functional effect at the food surface. The beneficial effects obtained by using edible film and coating in terms of physical, mechanical, and biochemical benefits have been reported in many publications, including the ability of edible film in retarding moisture, oxygen, aromas, and solute transport [9].

Attarasa (*Litsea cubeba* Lour. Pers) which belongs to the family Lauraceae is also recognized as name ki lemo (Sunda) and krangean (Java). Attarasa leaves contain essential oil with the main component of cineol (13.97 %), γ- elemene (8.27 %), caryophyllene (8.04 %), linalool (6.94 %) and limonene (6.78 %). Furthermore, essential oil of attarasa leaves composes of monoterpene hydrocarbons (32.12 %), oxygenated monoterpenes (27.2 %), sesquiterpene hydrocarbons (22.89 %), “others” (12.91 %), and oxygenated sesquiterpenes (3.75 %) [10]. *L. cubeba* oil also has antimicrobial activity to *Aspergillus niger*, which suggests that the oil directly damages the membrane of *A. niger*, change its structure, viscoelasticity and selective permeability [11].

This paper describes the effect of essential oil attarasa leaves (*L. cubeba* lour. pers) on physico-mechanical and microstructural properties of breadfruit starch-alginate edible film.

Materials and Methods

Preparation of Film

Film forming solutions were prepared from a mixture of breadfruit starch and sodium alginate (4:1) based on total weigth basis (5 g) including glycerol 20 % in 100 mL distilled water. Attarasa leaves essential oil was initially dilute to 4 % v/w concentration using ethanol (95 %) and then incorporated into the edible film forming solution. The mixture was heated to 75 ºC with continuous stirring for 45 min before it was cooled to room temperature. The solutions were casted onto plates (12 x 12 cm) followed by oven drying at 40 ºC for 24 hours. The dry films obtained were carefully peeled off and stored for further analysis [6].

Film Thickness

Film thickness was measured using micrometer to the nearest 0.01-mm accuracy at 5 locations, and the average value was calculated.

Mechanical Properties

The tensile strength and % elongation of the films were investigated using tensile machine according to ASTM 638-1991. Films were cut into strip according ASTM D638 and pinched on tensile machine. Examination were done with five replicates.

Water Vapor Transmission Rate (WVTR)

WVTR was measured using a modified ASTM (American Society for Testing and Materials). The film was sealed on an aluminum permeation cup containing silica gel. The cup was placed at 30 ºC in a desiccator containing the distilled water. It was then weighed at 2 h intervals over 12 h period and determinations were carried out in triplicate. Six films were used for WVTR testing . Weight loss graphs were plotted with respect to time, and the linear least-square method was used to calculate water vapor transmission rate (WVTR) using the equation [12]:

$$\text{WVTR} = \text{Slope} / \text{film area}$$

Simultaneous Thermal Analysis (STA) and Scanning Electron Microscopy (SEM)
Thermal characteristic of the film was measured by using a simultaneous thermal analysis (STA) and microstructural was observed using SEM. Films were placed on double-stick tape mounted on specimen holder, coated with 100 to 200 thicknesses of gold and photograped using SEM apparatus.

Results and Discussion

The possibility of edible film or edible coating to carry some food additives such as antioxidants, antimicrobials, colorants, flavors, fortified nutrients and spices has been reported [9]. The essential oil as the antimicrobial additives are introduced into the interstitial (empty) spaces of the polymer matrix by means of a proprietary process, The empty spaces act as reservoirs for the additives, which rise to the surface as needed to police for contaminants [13].

Film Thickness
Thickness of breadfruit starch-alginate edible film was 0.033 mm and breadfruit starch-alginate-attarasa leaves oil edible film was 0.036 mm. Addition of essential oil of attarasa leaves into edible film of breadfruit starch-alginate causes full scale increase of compound which is dissolved in solution edible film. The thickness of edible film increased with increasing of the compound dissolved in breadfruit starch-alginate edible film. Furthermore the addition of essential oil into edible film breadfruit starch-alginate causes intermolecular forces, in this case the dipole-dipole interaction, van der Waals force and hydrogen bonding, these interactions causes the increase thickness.

Mechanical Properties
Tensile strength is a measure of film strength, whereas elongation at break is a measure of film stretch ability prior to breakage. Both properties are important characteristics for packaging material [14]. The tensile strength and elongation at break changes of the edible film incorporated with attarasa leaves oil was higher than that of breadfruit starch-alginate edible film. Breadfruit starch-alginate edible film has tensile strength 32.8 Mpa and elongation at break 48.92 % while breadfruit starch-alginate-attarasa leaves oil edible film has tensile strength 37.0 Mpa and elongation at break 50.43 %. Addition of essential oil causes increased of component which was dissolved in solution edible film then increasingly matrix edible film formed, so that required by larger style to draw edible film so broken. Thus the addition of essential oil into edible film breadfruit starch-alginate cause intermolecular interaction, this thing affects at improvement of tensile strength.

Water Vapor Transmition Rate (WVTR)
The water vapor transmission rate breadfruit starch-alginate edible film was 142.9 g/m^2.hour and breadfruit starch-alginate -attarasa leaves oil edible film was 120.3 g/m^2.hour. Polysacharide-based films are generally rather poor water barriers, due their hydrophilic nature. Addition of essential oil into breadfruit starch-alginate film decreased water vapor transmission rate, because the hydrophobic character of essential oil. Water vapour migration only take place at hydrophilic area edible film and ratio between hydrophobic and hydrophilic side of component edible film affects value of water vapor transmission rate. This result is accordance with previously reported works: the greater of hydrophilicity of edible film, lower of water vapor transmission rate [15]. Essential oil play an important role in water vapor barrier from breadfruit starch-alginate- attarasa leaves oil edible film. The essential oil incorpareted to the breadfruit starch-alginate edible film inhibited the growth of tested microbes [16**].**

Simultaneous Thermal Analysis (STA)
Breadfruit starch-alginate edible film happened mass reduction 4.0 mg (Figure 1), and breadfruit starch-alginate-attarasa leaves oil edible film mass reduction 7 mg (Figure 2). Mass reductions takes its rise at ambient temperature 220 $^{\circ}$C, this thing there because of edible film have experienced process of like melting/ condensation and decomposition. Decomposition caused by heat happened at temperature 220 - 350 $^{\circ}$C. Breadfruit starch-alginate-attarasa leaves oil edible film besides containing the glycerol which starts to vapour at above temperature 200 $^{\circ}$C also there was attrasa leaves oil which represents compound volatil and when heated will soon release of edible film. Glycerol and essential oil will vapour and release of edible film, then process of decomposition edible film also takes place. This event shown by enthalphy change as event of endotherm.

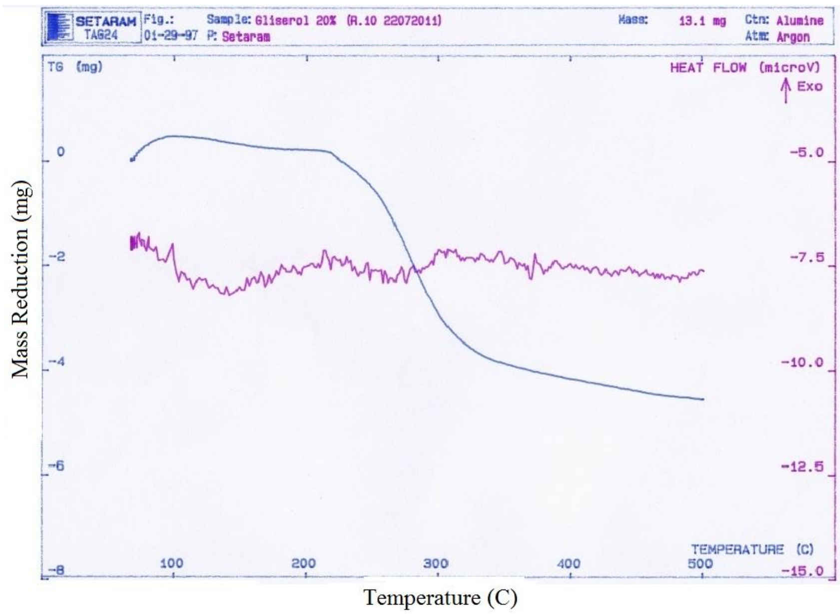

Figure 1. Mass reductions and enthalphy change to breadfruit starch-alginate edible film

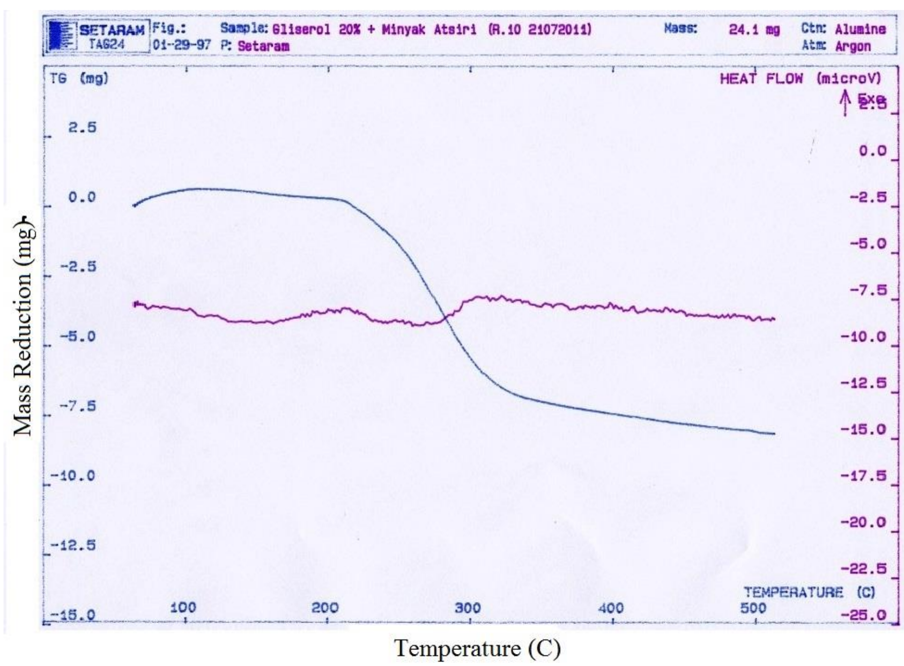

Figure 2. Mass reductions and enthalphy change to breadfruit starch-alginate-attarasa leaves oil edible film

Scanning Electron Microscopy (SEM)

Analysis of SEM breadfruit starch-alginate edible film (Figure 3) seen that surface was smooth and pore which is formed a few, this thing indicates that mixing between material in edible film there mixed with homogeneous.

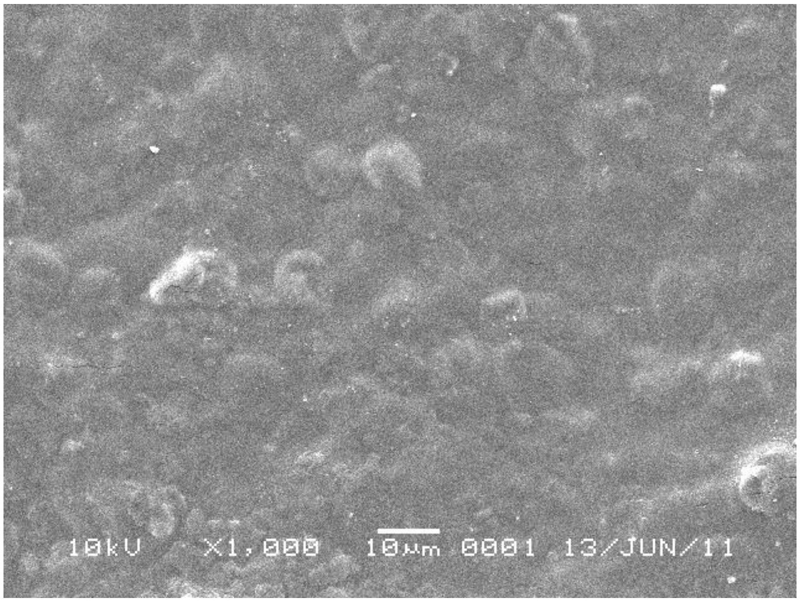

Figure 3. SEM of breadfruit starch-alginate edible film

Analysis of breadfruit starch-alginate edible film which had been incorporated with atarasa leaves oil (Figure 4) seen that surface harsher and more solid, this thing because of addition of essential oil which causes full scale addition of solid edible film.

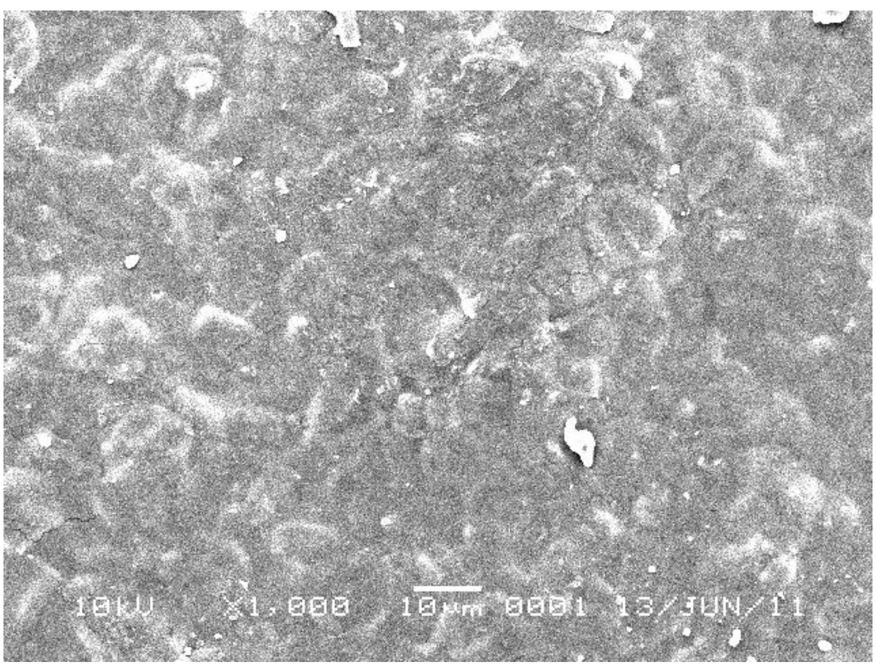

Figure 4. SEM of breadfruit starch-alginate-attarasa leaves oil edible film

Conclusion

The breadfruit starch-alginate edible film was incorporated with attarasa leaves oil have mechanical properties such as thickness of film, tensile strength and elongation of film, mass reduction were higher but water vapor transmission rate (WVTR) was lower than that of breadfruit starch-alginate edible film. SEM analysis showed that the surface microstructural of the edible film was more rough and soild compare with edible film without incorporation of essential oil.

References

1. Bertuzzi, M. A., Vidaurre, E. F. C., Armada, M. & Gottifredi, J.C. (2007). Water Vapor Permeability of Edible Starch Based Films. *Journal of Food Engineering.* 80: 972 – 978.
2. Tridjaja, N. O. (2003). Panduan Teknologi Pengolahan Sukun Sebagai Bahan Pangan Alternatif. Departemen Pertanian. Dirjen Bina Pengolahan dan Pemasaran Hasil Pertanian. Jakarta.
3. Akanbi. T. O., Nazamid S. & Adebowale, A. A. (2009). Functional and Pasting Properties of a Tropical Breadfruit (*Artocarpus altilis*) Starch from Ile-Ife, Osun State, Nigeria. *International Food Research Journal*. 16: 151 - 157.
4. Rincom, A. M. & Fanny, C. P. (2004). Physicochemical Properties of Venezuelan Breadfruit (*Artocarpus altilis*) Starch. *Archivos Latinoamericanos De Nutricion*. 53: 449 - 456.
5. Cheong, M. & Zhitomirsky, I. (2008). Electrodeposition of alginic acid and composite films. *Colloids and Surfaces A: Physicochem. Eng. Aspects*. 328: 73 – 78.
6. Maizura, M., Fazilah, A., Norziah, M. M. & Karim, A. A. (2008). Antibacterial Activity of Starch-Alginate Based Edible Film Incorporated with Lemongrass (*Cymbopogon citrates*) Oil. *International Food Research Journal*. 15: 233 - 236.
7. Han, J. H. 2000. Antimicrobial food packaging. *Food Technology*. 54: 56 – 65.
8. Pena, D. C. R. & Torres, J. A. (1991). Sorbic Acid and Potassium Sorbate Permeability Of an Edible Methylcellulose-Palmitic Acid Films: Water Activity and Ph Effects. *Journal of Food Science* 56: 497 – 499.
9. Pranoto, Y., Vilas, M.S. & Sudi, K.R. (2005). Physical and Bacterial Properties of Alginate-Based Edible Film Incorporated with Garlic Oil. *Food Research International.* 38: 267 - 272.
10. Wang, H. & Liu, Y. (2010). Chemical Composition and Antibacterial Activity of Essential Oil from Different Parts of *Litsea cubeba*. *Chemistry and Biodiversity*. 7: 229 – 235.
11. Man, L., Tang, F., Jiang, L., Huang, Y. & Li, J. (2004). Cytological Mechanism of Antimicrobial Activity of *Litsea cubeba* Oil on *Aspergillus Niger* Growth. *Chin J Appl Environ Biol*, 10: 236 – 238.
12. Srinivasa, P. C., Ramesh, M. N. & Tharanathana, R. N. (2007). Effect of Plasticizers and Fatty Acids on Mechanical and Permeability Characteristics of Chitosan Films. *Food Hydrocolloids*. 21: 1113 - 1122.
13. Kim, Y. T., Kim, K., Han, J. H. & Kimmel, R. M. (2008). Antimicrobial Packaging for Food. *in* Kerry, J. and Butler, P. *at* Smart Packaging Technologies. John Wiley and Sons Ltd. England.
14. Krochta, J. M. & Johnston, C. D. M. (1997). Edible and biodegradable films: challenges and opportunities. *Food Technology* 51: 61–74.
15. Garcia, M. A., Martino, M. N. & Zariky, N. E. 2000. Lipid Addition to Improve Barrier Properties of Edible Starch-Based Film and Coating. *J Food Sci*. 65: 941 – 947.
16. Zuhra, C.F., Kaban, J., Munir, E. & Marpongahtun. (2011). Aktivitas Antimikroba *Edible Film* dari Pati Sukun – Alginat yang di Inkorporasi dengan Minyak Atsiri Daun Attarasa (*Litsea cubeba* Lour. Pers). *Jurnal Biologi Sumatera.* Edisi Juli 2011