SPIN 7 (1) (2025) 1-9

SPIN

JURNAL KIMIA & PENDIDIKAN KIMIA

https://journal.uinmataram.ac.id/index.php/spin

CHARACTERISTICS OF CHITOSAN-ALGINATE BASED FILM AS ACTIVE PACKAGING WITH THE ADDITION OF MORINGA LEAF EXTRACT (*Moringa oleifera* L)

Yupita Tri Rezeki*[1], Baiq Amelia Riyandari[1], Yahdi[1]

[1]Program Studi Tadris Kimia, Fakultas Tarbiyah dan Keguruan Universitas Islam Negeri Mataram, Mataram, 83116.

DOI: 10.20414/spin.v7i1.11800

History Article
Accepted:
November 22, 2024
Reviewed:
Feb 28, 2025
Published:
July 10, 2025

Kata Kunci:
Daun Kelor,
Kitosan Alginat,
Pengemas.

Keywords:
Chitosan Alginat, Film, Moringa oleifera.

ABSTRAK

Tujuan utama dari penelitian ini adalah untuk mengetahui pengaruh penambahan ekstrak daun kelor terhadap sifat fisik, sifat mekanik dan aktivitas antioksidan film kitosan alginat. Jenis penelitian yang digunakan pada penelitian ini adalah penelitian ekperimen (true eksperimen). Sedangkan pendekatan yang digunakan pada penelitian adalah pendekatan kuantitatif. Desain penelitian yang digunakan pada penelitian ini adalah rancangan acak lengkap (RAL) non faktorial dengan tiga kali pengulangan. Faktor yang diteliti adalah konsentrasi dari ekstrak daun kelor, konsentrasi ekstrak daun kelor (E) yang digunakan meliputi: E_1=0,5%, E_2=0,75%, E_3=1%. nilai yang diperoleh kemudian dianalisis menggunakan one way anova dengan aplikasi SPSS versi 16. Hasil penelitian pada karakteristik film berbahan dasar kitosan-alginat dengan penambahan ekstrak daun kelor (*Moringa oleifera L*) dapat disimpulkan bahwa: Perlakuan Penambahan ekstrak pada konsentrasi 0%, 0,50%, 0,75, dan 1% berpengaruh secara signifikan terhadap nilai ketebalan film dan aktivitas antioksidan. Semakin tinggi konsentrasi ekstrak yang ditambahkan maka ketebalan dan peresentase aktivitas antioksidan mengalami peningkatan. Sedangkan penambahan ekstrak pada konsentrasi 0%, 0,50%, 0,75, dan 1% tidak berpengaruh terhadap nilai kuat tarik, elongasi serta kelarutan film kitosan alginat.

ABSTRACT

The primary objective of this study was to investigate the impact of adding moringa leaf extract on the physical, mechanical, and antioxidant properties of chitosan-alginate films. The type of research employed in this study is experimental research (true experiment), and the approach used is quantitative. The research design used in this study was a non-factorial completely randomized design (CRD) with three repetitions. The factors studied were the concentrations of Moringa leaf extract, the concentrations of Moringa leaf extract (E) used included: E_1*=0.5%,* E_2*=0.75%,* E_3*=1%. The values obtained were then analyzed using one-way ANOVA with the application of SPSS version 16. The results of research on the characteristics of films made from chitosan-alginate with the addition of Moringa oleifera L extract can be concluded that: Treatment Addition of the extract at a concentration of 0%, 0.50 %, 0.75%, and 1% had a significant effect on the value of film thickness and antioxidant activity. The higher the concentration of the extract added, the thickness and percentage of antioxidant activity increased. While the addition of the extract at concentrations of 0%, 0.50%, 0.75%, and 1% had no effect on the tensile strength, elongation, and solubility of the chitosan alginate film.*

How to Cite

Rezeki, Y. T., Riyandari, B. A., & Yahdi. (2024). Characteristics of Chitosan-Alginate Based Film as Active Packaging With the Addition of Moringa Leaf Extract (*Moringa oleifera* L). *SPIN-Jurnal Kimia & Pendidikan Kimia*. 7(1). 1-9.

*Correspondence Author:
Email: yupitaaita03@gmail.com

p-ISSN: 2580-2623
e-ISSN: 2745-6854

INTRODUCTION

One of the leading causes of decreasing food quality is lipid oxidation (Patrignani et al., 2015). Lipid oxidation is the primary cause of damage to various types of food that contain fat or oil. This process can result in a decrease in the quality of a food product because it can cause changes in odor, taste, and color in food products (Siswoyo & Ardiyati, 2009). Lipid oxidation is a very complex free radical arrangement between fatty acids and oxygen that causes a decrease in quality, commonly known as rancidity (Mozuraityte et al., 2015).

One way to protect food products from the lipid oxidation process is by adding antioxidants. Commonly used antioxidants are synthetic antioxidants, such as BHA (butyl hydroxy anisole), BHT (butyl hydroxy toluene), and TBHQ (tert-butyl hydroxy quinone). The use of synthetic antioxidants has begun to receive negative responses from the public because it is suspected of being dangerous and potentially causing cancer. The use of natural antioxidants has begun to be developed and is increasingly in demand because it is believed to be safer for health (Pujawati et al., 2019).

One of the breakthroughs in the food sector is the use of active packaging (Sianturi, 2011). Active packaging is a type of packaging that is designed to modify the properties of the packaged food, extending its shelf life, improving safety, and enhancing sensory properties (color, taste, aroma, texture) to meet consumer desires better. One type of active packaging is to insert additional materials into the packaging to control the composition of the air around the product (Rosyid, 2012).

Active packaging materials that are still commonly used are chitosan and alginate. Chitosan is a natural polysaccharide obtained through deacetylation of chitin and is known as a biodegradable, relatively inexpensive, and non-toxic polymer. One technique to enhance the mechanical strength of a film is to combine cationic polymers (such as chitosan) and anionic polymers (such as alginate). KPE film (polyelectrolyte complex) is a term to describe a complex formed by combining cationic and anionic polymers. Cationic polymers that have been used are gelatin, chitosan, and polyethyleneimine (Sugita et al., 2017).

Chitosan has good mechanical strength because it has a negatively charged hydroxyl group (OH) and a positively charged amine group (NH_2), so that chitosan is able to bond ionically very strongly (Anward et al., 2013). Alginate is also a natural polymer, the result of brown algae extraction. Films made from alginate have weak mechanical strength, because alginate only has a negatively charged hydroxyl group so that the bonds between molecules are weak. While films from alginate have high hydrophilic properties. The hydrophilic properties of alginate cause films made from alginate to be able to absorb water molecules. Therefore, researchers combine chitosan-alginate as the basic material for making films because they can produce better mechanical properties than using chitosan alone.

In addition to having high mechanical properties, chitosan-alginate films have the disadvantage of having weak anti-free radicals. Therefore, it is necessary to add antioxidants so that the anti-free radical properties become strong. Antioxidant compounds are widely found in plants, one of which is the moringa plant. The active substances contained in the moringa plant function as anti-free radicals and antioxidant compounds such as various types of vitamins (A, C, E, K, B_1, B_2, B_3, B_6), flavonoids, alkaloids, saponins, tannins, and terpenoids (Kurniasih, 2019). A compound is said to be a very strong anti-free radical if the IC_{50} value is less than 10 μg/ml, strong if the IC_{50} value ranges from 10-50 μg/ml, moderate if the IC_{50} value ranges from 50-100 μg/ml, weak if the IC_{50} value ranges from 100-250μg/ml and inactive if the IC_{50} value is more than 250 μg/ml.

From the description above, researchers are interested in studying the characteristics of chitosan-alginate-based films as active packaging with the addition of moringa leaf extract (*Moringa oleifera* L). The addition of moringa leaf extract (*Moringa oleifera* L) is expected to provide information on the potential of moringa leaf extract (*Moringa oleifera* L) as an active ingredient in chitosan-alginate films.

METHODS

Materials

The materials used in this study were chitosan, alginate, glacial acetic acid, *Moringa oleifera* L. leaves, DPPH, filter paper, and distilled water.

Tools

The tools used in this study include hot plates, dropper pipettes, scales, watch glasses, ovens, desiccators, silica gel, vernier calipers, micrometer screws, stirring rods, measuring flasks, measuring cylinders, beakers, grinders, magnets, volume pipettes, and petri dishes.

Research Procedures

This study was conducted using a completely randomized design with three treatment levels of moringa leaf extract concentrations: 0.50%, 0.75%, and 1.00%.

Extraction

A total of 5 grams of Moringa leaf powder was weighed and extracted using the maceration method with aquades solvent. The ratio between the sample and water used was 1:5. Furthermore, the sample was extracted for 18-20 hours. Then the macerate obtained was filtered and collected.

Filmmaking

Alginate solution was made by dissolving 5 mg of alginate powder into 4 mL of distilled water and stirring it with a magnetic stirrer on a hot plate. Then added 20 mg of chitosan powder that had been dissolved in 2% glacial acid that had been diluted as much as 16 ml and continued stirring for 30 minutes. The KPE film solution was stirred using a magnetic stirrer for 24 hours. The KPE solution (12 ml) was poured into a 6 cm diameter petri dish and dried for 96 hours at room temperature (25o). The dried film was then stored.

Mechanical Properties Analysis

Mechanical tests were carried out using tensile testing, the test results of which were then used to determine the tensile strength and elongation of the active packaging produced.

Physical Properties Analysis

The physical properties analysis carried out consisted of thickness and solubility tests. The resulting film was measured for thickness using a screw micrometer with an accuracy of 0.01 mm. Thickness measurements were performed five times at different points for each sample. The thickness of each sample obtained was used as the average value of the five measurements. Meanwhile, the film solubility test was performed by inserting the film into a cup containing 10 mL of distilled water. Solubility in water is expressed as the percentage of the film that dissolves in distilled water after soaking for 24 hours.

Antioxidant Activity

The antioxidant activity test was designed to determine the active compounds in the extract that have antioxidant activity. The antioxidant activity of KPE chitosan alginate film incorporating moringa leaf extract was determined using a fixed reaction time method. The film containing moringa leaf extract was soaked in 25 mL of 96% (v/v) ethanol. A volume of 0.5 mL of the test solution was added to the DPPH radical solution (75 µM, 3.5 mL), then incubated in a dark place at room temperature (25 °C) for 30 minutes. A DPPH radical solution with 0.5 mL of ethanol solution (without moringa leaf extract) added to it was used as a control. At certain time intervals, the absorbance of the DPPH radical solution was measured at 517 nm using a UV-Vis spectrophotometer. Radical scavenging activity (RSA) is defined as the decrease in absorbance of the sample compared to the DPPH control solution.

Data analysis

The data analysis technique used in this study is the one-way ANOVA Test with a significance level of 5%. This study analyzes three variables, namely independent variables, dependent variables, and control variables.

RESULT AND DISCUSSION

Tensile Strength

A tensile strength test was conducted to determine the film's resistance, namely the maximum strain required to pull the sample until it breaks. Tensile strength is one of the most important mechanical properties of the film, as it enables the film to protect the packaged product from mechanical disturbances. The test was conducted with two repetitions for each sample. The tensile strength test results showed an increase. This can be seen in Figure 1, there is a difference in the average tensile strength of each concentration of Moringa leaf extract. The highest average value is shown in the E_3 film with an average of 28.445 MPa. While the lowest average value is shown in the E_0 film with an average of 16.625 MPa.

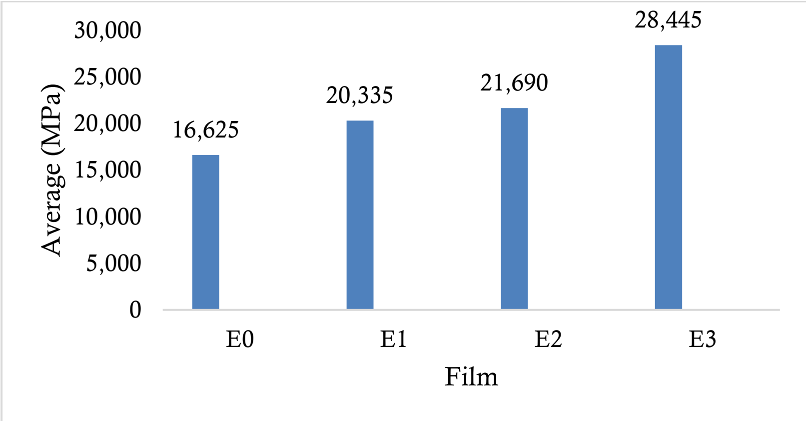

Figure 1. Tensile strength test results

The tensile strength test value shows an increase with increasing concentration of moringa leaf extract. Increasing the concentration of antioxidant compounds in the film composition will increase the tensile strength (Rachmawati, 2015). Moringa leaves have various active compounds, one of which is antioxidants (Rijai, 2012). Antioxidants have OH and OR groups that can bind well to polymers from chitosan and alginate (Purwaningsih, 2012).

Chitosan films with the addition of ginger extract tended to reduce the tensile strength of the film. The tensile strength value with the addition of 10% ginger extract was 1.455 (Estiningtyas et al., 2012). This shows that the addition of ginger extract concentration does not have a significant effect on the tensile strength of the film. This happens because the mechanical properties of the film depend on the strength of the material used.

Elongation Test

Elongation is the percentage of elongation that changes the maximum length received by the sample before the sample tears. The tensile strength value greatly affects the mechanical properties of the film; the higher the elongation value of a film, the higher its elasticity. Chitosan alginate film added with moringa leaf extract has a greater elongation value than the film without extract. The elongation test was carried out with two repetitions for each sample. The test results of the elongation test are shown in Figure 2.

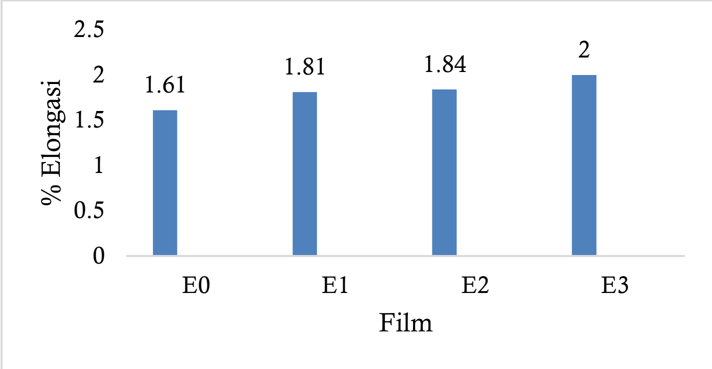

Figure 2. Variation of CaO/C mass on methylene blue concentration and percent degradation

As seen in Figure 2, the E_0 film without extract has the lowest value, which is 1.61%, while the highest value is found in the E3 film, which is 2%. This is because the mixture of chitosan alginate with a higher concentration can increase the percentage of elongation and flexibility of the polymer chain which causes the percentage of elongation to increase (Hayati et al., 2020). Based on the results of research conducted by Haidir on chitosan films with the addition of genjer extract, the highest percentage of elongation is found in films with the addition of 10% genjer extract concentration, while the lowest percentage of elongation is found in films without extract. The percentage of elongation of the film without extract (A_0) produced was 70.50%, 10% extract (A_1) was 63.66%, and 20% extract was 35.87%. This is influenced by the large amount of genjer extract added, which causes the film to become brittle (Ali et al., 2017). In a study conducted by Endang on the manufacture and characterization of avocado seed starch chitosan edible film, a low elongation value was obtained, which was around 2.5864% -17.2543% compared to using only chitosan. This is due to the addition of avocado seed extract, which makes the film brittle and not stretchable (Susilowati & Lestari, 2019).

Thickness Test

Thickness is a crucial parameter in determining the suitability of a film for food packaging, as it significantly affects the physical properties of the resulting film. It can be seen from Figure 3 that the highest value was obtained in the E_0 film without extract, which is 0.043 m, while the lowest value was obtained in the film with a concentration of 0.50%, 0.75%, and 1.00%, which is 0.041 m. The thickness of the film tends to decrease with the addition of Moringa leaf extract, which is due to a decrease in dissolved solids in the film solution, so that the resulting thickness decreases.

.

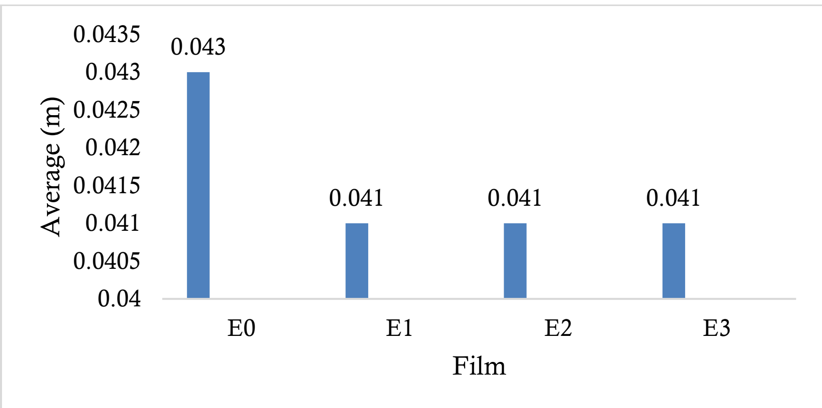

Figure 3. Thickness strength test results

Based on the results of previous research by May Kurnia Pratiwi (2017), the results of thickness testing using a screw micrometer obtained the average thickness of the chitosan membrane with the addition of 0%, 2.5%, 5% and 10% moringa leaf extract coating respectively are 0.110 mm, 0.116 mm, 0.113 mm, and 0.112 mm. The lowest thickness is on the chitosan membrane with 0% moringa leaf extract coating, which is 0.110 mm, and the thickest is 0.116 mm on the membrane with 2.5% moringa leaf extract coating. The less uniform thickness can be caused by the texture of the acetic acid chitosan solution formed with a ratio of 1:50 (Pratiwi, 2017).

Solubility Test

Solubility test is a parameter of a film that can dissolve, and also as a determinant of the biodegradable properties of the film used as a packaging material (Widodo et al., 2019). It can be seen in Figure 4 that the results of the solubility test, the greater the concentration used, the higher the percentage produced. The best solubility value was produced by the E0 film without extract of 29.44%, this is because the large concentration used in making the film affects the thickness produced, so that the film is easily dissolved.

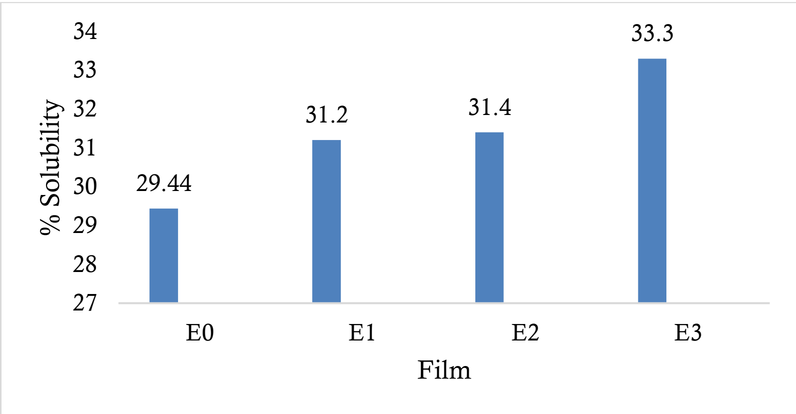

Figure 4. Results of solubility strength test

The results of Ade's (2019) research on the addition of chitosan to the characteristics of green tea kombucha films with four treatments, the best solubility test value was obtained from the P3 film of 49.408%. This is due to the large addition of concentration which causes the percentage of solubility produced to be more resistant compared to those not using green tea kombucha (Apriliani et al., 2019).

Antioxidant Activity

DPPH test is used to determine the percentage of antioxidant activity based on the concentration added to each treatment. Radical Scavenging Activity (RSA) is a substance like antioxidants that can help protect cells from damage caused by free radicals. The higher the percentage of RSA, the higher the antioxidant activity contained.

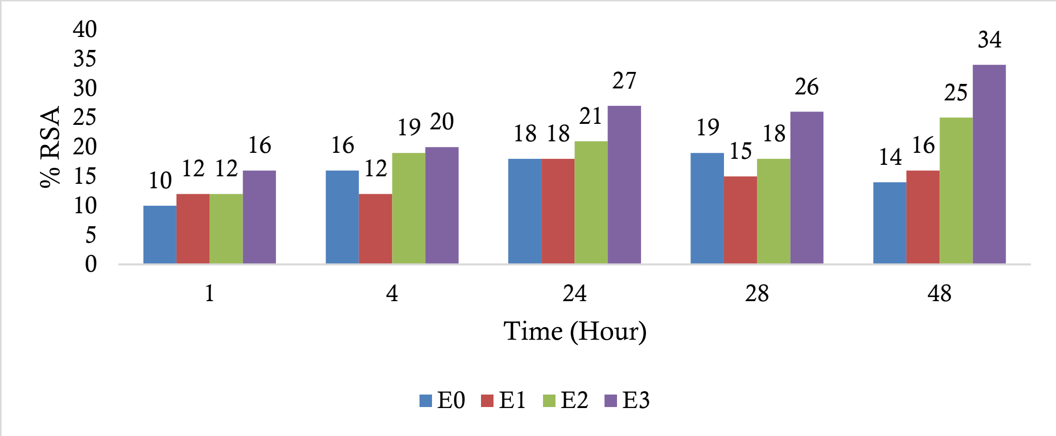

Figure 5. Results of antioxidant activity test

The presence of antioxidant activity from the sample causes a color change in the DPPH solution in ethanol which was initially dark purple to light purple. Figure 5 shows that the film without the addition of extract at 1 hour of immersion produces the smallest % RSA of 10% and the film with the addition of 1.00% extract produces the largest % RSA with immersion for 48 hours of 34%. This shows that the chitosan-alginate film has better antioxidant activity than one without the addition of extract (Adi Priyanto & Rimba, 2023). It can be concluded that the higher the concentration added, the stronger the inhibition of free radicals.

Based on previous research conducted by Nuraeni entitled Antioxidant and antibacterial activity of edible complex preparations of chitosan-mangrove fruit extract, it shows that the film without the addition of extract obtained the lowest IC_{50} value of 397.00 ppm and the film with the addition of 3% extract obtained the highest IC_{50} value of 98.00 ppm. It can be concluded that the addition of extract has better antioxidant activity than films without the addition of extract (Nuraeni & Sulistijowati, 2021).

CONCLUSION

From the results of research and discussion on the characteristics of chitosan-alginate-based films with the addition of Moringa oleifera L. leaf extract, it can be concluded that: Treatment Addition of extract at concentrations of 0%, 0.50%, 0.75, and 1% significantly affected the film thickness and antioxidant activity. The higher the concentration of the added extract, the greater the thickness and percentage of antioxidant activity. While the addition of extract at concentrations of 0%, 0.50%, 0.75, and 1% did not affect the tensile strength, elongation, and solubility of the chitosan alginate film.

REFERENCES

Adi Priyanto, R., & Rimba, F. (2023). Antioxidant Activity and Bioactive Compound in Mangrove Fruit (Rhizophora mucronata Lamk.). *Jurnal Ilmiah PLATAX*, *11*(2), 480–488. https://doi.org/10.35800/jip.v11i2.48758

Ali, H., Baehaki, A., & Lestari, S. D. (2017). Karakteristik Edible Film Gelatin-Kitosan dengan Tambahan Ekstrak Genjer (Limnocharis flava) dan Aplikasi pada Pempek. *Jurnal FishtecH*, *6*(1), 26–38. https://doi.org/10.36706/fishtech.v6i1.4449

Anward, G., Yusuf Hidayat, & Nur Rokhati. (2013). Pengaruh Konsentrasi Serta Penambahan Gliserol Terhadap Karakteristik Film Alginat dan Kitosan. *Jurnal Teknologi Kimia Dan Industri*, *2*(3), 51–56. http://ejournal-s1.undip.ac.id/index.php/jtkiTelp/Fax:

Apriliani, A. K., Hafsari, A. R., & Suryani, Y. (2019). Pengaruh Penambahan Gliserol dan Kitosan Terhadap Karakteristik Edible Film dari Kombucha Teh Hijau (Camelia Sinensis L.). *Proceeding Biology*

Education Conference, *16*(1), 275–279. https://jurnal.uns.ac.id/prosbi/article/view/38349

Estiningtyas, H. R., Kawiji, K., & Manuhara, G. J. (2012). The application of maizena-edible film with addition of ginger extract as natural antioxidant in cow sausage coating. *Biofarmasi Journal of Natural Product Biochemistry*, *10*(1), 7–16. https://doi.org/10.13057/biofar/f100102

Hayati, F., Dewi, E. N., & Suharto, S. (2020). Karakteristik dan aktivitas antioksidan edible film alginat dengan penambahan serbuk spirulina platensis. *Saintek Perikanan : Indonesian Journal of Fisheries Science and Technology*, *16*(4), 286–293. https://doi.org/10.14710/ijfst.16.4.286-293

Kurniasih. (2019). *Khasiat & Manfaat Daun Kelor Utk Penyembuhan Berbagai Penyakit*. Pustaka Baru.

Mozuraityte, R., Kristinova, V., & Rustad, T. (2015). Oxidation of Food Components. In *Encyclopedia of Food and Health* (1st ed.). Elsevier Ltd. https://doi.org/10.1016/B978-0-12-384947-2.00508-0

Nuraeni, N., & Sulistijowati, R. (2021). Aktivitas Antioksidan Dan Antibakteri Sedian Edible Kompleks Kitosan-Ekstrak Buah Mangrove Sonneratia alba. *Jambura Fish Processing Journal*, *3*(2), 51–59. https://doi.org/10.37905/jfpj.v3i2.10649

Patrignani, M., Conforti, P. A., & Lupano, C. E. (2015). Lipid oxidation in biscuits: comparison of different lipid extraction methods. *Journal of Food Measurement and Characterization*, *9*(1), 104–109. https://doi.org/10.1007/s11694-014-9215-2

Pratiwi, M. K. (2017). *Preparasi Membran Berbasis Kitosan dengan Penambahan Coating Ekstrak Daun Kelor (Moringa Oleifera) sebagai Antibiofouling* [Universitas Brawijaya]. https://repository.ub.ac.id/id/eprint/3704

Pujawati, R. S., Pujawati, R. S., Rahmat, M., Djuminar, A., & Rahayu, I. G. (2019). Uji efektivitas ekstrak serai dapur (cymbopogon citratus (dc.) Stapf) terhadap pertumbuhan candida albicans metode makrodilusi. *Jurnal Riset Kesehatan Poltekkes Depkes Bandung*, *11*(2), 267. https://doi.org/10.34011/juriskesbdg.v11i2.771

Purwaningsih, S. (2012). Aktivitas Antioksidan dan Komposisi Kimia Keong Matah Merah (Cerithidea obtusa) (Antioxidant Activity and Nutrient Composition of Matah Merah Snail (Cerithidea obtusa)). *ILMU KELAUTAN: Indonesian Journal of Marine Sciences*, *17*(1), 39. https://doi.org/10.14710/ik.ijms.17.1.39-48

Rijai, L. (2012). Beberapa Tumbuhan Obat Asal Kalimantan Timur sebagai Sumber Saponin Potensial. *Journal of Tropical Pharmacy and Chemistry*, *1*(4), 297–302. https://doi.org/10.25026/jtpc.v1i4.40

Rosyid, M. (2012). *Penyimpanan Buah Salak Pondoh (Salacca edulis Reinw.) Menggunakan Kemasan Aktif Penyerap Etilen* [IPB University]. https://doi.org/http://repository.ipb.ac.id/handle/123456789/149407

Sianturi, J. (2011). *Pengembangan kemasan aktif berbahan dasar kitosan dengan penambahan ekstrak bawang putih* [IPB University]. http://repository.ipb.ac.id/handle/123456789/47395

Siswoyo, T. A., & Ardiyati, T. (2009). Aktivitas dan Stabilitas Radical Scavenging L-Askorbil Palmitat Hasil Sintesis Secara Enzimatik. *Jurnal Teknologi Dan Industri Pangan*, *20*(2 SE-Research Paper), 124. https://journal.ipb.ac.id/index.php/jtip/article/view/1954

Sugita, P., Bintang, M., Achmadi, S. S., Pradono, D. I., Irawadi, T. T., & Siregar, H. A. (2017). *Segi Kimiawi dan Biokimiawi dari Sistem Pengantaran Obat*. IPB Press.

Susilowati, E., & Lestari, A. E. (2019). Preparation and Characterization of Chitosan-Avocado Seed Starch (KIT-

PBA) Edible Film. *JKPK (Jurnal Kimia Dan Pendidikan Kimia)*, *4*(3), 197. https://doi.org/10.20961/jkpk.v4i3.29846

Widodo, L. U., Wati, S. N., & Vivi A.P, N. M. (2019). Pembuatan Edible Film dari Labu Kuning dan Kitosan Dengan Gliserol Sebagai Plasticizer. *Jurnal Teknologi Pangan*, *13*(1). https://doi.org/10.33005/jtp.v13i1.1511