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Produksi Hidrogen dari Gliserol dan Air Secara Fotokatalisis dengan TiO_2 Termodifikasi N, Cu dan Ni

Hydrogen Production from Glycerol and Water By Photocatalytic using N, Cu and Ni Modified TiO_2

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Telah dikaji modifikasi fotokatalis TiO_2 dan pengaruhnya terhadap hasil produksi hidrogen (H_2) dari gliserol dan air. Prekursor yang digunakan adalah TiO_2 Degussa P-25. Modifikasi dilakukan dengan nitrogen (N), tembaga (Cu) dan nikel (Ni) sebagi *dopant*, dengan metode impregnasi. Pengaruh konsentrasi gliserol terhadap hasil produksi H_2 menggunakan katalis TiO_2 termodifikasi juga telah dilakukan. Hasil analisis *Diffuse Reflectance Spectroscopy* (*DRS*) menunjukkan bahwa *dopant* N, Cu dan Ni menyebabkan peningkatan absorbansi katalis TiO_2 ke arah pita cahaya sinar tampak, sehingga katalis memiliki kemampuan lebih untuk menyerap cahaya pada panjang gelombang yang lebih tinggi. Hasil pengujian menunjukkan fotokatalis TiO_2 termodifikasi mampu menghasilkan H_2 lebih banyak dibanding TiO_2 Degussa P-25, sebesar 4 kali untuk *dopant* N, 10 kali untuk *dopant* Cu(5%) dan N serta 8 kali untuk *dopant* Ni(5%) dan N. Pengaruh konsentrasi gliserol terhadap proses produksi H_2 dengan katalis TiO_2 termodifikasi Cu dan N menunjukkan bahwa semakin besar konsentrasi gliserol semakin banyak H_2 yang dihasilkan.

Kata kunci: Hidrogen, Gliserol, Fotokatalis, TiO_2 termodifikasi, Pemisahan air

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Dani Gustaman Syarif (Pusat Teknik Nuklir Bahan dan Radiometri - BATAN)

Pengaruh Penambahan La_2O_3 Terhadap Konduktivitas Ionik *CSZ* Sebagai Elektrolit Padat

Effect of La_2O_3 Addition on Ionic Conductivity of *CSZ* as Solid Electrolyte

Jurnal Sains Materi Indonesia, Vol. 15, No. 1, Oktober 2013, hal. 7-11

Penelitian tentang pengaruh penambahan La_2O_3 terhadap konduktivitas ionik *CSZ* sebagai elektrolit padat SOFC telah dilakukan. Pelet *CSZ*-La_2O_3 dibuat dengan cara kompaksi 4 ton/cm^2 dan penyinteran pada suhu 1450 ^oC selama 4 jam dengan konsentrasi La_2O_3 0 %, 1 % dan 3 %berat. Analisis struktur kristal menunjukkan bahwa setiap pelet *CSZ* membentuk struktur kristal kubik. Analisis strukturmikro menunjukkan terjadinya peningkatan pertumbuhan butir dan pengurangan porositas *CSZ* setelah penambahan La_2O_3. Analisis rapat massa menunjukkan terjadi peningkatan rapat massa *CSZ* seiring bertambahnya konsentrasi La_2O_3. Diketahui bahwa penambahan La_2O_3 dapat meningkatkan konduktivitas ionik *CSZ*.

Kata kunci: Elektrolit padat, *CSZ*, La_2O_3, Konduktivitas ionik, SOFC

Trimardji Atmono (Pusat Teknologi Akselerator Proses Bahan - BATAN)

Preparasi Multilayer P-N-Junction diatas Substrat Si(111) untuk Aplikasi Detektor Surface Barrier

Preparation of P-N-Junction Multilayer onto Substrat Si(111) for the Application as Surface Barrier Detector

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Telah dilakukan preparasi multilayer Au/SiP/SiB/Si(111)/Au, diikuti dengan pengamatan sifat statis dan sifat dinamis. Deposisi dikerjakan dengan menggunakan teknik RF Sputtering dan DC Magnetron Sputtering. Sifat statis yang diamati meliputi parameter penting pada aplikasi multilayer sebagai detektor partikel alfa, yaitu tahanan maju dan mundur, pengamatan kapasitansi sebagai fungsi dari tegangan terpasang (reverse bias), serta perhitungan lebar depletion layer. Pengamatan sifat dinamis dilakukan dengan menggunakan rangkaian spektroskopi, yaitu untuk mendeteksi pulsa keluaran yang merupakan karakter spesifik dari detektor surface barrier. Telah dipilih multilayer yang terbaik Au/SiP/SiB/Si(111)/Au, yang menunjukkan sifat proporsional dengan detektor komersial ORTEC. Parameter sputtering yang optimal adalah tegangan 4kV/0.6 A (DC) dan 200W-RF serta tekanan gas argon yang sama, dalam orde $7x10^{-2}$ mbar, dengan waktu deposisi 30 menit pada proses RF-sputtering untuk multilayer SiP/SiB serta masing-masing 2 menit dan 5 menit DC-sputtering untuk lapisan emas yang berfungsi sebagai jendela terobosan partikel alfa, dan sebagai elektroda. Nilai tahanan maju dan tahanan mundur terukur sebesar masing-masing 1,1 MΩ dan 4,1 MΩ. Diperoleh lebar depletion layer sekitar 410 mm pada tegangan reverse bias 22 V. Hasil pembuatan prototip detektor surface barrier menggunakan multilayer Au/SiP/SiB/Si/(111)/Au tersebut dapat merespon partikel alfa, memberikan Full Width Half Maximum (FWHM) sekitar 42 keV, sehingga mampu membedakan 2 puncak energi pada umumnya dari suatu sumber radioaktif pemancar alfa.

Kata kunci: Lapisan tipis, P-N-junction, Detektor Surface barrier

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Budiana dan Suasmoro (Jurusan Fisika, FMIPA - ITS)

Pelapisan *Yttria Stabilized Zirconia* dan *Calcia Stabilized Zirconia p*ada Baja S45C dengan Teknik *Flame Spray Coating*

Yttria Stabilized Zirconia and Calcia Stabilized Zirconia Coated on S45C Steel using Flame Spray Coating

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Telah dilakukan penelitian pelapisan *Yttria Stabilized Zirconia* (*YSZ*) dan *Calcia Stabilized Zirconia* (*CSZ*) sebagai pelapis baja S45C dengan lapisan pengikat (*bond coat*) NiCrAlY menggunakan teknik *flame spray coating*. Penelitian ini diawali dengan persiapan bubuk YSZ (ZrO_2-Y_2O_3) hasil kalsinasi ZrO_2 dan 7 %mol Y_2O_3, sedangkan untuk CSZ (ZrO_2-CaO) digunakan dari produk komersil. Karakterisasi dari lapisan yang terbentuk dilakukan dengan menggunakan *X-Ray Diffractometer* (*XRD*), *Scanning Electron Microscope* (*SEM*) dan *Electron Dispersive by X-Ray* (*EDX*). Dari penelitian yang dilakukan, NiCrAlY melapis dengan baik di permukaan substrat S45C dan *YSZ* kurang dapat melapis dibandingkan dengan *CSZ*.

Kata kunci: YSZ, CSZ, Flame spray coating

Evi Yulianti, Sudaryanto, Heri Jodi, Deswita and Mashadi (Center for Technology of Nuclear Industry Material - BATAN)

Li Ion Conducting Polymer Based on Polyvinylidene Fluoride and Li Triflate

Polimer Penghantar Ion Li Berbasis Poliviniliden Fluorida dengan Garam Li Triflat

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A Series of polymer electrolyte based on Polyvinylidene Fluoride (PVDF) for solid state rechargeable lithium battery has been prepared by solution casting technique. Lithium triflate salt was used as filler with various compositions. Bulk nature and surface morphology of the polymer electrolytes were studied by X-Ray Diffractometer (XRD) and Scanning Electron Microscope (SEM), respectively. The thermal properties of polymer and salt were confirmed by Differential Scanning Calorimeter (DSC). The electrical properties of electrolyte polymer membrane were studied by using impedance spectrometer. It was found that the highest ionic conductivity was obtained for PVDF + Li Triflate 10% (w/w) which is 4.5411×10^{-3} S/cm. It was also found that there was peak of each composition in the loss tangent suggests the presence of relaxing dipoles in the polymer electrolyte films. The peak shifts towards higher frequency side suggesting the speed up of the relaxation time.

Keywords: Polyvinylidene Fluoride, Lithium triflate, Ionic conductivity
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Albinur Limbong dan Horasdia Saragih (Laboratorium Teknologi Terapan, Universitas Advent Indonesia)

Distribusi Polarisasi pada PVDF dan Kopolimernya P(VDF/TrFE) Dekat Permukaan

Polarization Distribution in PVDF and its Copolymer P(VDF/TrFE) Near the Surface

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Pada makalah ini, distribusi polarisasi pada film polimer feroelektrik yang telah mengalami berbagai perlakuan poling, dilaporkan. Profil polarisasi diukur dengan menggunakan Laser Intensity Modulation Method (LIMM). Ditemukan bahwa film polimer yang belum mengalami poling memiliki lapisan polarisasi di dekat elektroda. Lapisan polarisasi ini diduga diakibatkan oleh adanya difusi elektron ke dalam polimer yang berasal dari elektroda logam. Dengan memberikan medan listrik yang disiklus kepada film polimer, maka dua ragam perubahan terjadi. Pertama, pengembangan profil polarisasi yang semakin merata (uniform) di sepanjang ketebalan film. Kedua, lapisan muatan di dekat kutub yang merupakan anoda, pada awal poling menjadi berkurang, sementara di dekat kutub yang merupakan katoda, pada awal poling menjadi lebih menonjol. Perubahan ini terjadi karena adanya muatan permukaan (space charge) yang dihasilkan dari proses pelelahan (fatigue) polimer.

Kata kunci: Distribusi polarisasi, PVDF, P(VDF/TrFE), Polimer feroelektrik
.

Lucia Indrarti and Indriyati (Pusat Penelitian Fisika - LIPI)

Biocellulose as Edible Strips with Ginger Extract

Bioselulosa Sebagai Edible Strips dengan Penambahan Ekstrak Jahe

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The purpose of the study was to analyze the prospect of biocellulose applied as edible strips, a thin film which can dissolve in the mouth. Edible strips have been prepared by mixing homogenized of biocellulose, Carboxymethyl Cellulose (CMC), glycerol, ginger extract and artificial sweeteners. Then, they were casting and drying. In order to evaluate the effect of the addition of ginger extract on edible strips properties, hedonic test was done with the attributes of color, aroma, taste, and solubility. Crude fiber and water content of edible strips were evaluated as well. The result showed that addition of ginger extract influenced the color, aroma, and taste of edible strips, with the value of 1.9-4, whereas the solubility remained stable at around 2.4-2.6 in 1-5 scale. Variation concentration of ginger extract did not influence the crude fiber and water content of edible strips. Water and crude fiber contents showed 11-14% and 4.5-5.5%, respectively. Temperature at 30 °C and 2 hours of drying of biocellulose composites solution showed the best results to get the optimum of save production cost and energy of edible strips. Based on this result, biocellulose has a prospect to be used as matrix in edible strips. .

Keywords: Edible strips, Biocellulose, Ginger extract, Hedonic test

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Ambyah Suliwarno (Pusat Aplikasi Teknologi Isotop dan Radiasi - BATAN)

Orientasi Sifat Mekanik dan Rasio Pengembangan Hidrogel Metilselulosa

Orientation of Mechanical Properties and Swelling Behaviour of Methylcellulose Hydrogels

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Telah diperoleh hidrogel dari iradiasi metilselulosa pada empat konsentrasi yaitu 10 %, 15 %, 20 % dan 30 %berat. Metilselulosa yang digunakan adalah metolose SM-100. Proses radiasi dilakukan dengan mesin berkas elektron tipe Cock-Croft Walton pada energi 1 MeV, 10 mA, dengan variasi dosis 10 kGy sampai 100 kGy, pada laju dosis 10kGy/lintas. Film hidrogel kemudian dikarakterisasi meliputi; rasio pengembangan, fraksi gel, kekuatan tarik dan persen perpanjangan putus. Pengamatan menunjukkan bahwa rasio pengembangan optimum untuk semua konsentrasi terjadi pada dosis 20 kGy dan menurun dengan naiknya dosis radiasi. Persen fraksi gel optimum ditemukan pada dosis 20 kGy, untuk semua konsentrasi dan naik seiring naiknya dosis radiasi, kecuali konsentrasi gel 10 %. Kekuatan tarik secara nyata terlihat mulai konsentrasi 20 % untuk dosis 20 kGy, dengan hasil tertinggi yaitu 0,50 MPa dari dosis 40 kGy. Pada konsentrasi 30 % kekuatan tarik terlihat turun relatif kecil yaitu 0,15 MPa pada dosis 40 kGy. Perpanjangan putus tidak ditemukan pada dosis 10 kGy, karena rasio pengembangan dan fraksi gelnya relatif rendah. Perpanjangan putus optimum terjadi pada konsentrasi 20 % dari dosis 20 kGy yaitu 200 %, dengan kecenderungan turun untuk kenaikan dosis radiasi, karena terjadi proses degradasi. Hidrogel metilselulosa SM-100 terikat silang secara optimum pada konsentrasi 20 % dengan dosis 20 kGy hingga 40 kGy. Pada kenaikan dosis berikutnya, gel akan terdegradasi dan untuk konsentrasi 30 % diperoleh gel yang keras dan rapuh.

Kata kunci: Metilselulosa, Iradiasi berkas elektron, Ikatan silang, Degradasi

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Aloma Karo Karo (Pusat Teknologi Bahan Industri Nuklir - BATAN)

Karakterisasi Kopolimerisasi Radiasi Pati dan Asam Akrilat Sebagai Bahan Pelapis Pupuk

Characterization of Starch-Acrilic Acids Radiation Copolymerization for Coating of Fertilizer

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Dalam upaya menaikkan nilai tambah dari polimer alam, telah dilakukan modifikasi pati yang ditambahkan oligo kitosan (2%) menggunakan reaksi kopolimerisasi iradiasi dengan monomer asam akrilat. Bahan ini selanjutnya digunakan sebagai bahan pelapis pupuk NPK yang bersifat dapat menyimpan air dan lepas lambat. Pati dengan konsentrasi 5% (b/v) yang ditambahkan oligo kitosan dibuat gelatin dengan pemanasan pada suhu 80 °C, kemudian direaksikan dengan asam akrilat dengan variasi konsentrasi 1%, 2%, 3% dan 4% (v/v) pada suhu 50 °C. Sampel selanjutnya diiradiasi dengan variasi dosis 10 kGy, 15 kGy dan 20 kGy dengan sinar gamma yang berasal dari Co-60. Hasil evaluasi menunjukkan bahwa pati-oligo kitosan yang dikopolimerisasi dengan asam akrilat dapat digunakan sebagai bahan pelapis pupuk NPK yang dapat menyimpan air. Diperoleh nilai swelling 520% sampai 700% tergantung dari konsentrasi monomer asam akrilat yang digunakan. Kondisi terbaik diperoleh untuk pati kopolimerisasi asam akrilat dengan dosis iradiasi 15 kGy dan konsentrasi asam akrilat 3%.

Kata kunci: Kopolimerisasi radiasi, Pati, Asam akrilat, Bahan pelapis pupuk

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Martalena Ramli, Rien Ritawidya, Cecep Taufik Rustendi, Titis Sekar Humani and Widyastuti Widjaksana
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Preparation of ^{99m}Tc-Tricine-EDDA-HYNIC-Folate, A Potential Radiopharmaceutical for Radiodiagnosis of Folate Receptors Over Expressed Cancer

Preparasi ^{99m}Tc-Tricine-EDDA-HYNIC-Folate, Radiofarmaka Potensial Untuk Radiodiagnosis Kanker Over Expressed Reseptor Folat

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Folate receptors (FRs) have been reported to be over expressed on various types of cancers. Therefore, it would be possible for its ligand in this case folic acid, also known as vitamin B9, to be used as delivery agent for diagnosis and therapy of FRs over expressed cancers. The aim of this project was to prepare ^{99m}Tc radiolabeled folic acid via 6-hydrazinonicotinamido-hydrazido (HYNIC) in the form of ^{99m}Tc-tricine-ethylenediamine diacetate-HYNIC-folate (^{99m}Tc-tricine-EDDA-HYNIC-folate), which was expected to be potential for radiodiagnosis of the FRs over expressed cancers. Preparation of ^{99m}Tc -tricine-EDDA-HYNIC-folate was initiated by preparation of HYNIC-folate by reacting of folate-ã-hydrazide with 6-chloronicotinic acid NHS ester which was then followed by addition of hydrazine-hydrate. The HYNIC-folate was recovered in its HCl salt-form which was then formulated to form a freeze dried kit which consisted of HYNIC-folate, tricine and EDDA (co-ligands) and Sn(II) as reducing agent. The formation of ^{99m}Tc-tricine-EDDA-HYNIC-folate was carried out by addition of ^{99m}Tc into tricine-EDDA-HYNIC-folate freeze dried kit which resulted in ^{99m}Tc-tricine-EDDA-HYNIC-folate with radiochemical purity of 97.0 ± 1.8% met with the requirement of a good radiopharmaceutical (³ 90%). The stability test showed that the ^{99m}Tc-tricine-EDDA-HYNIC-folate was still intact (radiochemical purity ~ 95%) when stored at 37 °C for four hours. .

Keywords: Folate receptors, Cancer, Diagnostic radiopharmaceutical, ^{99m}Tc-tricine-EDDA-HYNIC-folate

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BIOCELLULOSE AS EDIBLE STRIPS WITH GINGER EXTRACT

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ABSTRACT

BIOCELLULOSE AS EDIBLE STRIPS WITH GINGER EXTRACT. The purpose of the study was to analyze the prospect of biocellulose applied as edible strips, a thin film which can dissolve in the mouth. Edible strips have been prepared by mixing homogenized of biocellulose, Carboxymethyl Cellulose (CMC), glycerol, ginger extract and artificial sweeteners. Then, they were casting and drying. In order to evaluate the effect of the addition of ginger extract on edible strips properties, hedonic test was done with the attributes of color, aroma, taste, and solubility. Crude fiber and water content of edible strips were evaluated as well. The result showed that addition of ginger extract influenced the color, aroma, and taste of edible strips, with the value of 1.9-4, whereas the solubility remained stable at around 2.4-2.6 in 1-5 scale. Variation concentration of ginger extract did not influence the crude fiber and water content of edible strips. Water and crude fiber contents showed 11-14% and 4.5-5.5%, respectively. Temperature at 30 °C and 2 hours of drying of biocellulose composites solution showed the best results to get the optimum of save production cost and energy of edible strips. Based on this result, biocellulose has a prospect to be used as matrix in edible strips.

Keywords: Edible strips, Biocellulose, Ginger extract, Hedonic test

ABSTRAK

BIOSELULOSA SEBAGAI *EDIBLE STRIPS* DENGAN PENAMBAHAN EKSTRAK JAHE. Penelitian ini bertujuan menganalisis kemungkinan pemanfaatan bioselulosa sebagai *edible strip*, yaitu lembaran tipis yang dapat larut dalam mulut. Telah dibuat *edible strips* dalam bentuk lapisan tipis komposit bioselulosa yang merupakan formula campuran bioselulosa, *Carboxymethyl Cellulose* (*CMC*), gliserol, ekstrak jahe dan pemanis buatan yang selanjutnya di*casting* dan dikeringkan. Untuk mengetahui pengaruh penambahan ekstrak jahe terhadap *edible strips*, telah dilakukan uji hedonik terhadap warna, aroma, rasa, dan kelarutan juga kadar serat dan kadar air *edible strips*. Hasil uji hedonik menunjukkan bahwa penambahan ekstrak jahe mempengaruhi warna, aroma dan rasa *edible strips*, dengan nilai uji organoleptik pada kisaran 1,9 hingga 4, sedangkan kelarutannya menunjukkan nilai 2,4 hingga 2,6 pada skala 1 hingga 5. Variasi penambahan ekstrak jahe tidak mempengaruhi kadar air dan kadar serat *edible strips*. Kadar air menunjukkan kisaran 11% hingga 14% sedangkan kadar serat 4,5% hingga 5,5%. Suhu 30 °C dengan lama pengeringan 2 jam merupakan waktu dan suhu yang optimum pengeringan *edible strips* dalam menghemat biaya produksi dan konsumsi energi. Dengan hasil tersebut di atas, bioselulosa memiliki peluang dimanfaatkan sebagai *edible strip*.

Kata kunci: *Edible strips*, Bioselulosa, Ekstrak jahe, Uji hedonik

INTRODUCTION

Research on edible coatings and films has been intensely caried out in recent years because of their advantages over synthetic films for food applications. The main advantage of edible films over traditional synthetic packaging is their edibility which can be consumed with the products [1]. In addition, the films are produced exclusively from renewable, edible ingredients and therefore are anticipated to degrade more

readily than polymeric materials [1]. New sector for application of edible film is in the form of edible strips which have the matrix for conveniently holding and using nutrients, flavors and medicinal compounds such as breath fresheners. The slow-dissolving edible strips currently in use are typically produced from pullulan, sodium alginate, starches, carrageenans, gelatin, or combinations of these ingredients [2].

In this study, orally disintegrating or dissolving edible strips for use as a matrix for retaining and delivering nutrients, flavors and medicinal compounds are made from new liquid film casting compositions comprising a major proportion of biocellulose (BC). BC is a polysaccharide produced by bacterial action, *Acetobacter xylinum* and is employed in food industry as desert, which is famous as *nata de coco*. Several studies have investigated unique properties of BC attributed by the uniform ultrafine-fibre network structure and by the high planar orientation of the ribbon-like, namely porosity, crystallinity, and high mechanical properties [3-6]. Indeed, fragmented of BC fibers can readily be cast into film form [7]. This factor makes viable its potential use in edible film technology, in this case for dissolving edible strips.

The development of BC into edible strips products is a new field. The market for flavored film strips has potentially growth. Some industries have produced commercial edible strips, namely Watson, Inc., Tsukioka Film Pharma Co., Ltd., and Health essist Holding, Inc. Incorporating active ingredients creates a chance for expansion into new segments such as films with health benefits (e.g. breath fresheners, oral hygiene, vitamine and nutrient strips). Active ingredients can be added directly into the solution before the film being cast. These active ingredients become locked into the film matrix and remain stable until consumption.

The present study is directed to edible dissolving film of a material comprising BC in combination with lesser proportions of glycerol as plasticizers, *Carboxy Methy Cellulose* (CMC), aspartame for sweeteners, and active ingredient. As the active ingredient, ginger extract will be incorporated to give each strip the desired taste and aroma. The oleoresin is a volatile of ginger as brown liquid extracted from ginger root. Ginger (*Zingiber officinale* Roscoe) has been used as a spice since ancient times [8] and among others its carminative, diuretic, and expectorant properties are well known in medical research [9]. Ginger rhizomes contain both aromatic and pungent components responsible for its potent aroma and use in food and beverages, and these are mainly monoterpenoids such as geraniol, linalool and geranial [10]. Concentration of oleoresins in the dry rhizome ranges from 1.5 to 3% [11].

Despite the expansion in research of edible films, the amount of commercialization has not been as great as needed [12]. Rojas-Grau *et al*. [13] remarked in their review that most studies on food applications had been conducted at a laboratory scale. They suggested to study more in understanding the influence of active ingredients on the properties of edible films and coatings and focused on a commercial scale. Beside their microbial stability, adhesion, cohesion, wettability, and mechanical properties, sensory analysis is one of important properties in edible films and coatings [14]. Therefore, the purposes of this study were to develop dissolving edible strips from BC and to do sensory analysis based on consumer perspective. The evaluation was done using questionnaire to fifteen untrained judges. The attributes evaluated were: color, aroma, taste, and solubility. Prior to sensory analysis, the edible strips were characterized for their water and crude fiber content.

EXPERIMENTAL METHODS

Materials

Biocelluloce (BC) gel was purchased from local small medium enterprise in Cianjur, West Java. The gels were washed thoroughly in running tap water until their pH was neutral. Subsequently, the gels were boiled in 1% w/v NaOH solution for 1 h to remove its impurities and to eliminate bacterial cells. Finally, the gel-like pellicles were then washed again in running tap water until their pH was 7. Glycerol, *CarboxyMethyCellulose* (CMC), aspartame (food-grade), sulfuric acid, sodium hydroxide, and $NaHCO_2$ were purchased from Chemical Store in Bandung. Ginger root was purchased from local market in Bandung. To get the ginger extract, ginger root was washed, peeled, cut, homogenized and filtered.

Preparation of Edible Film

250 gr of BC gel was homogenized in 100 mL of distilled water. The slurry was kept in refrigerator for 24 hours and it was used to prepare the edible film. BC solution were made by mixing of BC slurry, 1.5% of CMC and 0.5% of glycerol under magnetic stirring for 30 min at 60 °C. Edible strips were prepared by mixing of ginger extract, BC solution, and aspartame (125 pm) under magnetic stirring at 60 °C until homogenous. To optimize the ginger concentration, addition of ginger extract was varied at the concentration of 20, 25, 30 and 35% of BC solution. After cooling, 0.1% of $NaHCO_2$ was added to adjust the pH. Then, the air bubbles in solution were removed by *ultrasonic cleaner.* Finally, the mixture was cast by spreader with 1 mm of thickness onto glass plate and allowed to dry in oven for 2 hours at 50 °C. After drying, the films were removed by manually peeling off, cut into one-inch squares, and stored in an airtight sealable bag at room temperature. In order to get the optimums drying condition, the drying temperature and time also varied for 2, 2.5 and 3 hours at temperature of 30, 40 and 50 °C.

Evaluation

Edible strips were evaluated visually. Then, treatments with 0.3N H_2SO_4 and 0.3N NaOH were performed to determine the percentage of crude fiber. Water content was determined by oven heating at 105 °C to constant weight. The initial weight and after-drying weight were recorded as W_i and W_f, respectively. The water content was calculated using the following equation:

$$\text{Water content (\%)} = (W_i - W_f)/W_i \times 100\%$$

Sensory analysis was conducted on edible strips based on BC. Fifteen students participated in this study as the consumers and were given a one-inch squares edible strip to be evaluated. They were asked to rate the quality of edible strips based on scale on Table 1 of color, aroma, taste, and solubility. The effect of ginger content and drying condition on the edible films was also evaluated by this test. The responses of the panellists with regard to their preference for the samples were averaged.

Table 1. Scale for each attribute in sensory analysis

Scale	Color	Aroma	Taste	Solubility
1	Light yellow	Not strong at all	Not hot at all	Not soluble at all
2	Light brown	Light strong	Light hot	Light soluble
3	Moderate brown	Moderate Strong	Moderate hot	Moderate soluble
4	Brown	Strong	Hot	Soluble
5	Dark brown	Very strong	Very hot	Very soluble

RESULTS AND DISCUSSION

Edible dissolving strips with the main proportion of Biocellulose (BC) have been prepared by casting method. Visually, the strips looked opaque with color of pale yellow. Incorporating ginger extract into BC solution enhanced the intensities of brown color of the strips (Figure 1). Ginger extract is able to penetrate into nanosize fiber of BC. This indicates that ginger extract is compatible with BC matrix. This observable fact is supported by the result obtained from sensory analysis.

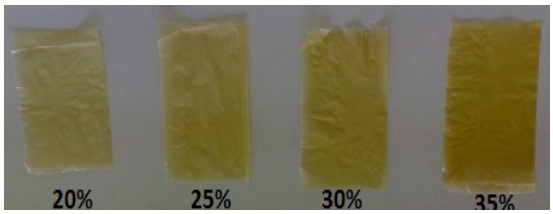

Figure 1. Optical photograph of edible strips as a function of ginger concentration.

Sensory analysis, which is one of the properties of edible strips, was conducted to fifteen students as the panelists. As shown in Figure 2, the result is in the middle value of each attribute. The panelists evaluated that the brown color of edible strips increased significantly as the function of ginger concentration where as solubility remained stable around 2.5 of 5-scale. On the other hand, the aroma and taste of edible strips only increase slightly corresponding to ginger concentration. However, addition of ginger extract to BC yielded edible strips with stronger aroma and more hot taste resulting in a pleasant sensation in the mouth. The browning color of edible film with increasing of ginger concentration is due to the essential oil as volatile oil content in ginger. Essential oil contained in

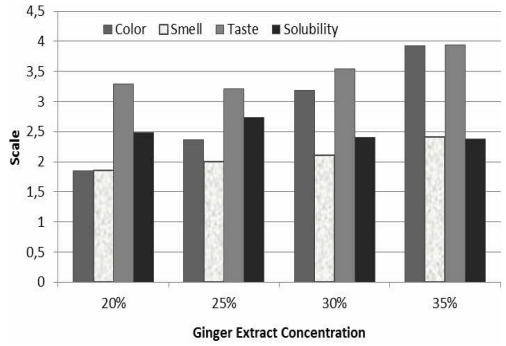

Figure 2. Sensory analysis of edible strips

ginger oleoresin also influences the aroma and taste of edible strips.

The solubility of edible film indicates that it would be dissolved quickly while it melts softly in the mouth. Addition of plastisizer increased water solubility. Glycerol modified the character of BC. It acts by decreasing intermolecular attractions between adjacent polymer chains by reducing hydrogen bonding between polymers chains [15]. Indeed, a small amount of glycerol added into the formula also to lower the brittleness, hence to prevent cracking upon drying process [16] and during handling and storage [15].

As can be seen in Figure 2, the panelists evaluated that the edible strips has moderate solubility, no dependency with the percentage of ginger extract. This is because the panelist felt some left over residue upon dissolving in the mouth. The residue comes from the fiber of BC, which is typical for polysaccharide-based edible strips [2]. However, the residue fiber is good for gastrointestinal health as well as lowering cholesterol.

In this study, it was observed that the crude fiber contents in edible films were about 4.5-5.5 %

Table 2. Crude fiber and water content of edible strips with variation of ginger extract concentration.

Ginger extract (%)	Chemical analysis	
	Fiber content	Water content
20	5.34	14.26
25	5.50	10.85
30	4.46	12.13
35	5.29	12.54

with ginger extract between 20 % and 35 % (Table 2). There is no significant difference in crude fiber content among the variation of ginger extract concentration. It is elucidating that crude fiber content is determined only by BC fiber.

When considering growth rates of microbial pathogen in food product, water is a critical consideration. Therefore, it is important to analyze the water content of edible strips. With the concentration of ginger extract between 20 % and 35 %, the resulted strips have water content ranging from 10.85 % to 14.26 %. No significant differences were observed among of the water content of edible strips corresponding to ginger extract concentration. The water content is affected by the relative humidity of the surrounding environment during storage time [17]. However, this small amount of water is needed to help dissolving the strips in the mouth.

Optimation of Drying (Temperature and Time)

In order to optimize the process, investigation of drying temperature and time was done by sensory analysis. With attributes of color, aroma, and taste, the characteristic of edible strips with variation of drying temperature and time as evaluated by panelists is shown in Figure 3. It is observed that the quality of aroma and taste of edible thin film have no significantly difference by variation of drying condition (temperature and time). However, there were slightly differences in the quality of color as a function of drying condition. Changing in color during drying process is due to drying of essential oil in ginger extract. Indeed, edible strips become browner and darker with increasing of drying temperature and higher rates evaporation of essential oil. From the result, drying temperature and time of 30°C and 2 hours, respectively were suggested to save the production energy and time.

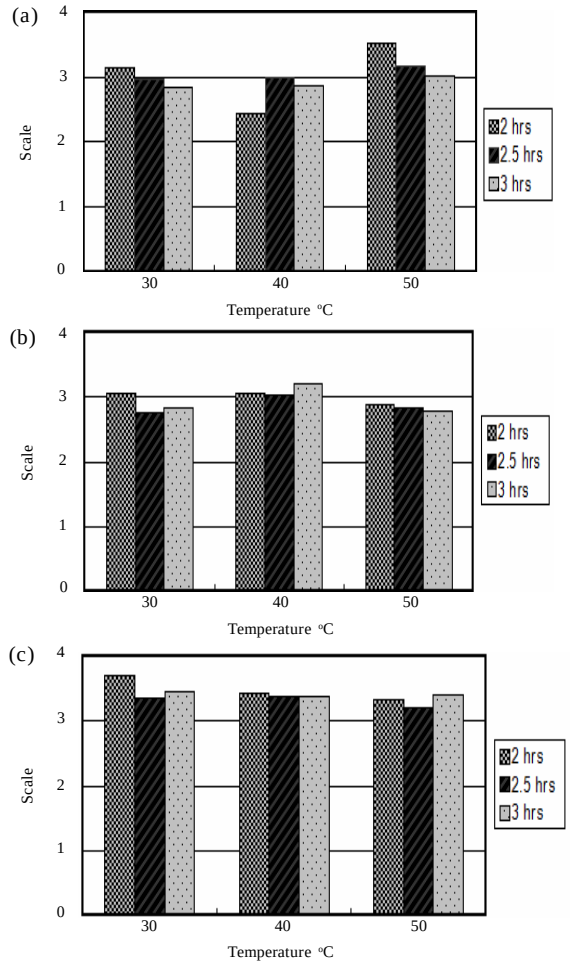

Figure 3. (a). Quality of Color, (b). Aroma and (c). Taste in Sensory Analysis as a Function of Drying Temperature and Time.

CONCLUSION

Orally dissolving edible strips have been made from Biocellulose (BC) with ginger extract as the active ingredient. Sensory analysis done by fifteen panelists revealed that incorporating ginger extract influenced the color of edible strips corresponding to ginger extract concentration. Addition of ginger extract also yielded edible strips with a pleasant sensation aroma and specific hot taste due to essential oil in ginger extract. However, there was no effect of ginger concentration in the solubility of the strips as well as their crude fiber and water content. The produced strips had left over residues that come from cellulose fiber with crude fiber percentage around 5 %. Water contents of 11 - 14 %were detected in edible strips and it is good to help the dissolving the strips in the mouth. To save production energy and time, 30°C and 2 hours were chosen as the drying temperature and time, respectively. Based on this result, BC has a prospect to be the matrix in edible strips.

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